DEVELOPMENT OF INSTRUCTIONAL STRATEGY FOR TEACHING SCIENCE AT STANDARD V BASED ON THE THEORY OF MULTIPLE INTELLIGENCES

A

Thesis Submitted to

The Maharaja Sayajirao University of Baroda

for the Degree of

Doctor of Philosophy in Education

GUIDE

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CERTIFICATE

This is to certify that the work contained in this thesis entitled ***DEVELOPMENT OF INSTRUCTIONAL STRATEGY FOR TEACHING SCIENCE AT STANDARD V BASED ON THE THEORY OF MULTIPLE INTELLIGENCES*** *submitted by* ***Mr. Mogera Praful Premvadan*** *to the Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India for the degree of Doctor of Philosophy (Education) is a record of bona fide research work carried out by him under my supervision and guidance. The results embodied in the same have not been submitted elsewhere for the award of any degree or diploma. It is further stated that the doctoral research was carried out fulfilling the requisite attendance criteria as per O.Ph.D.:3(i) of the Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India.*

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TO WHOM IT MAY CONCERN

This is to certify that Mr. Mogera Praful Premvadan has joined NCERT Doctoral Fellowships w.e.f July 1, 2009. The fellowship has been provided to him for doing Doctoral work on the topic "Development of Instructional Strategy for Teaching Science at Standard V Based on the Theory of Multiple Intelligences" at the Centre of Advance Study in Education, M.S. University of Baroda. The tenure of the fellowship will be three years from the date of joining or the date of submission of Ph D thesis, whichever is earlier, subject to the fulfillment of terms and conditions of the fellowship as stipulated in letter No. F. 4-204/DERPP (AKS)/2009/302, dated 10th June 2009.

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INTRODUCTION

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1.1 Introduction

The prosperity and development of society and nation at large depends on education. The innovation in science and technology revolutionized human being's standards of living and also added many new dimensions to luxury and prosperity. Thus, it has made life comfortable. Education plays a key role in designing the place of country in global competitiveness. Scientists, engineers, technocrats, and researchers of physical, chemical and social sciences are the backbone of such rapid and continuous development. Higher Education particularly related to Science is in high demand for such positive change. School Education supplies input to Higher Education system. Elementary Education provides basic learning experience which should be rich and interesting for students at Elementary level. The Elementary Education is the incubation period for a student wherein his/her dormant abilities can be waken up and it is the right time to help students to learn science using hands-on experiences. The science-teacher should help students to learn and express their understanding in numerous ways. The formative period spent by students in Elementary Education emerges as the most influential variable in shaping interest of students. This interest should be maintained, and students should be motivated for learning science. The scientific bent of mind, raising questions to solve any problem, suspending judgments without prior evidences and experiences, generating various alternative solutions, and evaluating the solutions with respect to multiple dimensions of the problem are the most inevitable characteristics of learners in the 21st century. Students, teachers and society can develop such cognitive bent of mind only if the learning science finds its due regard by them. It is also important for teachers to put ardent efforts to raise scientific literacy among students at Elementary level. Standard V is the stage wherein students in Gujarat state encounter science subject for first time in life. The elementary science teacher has to be innovative in providing interesting, challenging experiences promoting thinking in students. The elementary science teacher must also have adequate content mastery and thorough knowledge about how students learn science at this stage. The science teacher practicing at Elementary Education should have knowledge of various growth and developmental periods of students including the multiplicity of intelligences. The teaching of science should not be confined as per the so-called intelligence quotient measured by the traditional psychological tests but the students should be better understood using the theory of multiple intelligences. It is, therefore, science teacher has to plan the learning experiences to accommodate wide variety of students' individual differences to ensure that all will have equal opportunity to grow and all will have chance to learn using various intelligences while teaching science. The subsequent sections of this thesis discusses the importance of teaching science and the theory of Multiple Intelligences propounded by Prof. Howard Gardner in the year 1983 and 1999 along with the implication of the same in the context of teaching of science at Elementary Education.

1.2 Theory of Multiple Intelligences (MI)

Distinguished Professor Howard Gardner worked on the concept of 'intelligence' for a long time. The origin of his work on expounding the concept of 'intelligence' tracked back to his pioneer work on brain damaged veterans at 'Boston VA Medical centre' and his study of children's mind under the project zero at 'Harvard's Graduate School of Education'. Fundamentally, Gardner (1999) contributed his seminal work to answer the three basic questions in the field of psychology: (1) Is intelligence just one? (2) Is intelligence primarily inherited? (3) Is there inherent prejudice in tests of intelligence?

In his vigourous exercises in comprehending the concept of 'intelligence', he attacked on the unitary concept of 'intelligence' as defined by the traditional psychologists, and raised a question for the appropriateness of measuring entire mental faculties in so-called quantitative measure such as IQ. Gardner (2004) narrated the incident of a girl taking examination and initiated the discussion that though the test of IQ predicts the success of the girl (or any one) in examination, it fails to predict for the success outside the school affairs. He expressed his idea that psychometric tests address only linguistic, logical with some aspects of spatial intelligence while the rest forms have been entirely ignored such as giving an extempore talk (linguistic) or being able to find one's way in a new town (spatial).

The traditional psychologists hold the view that all human problem solving is governed by general intelligence *'g'*. The concept of *'g'* failed to explain different rate of intellectual development among younger children in mastering language skills, drawing, mathematics, dance and other areas. The child prodigies typically excel in one or two areas rather than showing excellence in different areas which should not be, if *'g'* prevails. For instance, the autistic savants or stroke victims may have weak capacities across the board but some brain-damaged people can play music beautifully but they are severely impaired in their use of language. Such examples show the failure of centrality of *'g'*. Such scenario led Gardner to explain various mental abilities that support a wide range of adult roles found over time and across culture.

Gardner, thus, challenged the notion of general intelligence *'g'* and questioned the very basis of prevailing intelligence test by asking how an individual's intellectual capacities could be captured in a single measure of intelligence. He asserted that every one has a set of multiple abilities related to multiple numbers of domains of knowledge in a particular cultural setting. In doing so, he dared to violate the rule of English grammar and used the word 'intelligences' rather than using the word 'intelligence', 'talents', or 'abilities.' The theory of multiple intelligences refers to how one is smart rather than focusing on whether one is smart based on IQ test. In other words, the propounded theory of multiple intelligences by Prof. Howard Gardner came into picture in his book 'Frames of Mind' in the year 1983, which was criticized by the traditional psychologists. Prof. Gardner made it clear that his theory is always open in the light of new evidences and he is focusing the aspects of mental faculties in a comprehensive manner rather than viewing intelligence from the traditional lens of the psychologists.

Silver, Strong and Perini (2000) indicated that Gardner broke the tradition of IQ theory, which previously adhered to two fundamental principles: (1) Human cognition is unitary (2) Individuals can adequately be described as having a single, quantifiable intelligence. According to Gardner (1999), intelligence is "a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture."

In other words, intelligence as defined by Gardner can be mentioned as under.

- The ability to solve problems that one encounters in real life.
- The ability to generate new problems to solve.
- The ability to make something or offer a service that is valued within one's culture.

According to Gardner (1999), there are eight relatively independent types of intelligence that grow and develop differently in people depending upon their hereditary characteristics or environmental experiences operating upon it. The eight intelligences are theorized based on the criteria developed by Gardner (1983) which are discussed as under.

1.2.1 Criteria of Multiple Intelligences

Gardner (1983) worked upon the evidences based on the studies of prodigies, gifted individuals, brain-damaged patients, idiots savants, normal children and adults, experts in different lines of work, and individuals from diverse background of cultures. He devised specific eight different criteria for the abilities or mental faculty to be qualified as candidate intelligence. His criteria can be classified under four different heads such as biological sciences, logical analysis, developmental psychology, and traditional psychological research as mentioned by the Williams (2002).

The eight different criteria designed by Gardner (1983) for building the theory of multiple intelligences are described in brief as under.

(1) *The potential of isolation by brain damage.*

Gardner as a neuropsychologist was particularly interested in evidence that one candidate intelligence could be dissociated from others. He observed that patients having lesions to a specific area of the brain or impaired faculties due to brain injury but their other faculties remain intact and show capabilities to excel in other areas. He found out that the patients exist who have intelligence spared despite other damaged faculties or there are patients having impaired faculty while others have been spared.

He added that either pattern increases the likelihood that a particular intelligence has been discovered. Therefore, Gardner (1983) pointed out the relative autonomy among human faculties. He exemplified that both the separation of language from other faculties and its essential similarity in forms like oral, aural, written and sign indicates separate linguistic intelligence.

(2) *An evolutionary history and evolutionary plausibility.*

Gardner (2004) added that human species including all species display areas of intelligences (and ignorance). A specific intelligence becomes more plausible to the extent that one can locate its evolutionary antecedents, including capacities that are shared with other organisms. He gave example that discrete aspects of musical intelligence may well appear in several species but are only joined in human beings. Gardner (1999) further mentioned that most of the evidence came from either inferences about Homo sapiens and its predecessors or information about contemporary species. He added that early hominids had to be capable spatially of finding their way around diverse terrains. Mammalian species like rats also demonstrate highly developed spatial capacities. Evolutionary psychologists attempt to infer the selection pressures that led over thousands of years to the development of a particular faculty from the contemporary operations of human capacities. As per Gardner's view (1999), these studies give new plausibility to evolutionary accounts of such faculties as the intelligence which scrutinizes either the world of plants and animals or computes the motives of other species. Both above the criteria (1) and (2) are from the biological sciences.

From logical analysis, the two criteria derived are as under.

(3) *An identifiable core operation or set of operations.*

It attempts to define human intelligence as a neural mechanism or computational system which is genetically programmed to be activated by certain kinds of internally/externally presented information. Gardner (2004) exemplified that sensitivity to pitch relations and the ability to imitate movement by others as core of musical and bodily intelligences respectively. It is important to identify core operations to locate their neural substrate, and to prove that these "cores" are indeed separate. Analysis indicates linguistic intelligence calls for core operations related to phonemic discriminations, syntax, and sensitivity to pragmatic use of language. On the other hand, spatial intelligence demands the component operations: sensitivity to large scale, local, three and two-dimensional spaces.

(4) *Susceptibility to encoding in a symbol system.*

The use of spoken and written language, mathematical systems, charts, drawings, logical equations are different developed ways by people to communicate culturally meaningful information systematically and accurately. Gardner (1999) added that there are both societal and personal symbol systems with respect to each human intelligence that allow people to traffic in certain kinds of meanings. Therefore, humans isolate events and draw inferences about them that led to have developed linguistic and pictorial symbols to capture the meanings of events. Putting together, human brain seems to have evolved to process certain kinds of symbols efficiently. In other sense, symbol systems may have been developed precisely because of their pre-existing, ready fit with the relevant intelligence or intelligences.

From developmental psychology, (5) and (6) - criteria are drawn and discussed as under.

(5) *A distinct developmental history along with a definable set of expert "end-state" performances.*

Intelligence should have its own trajectory- an identifiable developmental history through which both normal and gifted individuals pass in the course of ontogeny. There may be different critical periods in the developmental history, linked either to training or to physical maturation. Gardner (1999) added that an individual do not exhibit intelligences "in the raw" but s/he does so by occupying certain relevant niches in the society by passing through an often lengthy developmental process. It indicates that intelligences have their own developmental histories. It means people who want to be mathematician must develop their logical-mathematical abilities in certain ways while other people must follow distinctive developmental paths to occupy certain positions in society. For example, clinicians have well-developed interpersonal intelligence and musicians have well developed musical intelligence.

(6) *The existence of idiot savants, prodigies, and other exceptional people.*

The savant shows stunning strength in particular area with other ordinary abilities or marked deficits. Some autistic children exhibit having outstanding performance in mathematics, drawing or music, or reproduction of melodies. But, they show marked impairments in communication and sensitivity to others. The prodigy is outstanding in a specific area and talents, but s/he is at least average in other areas. Prodigies are able to work effectively with much older people, but they may also have difficulty relating to their peers. The prodigies are experts in an area that draws on one or more intelligences. The examples of idiot savants, prodigies, and autistic persons who exhibit an area of stunning strength along with other ordinary abilities or even marked deficits lead one to observe the human intelligence in relative-isolation. Gardner (2004) indicated that the claim for a specific intelligence is enhanced if the condition of the prodigy or the idiot savant can be linked to genetic factors or to specific neural regions to the extent. He considered that autistic children or youngsters with learning disabilities provide a confirmation-by-negation of certain intelligences.

From traditional psychological research, the criteria (7) and (8) are drawn.

(7) *Support from experimental psychological tasks.*

Psychologists attempt to find out the extents of the relationship between operations involved in solving by assigning tasks to people. If one activity does not interfere with the other, it can be assumed that the activities draw on discrete brain and mental capacities. For example, people generally have no trouble while walking or finding way around while conversing as the intelligences involved are separate. On the other hand, people find difficulty in conversing or listening to a song with words while solving crossword puzzle. In this case, it indicates the two manifestations of linguistic intelligence are competing. As per Gardner (2004), to the extent that various specific computational mechanisms or procedural systems work together smoothly, experimental psychology can help to demonstrate the ways in which modular or domain-specific abilities may interact in the execution of complex tasks.

(8) *Support from psychometric findings.*

As per Gardner (2004), to the extent that the tasks that purportedly assess one intelligence correlate highly with one another and less highly with those that purportedly assess other intelligences, the credibility of his work is enhanced. He also added that to the extent that psychometric results prove unfriendly to his proposed constellation of intelligences, there is cause for concern. He indicated that intelligence tests do not always test what they are claimed to test. For example, many tasks actually involve the use of more than their targeted ability, while many other tasks can be solved using a variety of means such as certain analogies or matrices may be completed by using linguistic, logical, and / or spatial capacities.

Psychometric studies of spatial and linguistic intelligence suggest that these two faculties showing weak correlations. Gardner (1999) referred here the studies of social intelligences which have revealed a set of capacities different from standard linguistic and logical intelligences. Similarly, it is revealed that emotional intelligence, a new construct may well be independent of how one scores on the traditional intelligence-testing items.

Gardner's theory deals initially with seven different intelligences namely verbal-linguistic, logical mathematical, visual-spatial, bodily-kinesthetic, interpersonal and intrapersonal. He indicated that all the intelligences are relatively autonomous with reference to one another. Gardner (2004) stated that intelligences are not equivalent to sensory systems and mentioned that intelligence is neither case solely dependent on the single sensory system, and nor has any sensory system been immortalized as an intelligence. He went further on saying that intelligences are capable to be realized through more than one sensory system. Later on, Gardner (1999) added one more intelligence namely naturalistic intelligence in his list of the multiple intelligences. Thus, there are total eight different intelligences. According to Gardner (1999), emotional intelligence is the amalgam of the interpersonal and intrapersonal intelligence and Gardner (1999) does not add existential intelligence as the ninth one to the list of multiple intelligences.

Chapman and Freeman (1996) classified Gardner's multiple intelligences into three major groups: languages, object and person related. Linguistic and musical are classified as languages related intelligence. Logical-mathematical, visual-spatial, bodily-kinesthetic and Naturalist are classified as object related intelligence. The remaining two intelligences: inter- and intra- personal intelligence are grouped as person related intelligence.

As mentioned above, linguistic and musical intelligence has its own specific notations, symbols that are used to communicate the meaning and information successfully in interaction. Logical, visual-spatial, bodily-kinesthetic and naturalist intelligences are generally dealing with the objects such as logical for working with abstraction and a desire for exploration using inductive and deductive thought processes, visual for sculpture and artifacts of aesthetic appeal. The bodily-kinesthetic is based on the ability to manipulate objects with deftness and using bodily movements to do the task, and naturalist is dealing with the flora, fauna, rock and surroundings. Intra- and interpersonal intelligences are focused on a person's ability to communicate and ability to know one's strength and weaknesses and working accordingly to do the task respectively.

1.2.2 Description of Eight Multiple Intelligences

The pluralistic view of intelligence is fragmented into different heads and is described in brief as under.

- **Linguistic Intelligence**

  This gives rise to competencies related to linguistic intelligence. Lawyers, writers, storytellers, novelists, journalists, public speakers, comedians and poets widely use this intelligence. This intelligence involves the knowledge that comes through language, through reading, writing, and speaking involving understanding of the order and meaning of words in both speech and writing and a sense of proper use of language. It covers understanding of the socio-cultural nuances of a language, including idioms, plays on words, and linguistically based humour.

- **Logical - mathematical Intelligence**

  It is composed of components like deductive and inductive reasoning, including solving of logical puzzles, doing calculations and the like. This intelligence uses numbers, mathematics, and logic to find and understand various patterns. It begins with concrete patterns in the real world but gets increasingly abstract as we try to understand relationships among patterns. It makes one capable to perceive relationships and connections, and to use abstracts, symbolic thought.

- **Visual - spatial Intelligence**

  Many of us knowingly or unknowingly make use of visual-spatial intelligence in day-to-day life which requires the abilities and skill involving the representation and manipulation of spatial configuration and relationship. This intelligence covers sensitivity to colour, line, shape, form, space and relationship among these elements. Painters, land surveyors, architects, engineers, mechanics, navigators, sculptors and chess players generally use this type of intelligence.

- **Musical Intelligence**

  The works of professionals like singers, musicians, composers and instrumentalists demonstrate the use of musical intelligence who are smart enough in pitch discrimination, sensitive enough to rhythm, texture and timbre**.** This intelligence covers the sounds of world, environmental and musical, and one's awareness, enjoyment and ability to use these sounds.

- **Bodily - kinesthetic Intelligence**

  This is basically related with abilities, talents and skills to perform skillful and purposeful movements. It encompasses the capacity to manipulate objects and use a variety of physical skills. This intelligence requires sense of timing and the perfection of skills through the union of mind and body. Generally, dancers, gymnasts and athletes widely use this intelligence.

- **Intrapersonal Intelligence**

  Intrapersonal intelligence includes the capacity to understand oneself. This intelligence helps one to know one's strength and weaknesses. It enables to have an effective working model of oneself covering one's own desires, fears, and capacities. It enables person to use self knowledge effectively in regulating his/her life. Intrapersonal intelligence is evident in psychologists, spiritual leaders, philosophers.

- **Interpersonal Intelligence**

  Interpersonal intelligence encompasses the ability to understand the intentions, motivations, and desires of other people. Thus, it helps one to work effectively with others. The interpersonal intelligence includes sensitivity to facial expressions, voice, gestures. It encompasses the capacity to discriminate different kinds of interpersonal cues and the ability to respond effectively to them. Generally, Interpersonal intelligence is highly developed in teachers, therapists, politicians, and religious leaders.

- **Naturalist Intelligence**

  Naturalist intelligence includes the ability to understand, discern and appreciate different kinds of flora and fauna of nature. It covers the capacities such as recognizing and classifying species, raising/taming animals, and growing plants. It also involves curiosity to know about the natural worlds, its creatures, and weather patterns. Generally, farmers, hunters, gardeners, zookeepers, nature guides, forest rangers widely make use of naturalist intelligence.

1.2.3 Key and Subabilities of Multiple Intelligences

Baum, Viens and Slatin (2005) mentioned the key and sub abilities of intelligences as under.

1. Key Abilities of Linguistic Intelligence

- Involves perceiving or generating spoken or written language.
- Allows communication and sense making through language.
- Includes sensitivity to subtle meanings in language.

a. Subabilities

- Expressive language
- Invented narrative or storytelling
- Descriptive/instructional language
- Reporting
- Poetic use of language
- Wordplay

b. Linguistic Intelligence is NOT-

- Bilingualism (but might include facility in learning languages)
- Being talkative / liking to talk

2. Key Abilities of Logical-mathematical Intelligence

- Enable individuals to use and appreciate abstract relations.
- Includes facility in the use of numbers and logical thinking.

a. Subabilities

- Numerical reasoning (calculations, estimations, quantification)
- Logical problem solving (focusing on overall structure and relationships, making logical inferences)

b. Logical-mathematical intelligence is NOT

- Oriented only to numbers (it also includes non-numerical logical relations)

3. Key Abilities of Musical Intelligence

- Involves perceiving and understanding patterns of sound.
- Includes creating and communicating meaning from sound.

a. Subabilities

- Music perception
- Music production
- Composition or notation

b. Musical Intelligence is NOT

- Engaged by playing background music

4. Key Abilities of Visual-spatial Intelligence

- Involves perceiving and transforming visual or three-dimensional information in one's mind.
- Allows for re-creation of images from memory.

a. Subabilities

- Understanding causal or functional relationships through observation
- Use of spatial information to navigate through space
- Sensitive perception or observation of visual world and arts
- Production of visual information or works of art

b. Visual-spatial Intelligence is NOT

- Necessarily visual (blind people need excellent spatial abilities)

5. Key Abilities of Bodily-kinesthetic Intelligence

- Allows use of one's body to create products or solve problems.
- Refers to the ability to control all or isolated parts of one's body.

a. Subabilities

- Athletic movement
- Creative movement (including responsiveness to music)
- Body control and fine motor abilities
- Generating movement ideas (as in choreography)

b. Bodily-kinesthetic Intelligence is NOT

- Necessarily demonstrated by a physically active child
- Unstructured release of energy through physical activity

6. Key Abilities of Interpersonal Intelligence

- Is a sensitivity to the feelings, beliefs, moods, and intentions of other people.
- Involves the use of that understanding to work effectively with others.
- Includes capitalizing on interpersonal skills in pursuit of one's own ends.

a. Subabilities

- Assumption of distinctive social roles (e.g., leader, friend, caregiver)
- Ability to reflect analytically on the social environment or other people
- Taking action (e.g., political activist, counselor, educator)

b. Interpersonal Intelligence is NOT

- A preference for working in a group
- Being well-liked
- Being polite
- Possessing "social graces"
- Being ethical or humane

7. Key Abilities of Intrapersonal Intelligence

- Enables individual to form a mental model of themselves.
- Involves drawing on the model to make decisions about viable courses of action.

- Includes the ability to distinguish one's feelings, moods, and intentions and to anticipate one's reactions to future courses of action.

a. Subabilities

- Self-understanding
- The ability to self-reflect analytically
- Articulating that understanding through other types of expression or intelligences (poetry, painting, song, etc.)
- Using that self-knowledge well toward personal or community goals.

b. Intrapersonal Intelligence is NOT

- Preferring to work alone and /or in isolation

8. Key Abilities of Naturalist Intelligence

- Includes the ability to understand the natural world well and to work in it effectively.
- Allows people to distinguish among and use features of the environment.
- Is also applied to patterning abilities.

a. Subabilities

- Observational skills
- Pattern recognition and classification
- Knowledge of the natural world
- Employing that knowledge to solve problems and fashion products (e.g., farming, gardening, hunting or fishing, cooking)

b. Naturalist intelligence is NOT

- Limited to the outside world

1.2.4 Brief Summary of Theory of Multiple Intelligences

Chapman and Freeman (1996) summarized the theory of multiple intelligences which is mentioned as under.

1. There is more than one intelligence.

There are at least eight intelligences qualified as per the eight criteria till date. The theory of multiple intelligences indicates that intelligence originates biologically.

2. Intelligences are educable.

Individual can work upon his/her weaknesses and strengths for further improvement and enrichment. This development process encompasses four stages such as: (1) exposure that activates senses, (2) the opportunity to explore and strengthen an intelligence, (3) formal training of the intelligence through guidance of teachers and parents, and (4) the "embrace" or the mastery of the intelligence.

3. A brain is as unique as a fingerprint.

The theory of multiple intelligences does not indicate that intelligence is purely genetic and inherited though it claims a biological basis of intelligence. It suggests that each person is born with all intelligences and possesses unique profiles of intelligences. These intelligences are developed through life's journey of learning, experiences, opportunities, influences, and schooling.

4. Intelligences are forever changing throughout life.

Teacher must believe that every learner can learn but they must also have willingness to learn. The learner has to be stimulated and motivated to learn and internalize new knowledge and skills.

The multiple intelligences as theorized by Gardner leads educators to understand learners with wide variety of strengths in different areas of intelligences: linguistic, logical, visual-spatial, interpersonal, intrapersonal, bodily-kinesthetic, musical and naturalist. The theory of multiple intelligences indicates that learner's strength should not be narrowly defined but teacher should try to activate students' intelligences by providing different curricular inputs.

1.3 Importance of Science Education

The subject of 'Science and Technology' is included at Elementary level in School Education with unique purposes. The world is in the era of 21^{st} century wherein globalization has brought numerous changes in mankind's life. The logic behind inclusion of Science and Technology subject at Elementary level is to emphasize the need and importance of Science and Technology in one's life so that an individual will be able to take decisions wisely. The role of Science and Technology subject at primary level is to develop scientific understanding in learners. Such able learner will be able to solve problems appropriately.

According to Harlen (2011), the contribution of Science Education is to

- Sustain and develop curiosity and a sense of wonder about the world around.
- Provide information that can lead to understanding which helps decision-making about matters related to health, diet, lifestyle, etc.
- Enable informed participation in debates about major issues such as environmental preservation, genetic engineering and the use of energy.
- Give access to ways of investigation and enquiry that are based on evidence and careful reasoning.
- Provide satisfaction in finding answers to questions through one's own mental and physical activity.

Harlen's views on contribution of Science Education evidently mention the multiple facets of the nature of science and its importance in developing thinking, enquiry and problem solving skills to gather and evaluate evidences. It also suggests the importance of Science Education to enable students to respond current issues pertaining to environment, genetic engineering and energy scientifically.

According to Roden and Ward (2005), the major purpose of Science Education is not only to produce well-qualified scientists but also to produce well-balanced individual members of society. NCF (National Curriculum Framework) (2005) views science as a dynamic, expanding body of knowledge which covers ever-new domains of experience. It also hopes that science can play a truly liberating role, helping people escape from vicious cycle of poverty, ignorance and superstition. This suggests that teacher has to teach science in a way that helps learner to acquire scientific bent of mind to take up suitable decisions and to learn employability skills. It also indicates major role of Science Education in developing country in India to bring socio-cultural and technological changes for welfare of people.

Alsop and Hicks (2003) discussed below mentioned reasons for need of Science Education.

- Knowledge and understanding of science helps pupils in making sense of natural phenomena.
- Knowledge and understanding of science and of the ways scientists work can help pupils understand basis for decisions in an increasingly technological world.
- Through science, pupils can develop investigative and practical skills which can help them to solve problems.
- Science is interesting and intellectually stimulating.
- Science is an important part of contemporary culture, and is relevant to and has implications for people of all nations.

The reasons mentioned by Alsop and Hicks (2003) indicated that Science Education is the need of hour due to increased complexity of the technological world which governs the day-to-day life of the human beings. Besides, nature of science itself makes its inclusion in curriculum imperative to nurture and develop investigative, critical, logical, problem-solving, and decision-making skills. It is apparent that learning science is of value to learners as it is interesting and develops multiple mental faculties. Another important reason is the fabrication of science in our culture so that learning science will help learners to derive its implications in daily lives. The individual familiar with the science and technology will be able to work efficiently. The investigative and research skills learnt during learning science will empower learner to employ the same to understand the problems and s/he will become able to generate workable solutions to a problem.

It is observed that science has been viewed as necessity for the young generation to cope with challenges and problems in one's life. One of the aims of teaching of science is to educate the young generation with the investigative and practical skills so that they will be able to take wise decisions. Science has been considered as a part of the culture and the need is felt that the young generation must have an understanding of the surrounding world based on science so that they will be able to contribute positively to build up healthy atmosphere in society.

1.3.1 Objectives of Teaching of Science at Primary Level

According to Settlage and Southerland (2007), the goal of science teaching has moved away from a single-minded pursuit of assembling a new generation of scientists and opined that it is inappropriate strategy to teach science only to produce scientists. Science teaching focuses on helping students become scientifically literate and to help them develop useful and applicable understanding of science. Both the authors recognize that those individuals who have greater skills and stronger understanding of science will have more control over the choices they make about their lives.

Teaching of science seeks basic guidelines from the objectives of teaching science. The objectives of teaching any subject provide the outline to teach. It seeks to explain what to teach and why to teach. The general objectives of teaching science at Primary level (Standard I to V) provided by NCERT in 'National Focus Group on Teaching of Science' in the year 2006 are as under.

- To arouse curiosity about the world (natural environment, artifacts and people).
- To engage in exploratory and hands-on activities that leading to the development of basic cognitive and psychomotor skills through language, observation, recording, differentiation, classification, inference, drawing, illustrations, design and fabrication, estimation and measurement.
- To internalize the values of cleanliness, honesty, co-operation, concern for life and environment.
- To emphasize language development through and for science learning.

The 'National Focus Group on Teaching of Science' by NCERT (2006) for primary stage (Class I to V) denoted,

"The pedagogy should essentially be based on the activities in and out of classroom, as well as other methods such as stories, poems, plays and other kinds of group activities………Activities should allow free exploration, seeing patterns, making comparisons and understanding the web of relationship."

The ‘National Focus Group on Teaching of Science’ by NCERT (2006) emphasizes creative expressions of the students in non-formal ways both in and out of school activities, on practical work, on developing elementary technological modules, on surveys of biodiversity, health and other aspects of environment. It also stressed to include the exploratory and imaginative activities.

This shows that objectives of teaching science primarily focus on the development of interest and curiosity towards science. The objectives of teaching of science also focus on discovery of the basic processes embedded in the natural phenomena and the day-to-day life by hands-on experiences. In addition to that, teaching of science also centres its attention to the nurturance and development of values such as cleanliness, honesty, co-operation, concern for life and environment.

1.3.2 Science Process Skills

Science educators have been discussing science both as a product and process. The nature of science is as such it requires inquisitiveness to explore. During the process of exploration while learning science, learners require skills to investigate objectively. The results thus, obtained need to be verifiable and reproducible in the same conditions. The investigation in science requires patience and step-by-step implementation of various mental operations. Such mental operations are clubbed as a particular set of behaviour and termed as science process skills.

Harlen and Elstgeest (2008) referred process skills as the route by which children explore and gain evidence which they use in developing ideas. Both the authors further concluded that if children do not interact with things in a scientific way using process skills rigorously, then the ideas they form may not be scientific in the sense of not really fitting the evidence. Hammerman and Musial (2008) considered process skills of science are the ways of thinking and acting used by scientists in their work. As per Hammerman and Musial (2008), observation, classification and prediction skills are used on a basic level wherein the thinking skills of hypothesizing, controlling experimental variables, and drawing conclusions are of a higher level. Bentley et al (2007) mentioned observation, inference, classification, communication, measurement, and prediction as the basic science process skills. Martin et. al. (1998)

classified science process skills into two major groups: Basic skills and Integrated Skills. The basic science process skills involve observation, classification, communication, measurement, estimation, prediction, and inference. The integrated skills involve identifying, controlling variables, defining operationally, hypothesizing, experimenting, graphing, interpreting, modeling, and investigating. The process skills are discussed in brief as under.

1. Observation

It is fundamental scientific skill and the first step of scientific investigation which leads learner to infer valid conclusions. Settlage and Southerland (2007) mentioned that varied ways of observing such as seeing, tasting, touching, listening and smelling are important to help students to build a more complete understanding of experiences. The shortcuts such as "jumping" to the conclusion without systematized and detailed observation have no place in journey of scientific exploration which can be taken care by "observing" and not "seeing." According to Trojcak (1979), the entire scientific is built on the skill of observing and mentions that all attempts to gain information about objects or events begin by observing. Wolfinger (1984) defined observation in line with Trojcak's view, as the ability to observe accurately without making judgments from observations made at first and identified this as the most basic of all science processes.

Young (1994) mentioned observation may include all the senses namely seeing, hearing, feeling, tasting, and smelling. Bentley et. al. (2007) also referred observation as the use of one's senses to perceive objects, events, their properties, and behaviour. Observation feeds the process of meaning making. According to Gega (1977), a child is said to be observing when he:

- Identifies such properties of objects as colour, size, and shape by using any or all of the senses.
- States noticeable changes in objects or events.
- States noticeable similarities and differences in objects or events.

Settlage and Southerland (2007) denoted that observation should focus on telling "what it is'', and "how it is", but not "why it is". Observation should be free from bias. It means that observation should not be messed by one's own prejudices and opinions to approach objectivity.

2. Measurement

Bentley et al (2007) mentioned measurement as the act of using numbers to describe objects or events. It involves a specific form of observation called quantitative observation. As per Young (1994), measurement is concerned with the kinds of comparisons such as size of objects, areas, speeds, weights, temperatures and volumes… and so on. Trojcak (1979) referred measurement as the comparison of one physical aspect of an object or event with a standard unit. Gega (1977) mentioned child is measuring when he:

- Uses such standard tools as the meter stick, yard stick, ruler, clock, balance, and protactor to find quantity.
- Uses familiar objects as arbitrary units to find quantity.
- Makes scale drawings or models.
- Uses simple sampling and estimating techniques.

Settlage and Southerland (2007) described "measuring" as a special type of quantitative observation and provide the reason that some tools are required to measure which assist one's observation.

3. Classification

Trojcak (1979) considered classification a complex learning activity that embraces subordinate skills and in which objects and phenomena are grouped according to their common characteristics. Wolfinger (1984) defined classification as the ability to place objects into groups on the basis of the characteristics that those objects either do or do not possess. Young (1994) mentioned recognition of properties and ordering are skills which can be grouped together under the process of classification. Bentley et al (2007) referred classification as the act of grouping objects or events into categories based on specified characteristics or attributes. According to Gega (1977), a child is classifying when he:

- Groups objects or events by their properties or functions.
- Arranges objects or events in order by some property or value.

Settlage and Southerland (2007) mentioned “classifying” as the process of organizing objects into groups based on observable properties. One comes to identify the patterns that are not apparent at first sight when objects are viewed as a large group. According to Settlage and Southerland (2007), one should not use a single property to subdivide a group into more than two subgroups.

4. Inference

According to Gega (1977), process of inferring is interpreting, or drawing a conclusion from what one observes. Wolfinger (1984) defined inference as an interpretation of the observations one makes during an activity or experiment and pointed out that inference may also be thought as a statement showing a relationship among the parts of a system and frequently detailing cause-and-effect relationship. Young (1994) mentioned that scientists work like detectives. Scientists gather as much as information, think critically and do not make blind guesses. He makes an inference which fits all the information he has at the time. It may not be his final inference but it is an acceptable one for the moment. Bentley et al (2007) referred inference as the act of making statements that attempt to explain or interpret objects or events that are based on observations. Students may need help in distinguishing between observations and inferences. According to Gega (1977), a chid is inferring when he:

- Distinguishes between an observation and an inference.
- Interprets recorded data.
- Interprets data received indirectly.
- Predicts events from data.
- Hypothesizes from data.

Settlage and Southerland (2007) defined the term "inferring" as developing an explanation based on and supported by valid observation. Settlage and Southerland (2007) further added that inferences are not the facts but opinions based on supporting facts while judging the inference made.

5. Prediction

Young (1994) mentioned scientists foretell or predict events of the future. They make use of their present observations or measurements to predict which is the first step towards understanding and control of the environment. As per Wolfinger (1984), prediction is a special form of inference that attempts to determine on the basis of data collected that what will happen in future and stressed prediction is not a guess. A reason is given that prediction must have a sound foundation in data that has been collected or in background experiences. Settlage and Southerland (2007) defined "predicting" as making a statement that forecasts what will happen in future and further added that goal of prediction is not to make a "good prediction" simply but to find patterns that allow us to decide whether our observations and the inferences we made from these observations make sense. Prediction process skill is different from "guessing" altogether as one relies on the patterns that one has observed or even measured while predicting. On the other hand, "guessing" has not always much basis for the statement guessed.

6. Communication

Young (1994) viewed communication as a two-way skill in which a scientist has to read what other scientists have written. It includes making of a table, graph or histogram, drawing, diagram or model as he needs to share his idea with other scientists. Wolfinger (1984) defined communication as means for passing information from one individual or group of individuals to others wherein pictures, work sheets, models, movement, oral and written communication have been used. Bentley et al (2007) mentioned communication as transmission of information from one person to another by verbal or nonverbal means by which people interact and share ideas. According to Gega (1977), communicating means as putting of the data (information) based on observations into some form. Gega (1977) further mentioned that a child is said to be communicating when he:

- Defines words operationally (through some action) when needed.
- Describes accurately objects or events.
- Makes accurate charts and graphs.
- Records data accurately as needed.
- Constructs accurate exhibits and models.
- Draws accurate diagrams, pictures, and maps.

The communication process skill includes written text, drawing, models, the verbal inferences and measurements in the form of graph as explained by Settlage and Southerland (2007).

1.3.3 Importance of Science Process Skills in Learning Science

The science process skills help learners to learn science systematically and develop the logical bent of their minds. The process skills-based inquiry helps learners to understand concepts easily and engages their various mental faculties.

Trojcak (1979) mentioned the importance of process skills as under.

1. Process skills trigger assimilation and accommodation and thus they facilitate learning.
2. Process skills equip learners with the tools of making sense out of chaos, and order out of disorder. Learners become able to make continual discoveries.
3. Process skills lead to new awakenings, explorations and revelations.
4. The use of process skills enables learner to move from "I don't get it", a state of being bothered to a state of "I've got it". Successful use of process skills regulates learning and motivates learners.

Science process skills provide the framework for development of children's thinking. Observation and measurement are the backbones or vertebral column which serves as the support systems. The process skills distinguishing spatial and temporal relationships, classifying and communication are like the ribs which are closest to the heart and breath of scientific endeavours. The skills such as inference, prediction, hypothesizing, controlling of variables, interpreting data and defining operationally are similar to the appendages. They enable a learner to move forward. Experimenting incorporates the most logical operations. It is like the skull which houses the brain. If the backbone is weak; the rest of the skeletal system is affected. (Trojcak (1979))

Martin et al (1998) mentioned basic science process skills which help children to expand their learning through experience. Learners begin with simple ideas and then these ideas compound and from new and more complex ideas. They further added that emphasis on science process skills help children to discover meaningful information and accumulate knowledge by constructing understanding within and beyond the science classroom. Ward and Roden in Ward et al (2005) mentioned that children's process skills are limited and unsystematic which are characterized by trial and error exploration. Young children make use of simple individual process skills all the time during their exploration of the world and these individual skills become more important in their formal education later on. Therefore, the teacher should develop the process skills in children. So, when children get older, they will able to approach the exploration of the world in a more systematic, organized and meaningful way. Ward and Roden in Ward et. al. (2005) suggested that the teacher should identify individual process skills and provide opportunity to pupils to practise each skill that make up procedural understanding. A Position Paper on Teaching of Science by NCERT (2006) also emphasized that there should be enough time and space for teachers and students to plan experiments, discuss ideas, critically record and analyze observations. It means that there should be enough room for students to have hands-on experiences, recording observations and reflecting on them using process skills.

Settalage and Southerland (2007) described four benefits of process skills: Sense-Making Tools, Supporting Language Development, Creating a Community of Learners and Fostering Natural Curiosity.

1. **Sense-making Tools**

   It is argued that frequent and increasingly challenging use of the science process skills support students in developing their efforts and scientific inquiry. The students became less dependent on the teachers, more skilled and confident with science and they start to make connections for themselves.

2. **<u>Supporting Language Development</u>**

   It is mentioned that use of science process skills engage students to discuss with others. They need to communicate well with other students to describe their ideas and what they have observed. They need to use descriptive words and ideas which create the need to find specific and elaborate ways of language.

3. **<u>Creating a Community of Learners</u>**

   The use of process skills by students help them to create a community of learners as they are working with materials using their ideas which they share with others. The process of learning includes exchange of information wherein explanation is ventured and understanding is negotiated. Collective efforts to understand science make the class less dependent on teachers and students participate actively.

4. **<u>Fostering Natural Curiosity</u>**

   It is mentioned that when people are attracted by equipment or an artifact from the natural world, the challenge of motivating them is almost saved. The active use of process skills in learning science will kindle curiosity in students for learning new things and exploration. The students will be motivated when they explore by their own efforts using process skills.

Gregory and Hammerman (2008) mentioned process and thinking skills as sets of behaviours and ways of thinking that students use to construct understanding. The process skills and thinking skills are tools for learning as they engage students both physically and mentally in the learning process. Both the authors further added that instruction rich in sensory input and opportunities to use and develop process and thinking skills and strategies is critical for developing important concepts and principles in science. The students develop clearer understanding. They create new and more elaborative mental modes of knowing when they make sense of what they experience.

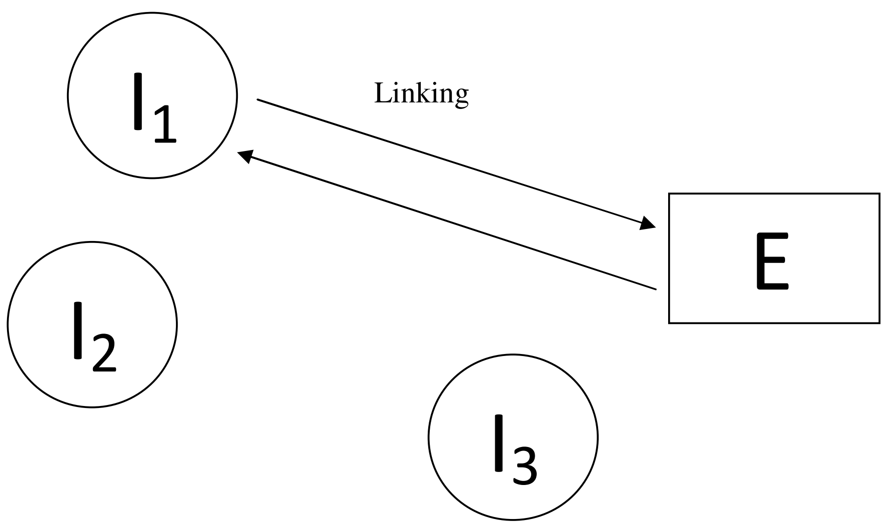
It is understood that learning science using process skills has many advantages. Learning becomes more concrete and meaningful. Learners become active and learn the logic behind particular happening in the surrounding. The mental modes of knowing become more clear and are refined. They also learn the systematic ways of scientists. This promotes not to believe without any evidences. The skills to observe, test, collect the required data, evaluate the evidences and setting the trustworthiness of one's enquiry are inculcated and nurtured in longer run. Such skills are of utmost importance to eradicate superstition and live in 21st century.

1.3.4 Process Skills in Learning Science

This section deals with the use of science process skills in modifying the existing understanding of students and process of learning science.

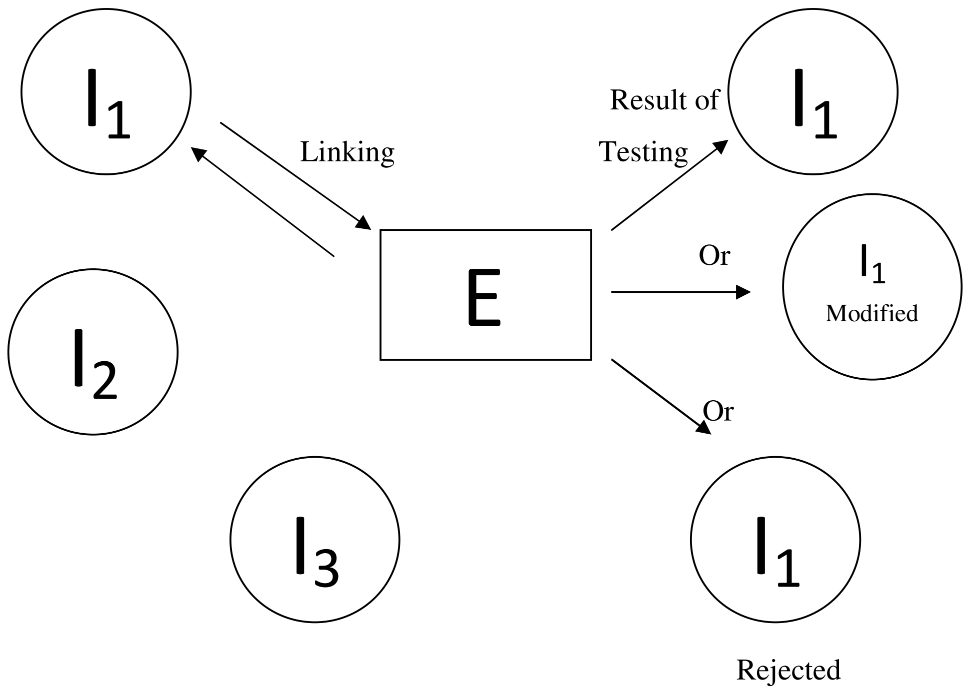
Harlen and Elstgeest (2008) explained the role of process skills in development of concepts and indicated that understanding of the world becomes clear when development of concepts occurs. The development of concepts is related with the refinement and extension of the process skills used while learning science. According to Harlen and Elstgeest (2008) how learning takes place in science can be shown in figure 1.

Figure 1 Learning Science and Process Skills as indicated by Harlen and Elstgeest (2008)



The circles I_1, I_2, and I_3 represent various existing ideas and E represents a new experience. The either of the existing ideas is linked with the new experience due to some perceived similarities. The processes involved may include observation, hypothesizing and communication. The linked idea with the experiences is then tested against the evidence to see whether it helps in making sense of new experience. If it succeeds in doing so, it will be considered as a more useful idea. Consideration of idea for modification or rejection depends on the way in which the testing processes are carried out. The testing processes include raising questions, predicting, planning and carrying out investigations, interpreting and making inferences, and observing, measuring and communicating. The below mentioned figure 2 shows how learning takes place using the process skills.

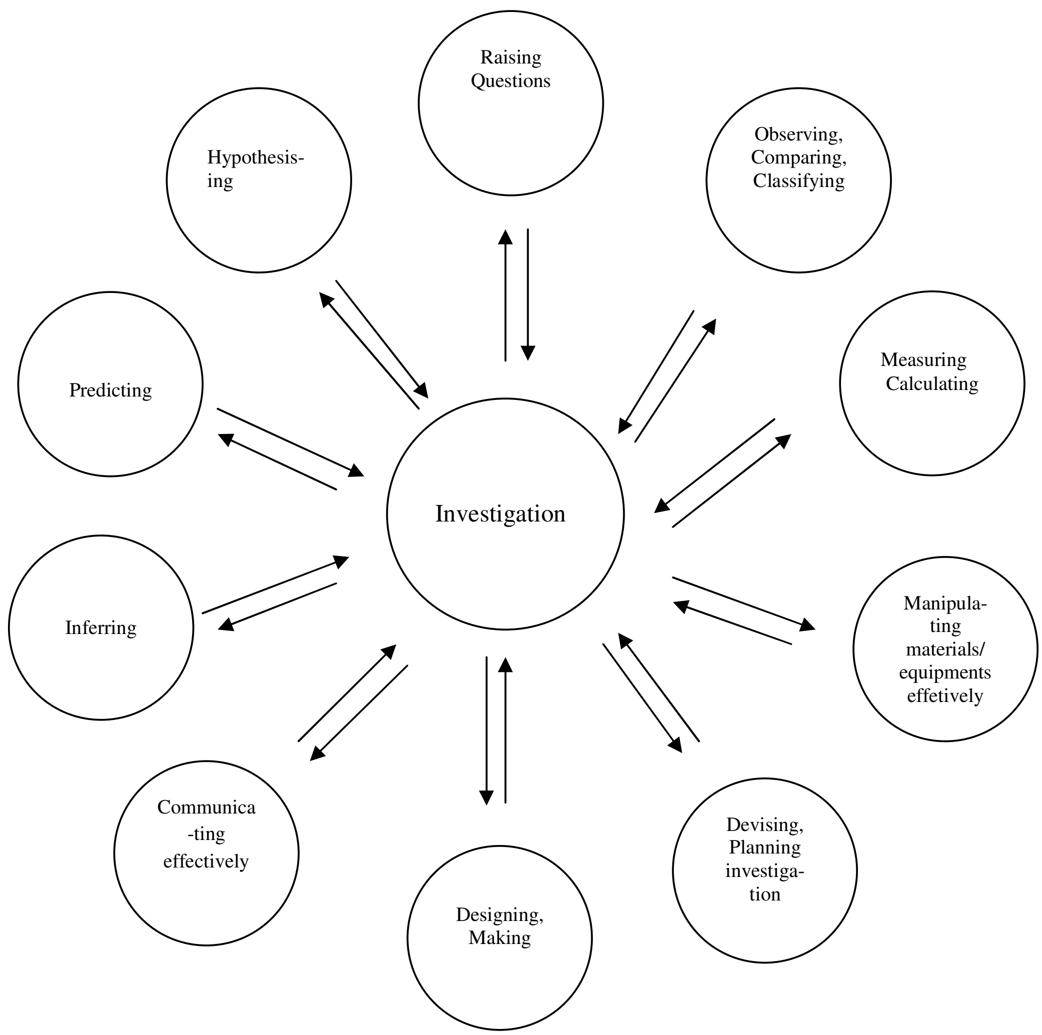
Figure 2 Modification of Learning in Science as indicated by Harlen and Elstgeest (2008)



The possibilities represented in above diagram are dependent on the existing ideas and the nature of new experience as well as on the extent to which scientific process skills can be used. Here, the attitude has also emerged as a determining factor whether or not available skills would be deployed.

Harlen and Elstgeest (2008) indicated investigating process in science which is mentioned in figure 3. According to Harlen and Elstgeest (2008), there is as such no hierarchy or sequence present in the use of process skills in learning concepts of science. It means that all the process skills are part of a whole called scientific investigation.

Figure 3 Investigation in Science Using Process Skills as indicated by Harlen and Elstgeest (2008)



1.4 Multiple Intelligences (MI) Based Instructional Strategy For Learning Science

Gardner's theory of Multiple Intelligences offers unique educational implication for designing learning experiences. The MI theory provides educationists and teachers a wider panoramic view of students' abilities. The MI theory points out that each one is smart in various ways, and it is not advisable to segregate students on the basis of their performance in paper - pencil test. It also suggests that there can be more than one way to teach the same content so as to sustain and involve students in the learning process. The educational implication of the MI theory clearly indicates that teachers have to shift from one mode of expression in teaching to another mode like singing to talking, talking to organizing group discussion session, from group discussion session to personal reflection, from personal reflection to kinesthetic activities, and from kinesthetic activities to visual imagery or visual presentation. The way the teacher selects the mode of presentation of content in his/her framed instructional strategy, makes classroom interaction filled with higher level of students' involvement. It, thus, offers teachers various ways to engage the learner in the process of problem solving, working on projects, sharing their views, reflecting their roles and connecting the situation to their lives. The organization of learning experiences perhaps seems difficult, but Chackely (1997) pointed out that the learning experiences should not be like stretching – it – out on the part of learners. Stating more clearly Chackley's stand, it is apt to engage one or more intelligences of learners depending upon the scope of the content, age and interest level of students. As logical-mathematical intelligence is hallmark of scientists and engineers, architectures and lawyers, it does not mean that a teacher can involve only logical-mathematical intelligence while tailoring learning experiences for learning science. The rest seven intelligences are also used by scientists in solving problems, and to communicate. Science is also understood well by involving various experiences such as visual imagery and presentation, connecting the situation with one's self, understanding musical patterns, finding the patterns in the natural world, and expressing scientific phenomena by kinesthetic experiences. According to Howard Gardner's MI theory, all have all intelligences with different strengths and doing something will usually require use of more than one intelligence. According to Gardner (1995), most topics can be powerfully approached in number of ways but there is no point in assuming that every topic can be effectively approached in at least seven ways, and it is a waste of effort and time to attempt to do this. Hammerman (2006) mentioned that it is important to keep in mind that most students associate with more than one intelligence and exposure to a variety of instructional strategies is more likely to increase learning potential among a group of students.

Thus, various intelligences based science instruction will offer new stimulus to students and will act as motivator. It will help teachers to remove boredom also. Therefore, intelligences which are less valued in particular culture should also be addressed by teacher in teaching. Hence, all intelligences should be targeted by a science teacher effectively.

According to Armstrong (2000), a teacher should follow below mentioned process step by step while designing MI based instructional strategy.

- Formulation of objective.
- Ask how all the intelligences will be addressed.
- As per the scope of addressing all the intelligences, think about what techniques, materials are more suitable? Then, enlist them.
- List the approaches to teaching.
- Select the most suitable methods, media and approach.
- Select appropriate activities.
- Set a plan of action.
- Execute the plan of action.

Table 1 shows MI based teaching strategies mentioned by Armstrong (2000).

Table 1 MI based Teaching Strategies

(Compiled from Armstrong (2000))

Intelligences	Teaching Strategies
Linguistic	Storytelling, Brainstorming, Tape Recording, Journal writing, Publishing
Logical-Mathematical	Calculations and Quantifications, Classifications and Categorization, Socratic Questioning, Heuristics, Science Thinking
Visual-spatial	Visualization, Color cues, Picture Metaphors, Idea Sketching, Graphic Symbol
Bodily-kinesthetic	Body answers, The Class room Theatre, Kinesthetic Concepts, Hands-on thinking, Body Maps
Musical	Rhythms, Songs, Raps and Chants, Discographies, Supermemory Music, Musical Concepts, Mood music
Interpersonal	Peer sharing, People Sculptures, Co-operative Groups, Board Games, Simulation
Intrapersonal	One-minute reflection periods, Personal Connections, Choice Time, Feeling Tone Moments, Goal-setting Sessions
Naturalist	Nature walks, Windows onto learning, Plants as props, Pet-in-the-classroom, Ecostudy

The science teacher should find ways to locate the scope to teach the content using MI based teaching strategies as mentioned in Table 1. According to Tisher, Power and Endean (1972), a science teacher should provide both direct and vicarious experiences and several modes of communication such as speaking-listening, visualizing-observing and writing-reading mentioned as under.

a. Direct Learning through first-hand experiences: (Immediate sensory contacts with reality), Exhibits, contrived experiences, demonstrations, projects, laboratory work, excursions, field trips and environmental encounters.
b. Vicarious Learning through Audio-visual Materials: (mechanical representation of reality) Charts, graphs, pictures, slides, film-strips, specimens, models, films, and television
c. Vicarious learning through Words and Symbols: (Abstract representation of reality) Mathematical models, formulae, equations, speech, and writing.

Below are the general criteria which should be considered for the selection of intelligence specific learning experiences.

a) **Appropriateness:** It should ensure that whatever experiences are provided should be appropriate to the content and instructional objectives of teaching.
b) **Comprehensiveness:** It should be taken care to offer adequate opportunities to all students to think and to convey what they learn through writing, demonstration and using different process skills when required depending upon the nature of the content and scope of the activity thus tailored.
c) **Variety:** It should offer different intelligences focused learning experiences.
d) **Relevance:** The difficulty level of activities and intelligences focused experiences should be matched with students' needs, interests and abilities.
e) **Usability from the Teacher's Perspective:** MI based instructional strategy should be used easily using computer, charts, experiments and simple project works across India.
f) **Cost:** Cost should be minimal so that MI based instructional strategy can be implemented again whenever required.
g) **Demand:** It should assure a high degree of involvement on the part of students by making them use different process skills and a particular intelligence at a time or different intelligences together.

1.4.1 Multiple Intelligences (MI) Based Instructional Strategy for Teaching Science at Elementary Stage of Education

The teacher should develop MI based instructional strategy keeping in mind the nature of content of science and scope of incorporating the combination of multiple intelligences together or sometimes separately. The age specific characteristics of the target group which influence learning of science should also be considered while developing MI based instructional strategy.

Learners of this age are very curious, interested in doing, working with their hands and they tend to explore the surrounding world. They prefer activities rather than simply listening to their teacher's act. Moreover, their attention span is smaller in comparison to learners of secondary and higher secondary stages. As per Piaget's theory of cognitive development, students of this age fall under the concrete operational stage. It is the incubation phase of students to develop their higher level mental abilities and understand the scientific phenomena from holistic point of view and also viewing the phenomena from multiple viewpoints. Concrete and simple experiences should be provided to the learner and the difficulty level of learning experiences can be gradually increased to maintain their pace of learning. The learning experiences should offer the opportunity to learners to observe, classify, infer, predict, measure, and conclude so that they can learn to work as scientists do. The challenge is to a science teacher is to find novel but stimulating intelligences specific ways to engage combination of intelligences together or separately as per the scope of the content. Table 2 shows how multiple intelligences of the students can be addressed in teaching of science.

Table 2 Teaching Science in Multiple Intelligences Way

Intelligence	Teaching Science in Multiple Intelligences Way
Linguistic	• Instruct students to write brief report on contribution of scientists by referring print and on-line resources. • Encouraging students to write sentences, poems, or stories about living and events. • Incorporating letter writing activity such as asking permission to zoo, aviary mentioning clear academic purposes. • Ask students to solve crossword puzzles on concepts of science.
Logical-mathematical	• Provide scope to learn science by using metric measurements, conversion of measurement unit. • Using inquiry and problem solving approach. • Calculating usage of water and sources of energy and suggesting ways of conservation of the same based on logical reasons. • Thought-provoking question –answer sessions.
Visual-spatial	• Use graphs, drawings, illustrations, maps, and diagrams and encourage students to present their learning in visual presentation including PowerPoint Presentation and using over head projectors. • Use graphic organizers. • Guide students to construct two/ three dimensional models of molecules. • Provide opportunity to students to prepare assignments using photographs taken by camera. • Provide scope to use microscopes and telescope and ask them to present their learning in the form of images and drawing. • Promote thinking in images.
Musical	• Investigate the nature of sound and the variables that create sounds in the natural environment. • Provide opportunity to students to use musical instruments and ask them to explain why different instruments vary in their production of sound in pitch. • Encourage students to prepare raps and songs on the topics of science such as energy, universe, instruments and natural world (flora, fauna, living, rock, sources of water, wind) • Provide them opportunity to study music affects living. (human being and plants)
Bodily-kinesthetic	• Incorporate games, dance, drama, experiments, role-play and demonstrations • Engage them to learn using puppet shows. • Provide opportunity to students to participate in community affairs by working on projects like health and sanitation, AIDS, communicable diseases with the medical professionals, village education committees, Parent Teachers' Association and people of village. • Action research.

(*Table 2 is continued on next page.)

Table 2 Teaching Science in Multiple Intelligences Way

Intelligence	Teaching Science in Multiple Intelligences Way
Inter-personal	• Use cooperative learning strategies such as peers' assisted learning, learning in groups or allow them to work in pairs for experimentation, assignments, and projects. • Use role playing activities. • Ask them to prepare group report and ask them to present by means of group discussion and skit. • Use collaborative action research projects. • Provide them opportunity to interview the scientists, science teachers, parents to learn scientists' inventions.
Intra-personal	• Use daily log writing activity so that students can track the record of their behavior and can modify the same. • Help them to decide personal goals and ask them to review. • Ask students to link science learning with their lives. • Ask students to identify their strengths and weaknesses and invite them to prepare plan of action to work in groups or alone. • Use exercise of personal reflection.
Naturalist	• Promote students to learn concepts of science using investigation of the natural phenomena. • Organize visit to aviary, zoo and sanctuary and ask them to write report on characteristic features of the animals. • Bring pets to the class for study. • Ask them to show their understanding of the natural world by presenting information in images, photographs of the natural world. • Ask them to watch channels TV like Discovery, Animals Planet and provide them opportunity to share what they saw and learnt about different inventions, plant and animal kingdom.

1.5 Rationale for the Present Study

The review of related literature assisted the researcher to gain insight about studies conducted in the area of MI. It was found that a few studies have been carried out in India and that too at secondary level. Besides this, Multiple Intelligences is completely an exotic idea like others but not utilized in Indian set-up as it should have been. One cannot predict by the IQ measured on traditional intelligence test that particular person might have capacity to become a musician or a dancer. The theory of Multiple Intelligences provides scope to understand each person with different domains of abilities and talents. It also directs educationists to identify learners as per their strengths in multiple intelligences and also to render instructional strategy to allow them to use abilities for learning different subjects, especially science. NKC (National Knowledge Commission) (2008) expressed genuine concern for the enrollment of fewer students in science and mathematics education. It recommended popularization of science among children across India. NKC (2008) advocated that the programme should bring all popular science activities under one umbrella for rapid implementation.

The National Curriculum Framework for School Education- NCF (2000) mentioned that the multiple Intelligence approach offers learners many opportunities for the exploration of significant concepts and topics leading to think about them on their own and to have many ways to make sense of what they find. NCF (2000) also indicated that as MI (Multiple Intelligences) provides a variety of experiences, it helps large number of learners to succeed. It further added that the use of Multiple Intelligence in curriculum provides a variety of experiences which become the entry points into the lesson content and reach the learners in ways they can understand. It denoted that the multiple intelligence education provides a frame work that helps curriculum planners and also teachers to look for varying levels of strengths of their learners, and develop the optimum range of their intelligences. Fischer (1997) found that the use of Gardner's theory enabled educators to create learning environments that enabled all types of students to learn better.

Goodnough (2000) conducted a qualitative case study to explore Howard Gardner's theory of multiple intelligences and its merit for making science teaching for making science teaching and learning more meaningful. Many positive outcomes resulted from this study on areas such as curriculum development, teacher development, and student learning in science. The researches documented by the researchers of the Schools Using Multiple Intelligences Theory (SUMIT) as mentioned in Kornhaber, Fierros, and Veenema (2004) supported that the application of multiple intelligences theory was found useful in solving academic problems such as score on standardized achievement test, performance of learning of disabled students' in test, disciplinary problems and parental participation. Davis (2004) found a positive attitude among students about learning in science and the significant improvement in students' achievement, behavior, and self-esteem. Therefore, based on research evidences and noticing the dearth of multiple intelligences based studies in India, the researcher was led to select the theory of multiple intelligences to design and develop the instructional strategy for teaching science at standard V as the researcher belongs to science background. The Government of Gujarat in the year 2010 - 2011 introduced the concept of theory of multiple intelligences and life skills with the introduction of semester system at secondary education. This suggested timely application of the theory of multiple intelligences at elementary level.

NCF (2005) suggested that curriculum must enable children to find their voices, nurture their curiosity to do things, to ask questions, to pursue investigations, to share and to integrate their experiences with school knowledge rather than their ability to produce textual knowledge. The report of the Education Commission (1964-66) aptly denoted, "In recent year, several countries have been able to raise their GNP (Gross National Product) very rapidly because of their investment in basic science, technology, and education. We are at a crucial stage in the process of development and transformations; and in this context the role of science (using the world in its broadest sense) is of the utmost importance." This shows the importance of science education and relates it to the development of a nation. It is therefore required to use novel approach and methods in teaching science to enrich the teaching of science so as to maximize the learning to develop scientific attitude right from the beginning and to instill and develop interest towards science. NCERT (1969) mentioned, "Science is more than a collection of knowledge; it is also the intellectual activity in which scientists are engaged. That is, science is not just a subject- it is also a pattern of methods for solving real problems, large and small, scientific and otherwise."

It means in present context that science is required to develop the problem solving abilities and skills among young students. The teaching of science should aim to develop logical thinking along with nurturing and developing the interest towards science. It should also develop the creativity and critical thinking as they are inevitable for better living in 21st century. Various experiences such as reading, experimenting, listening, thinking, reflecting, writing and expressing oneself in speech are helpful to understand the concepts of science and retain the scientific understanding. The retaining of scientific understanding is also required as the problem solving ability builds upon small piles of scientific understanding. The conceptual understanding can be developed by engaging students actively in learning process. Active involvement involves exploration, enquiry, questioning, discussion, reflection leading to creation of ideas. Hence, the challenge lies before the teacher is to ensure active involvement of the students. The National Curriculum Framework by NCERT emphasized on active learning. This can be made possible by taking advantage of ICT and working on multiple intelligences models.

In Gujarat, subject specialization in schools is being offered after the 10th class. Primary schooling leaves intangible effects on tender minds of children. This is the most formative period of the development of interest towards science subject as it is the first experience for student to have science textbook in his / her syllabus, to know the miracles of the nature and the laws governing behind it. The success in developing interest of students towards science is largely possible by providing instructions in ways that would appeal to their student's interest. Moreover, the Government of Gujarat has introduced a new Science and Technology textbook in the year 2007 in standard-V. It is therefore, standard-V was selected for the present study.

1.6 Statement of the Problem

Development of Instructional Strategy for Teaching Science at Standard V Based on the Theory of Multiple Intelligences

1.7 Objectives of the Present Study

(1) To design and implement instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V.

(2) To study the effectiveness of instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V in terms of academic achievement.

(3) To study the process of learning science among the standard V experimental group students in relation to process skills.

(4) To study the opinion of experimental group students for implemented instructional strategy for learning science based on the theory of Multiple Intelligences.

(5) To study the Multiple Intelligences profile of standard V students of experimental group with respect to academic achievement of students in science subject.

(6) To develop the guidelines for teaching science at standard V based on the present study.

1.8 Explanation of the Terms

1.8.1 Instructional Strategy

The instructional strategy would comprise of integration of various activities, methods and media for learning concepts of Science at standard-V based on the theory of Multiple Intelligences.

1.8.2 Multiple Intelligences

The Multiple Intelligences theory propounded by Howard Gardner in 1983 and 1999 is considered as a base for the present study. It includes eight different intelligences namely linguistic, logical-mathematical, visual-spatial, musical, bodily-kinesthetic, intrapersonal, interpersonal, and naturalist intelligence. Multiple Intelligences is abbreviated as 'MI' in the present study.

1.8.3 Process Skills

Science process skills are the systematic pathways to explore and gain evidence to study particular phenomena under study objectively. This systematic enquiry helps in developing ideas. The science process skills help to test and verify the results. Science process skills such as observation, communication, inference, measurement, classification and prediction were included in the study.

1.9 Operationalization of the Terms

1.9.1 Academic Achievement

The marks scored in pre- and post-tests are considered here as an academic achievement.

1.9.2 Studying the Process of Learning Science in relation to Process Skills

The indicators of science process skills given by Fraser-Abder (2011) were considered to analyze the process of learning science in relation to process skills. It was studied in observation process skill whether the students were able to identify the similarities, dissimilarities, noticeable changes and properties of the objects such as colour, size and shape. In measurement process skill, it was studied whether the students were able to measure the length, and width of the given objects using a standard tool such as ruler or meter tape accurately and precisely. The students' ability to measure volume of liquid using measuring cylinder was also studied. The students' abilities to classify given objects/substances based on their similarities were considered here. In inference science process skill, it was studied that whether the students were able to infer based on the acquired understanding through observation, measurement, and classification. It was studied that how students use their prior knowledge systematically and logically to think and predict what will happen for particular phenomena under study. The communication science process skill was studied with reference to how effectively the students were able to communicate their understanding about the scientific phenomena using charts, diagrams, and models, written and verbal modes of expression.

1.10 Hypothesis of the Study

There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.

1.11 Delimitation of the Study

The present study is delimited to

- English medium schools following Science and Technology textbook prescribed by Gujarat State Board of School Textbooks, Gandhinagar.
- The Instructional strategy was developed for chapters - 2 to 7, 9, 11, 12, 14 and 16 of Science and Technology textbook of standard V, Gujarat State Board of School Textbooks, Gandhinagar. The lessons included are: Learn Preparing Groups, Living - Non Living, Let Us Know the Soil, Seed and Its Germination, Water and Its Importance, Observation of Living World, Food and Health, Air, Light and Its Properties, Measurement of Length and Energy.

CHAPTER - II

REVIEW OF RELATED LITERATURE

CHAPTER : II - REVIEW OF RELATED LITERATURE

2.1 Introduction

The focus of the present research problem is the development and implementation of Multiple Intelligences based Instructional Strategy for Teaching Science at Standard V. Therefore, the studies conducted using the multiple intelligences as a broader framework have been reviewed. The reviews were carried out to explore the Multiple Intelligences based practices in School Education, and Teacher Education as well with a purpose to find out the types of the studies, methodologies, variables and findings based on the their availability at the best. The reviews of the studies have been categorized into different subcategories as mentioned under.

- Studies Conducted in the Area of Multiple Intelligences in General
- Studies Conducted in the Area of Multiple Intelligences at Elementary Education
- Studies Conducted in the Area of Multiple Intelligences at Secondary and Higher Secondary Education
- Studies Conducted in the Area of Multiple Intelligences at Teacher Education

Each above mentioned subcategory is further discussed with the implication. A brief discussion was also carried out to show the variables and findings of prime importance.

2.2 Studies Conducted in the Area of Multiple Intelligences in General

Armstrong (1987) attempted to describe strengths in children who were identified as ‘learning disabled’ using Howard Gardner’s theory of multiple intelligences as an organizing framework. The study examined the strengths of thirty children identified as "learning disabled." Questionnaires, interviews for parents and naturalistic observation was used to gather the data. The children’s personal documents (drawings, photographs, and work samples) were analyzed, and naturalistic observation was used. Howard Gardner's theory of seven multiple intelligences:

linguistic-verbal, logical-mathematical, visual-spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal was used as a theoretical framework. Personal documents supported the view that children identified as "learning disabled" were strong in visual-spatial intelligence. Thirteen of the thirty three documents analyzed consisting of drawings showed evidence of visual-spatial ability. It was suggested that educators use Gardner's model as a way of assessing strengths and to develop instructional strategies based on the same strengths to assist children identified as "learning disabled."

Vialle (1991) constructed case studies of African-American children drawn from low socio-economic day-care settings using Gardner's Multiple Intelligences Theory as a framework. The aim of the case studies was to determine whether children at the ages of four and five exhibit differing strengths and weaknesses across the seven intelligence domains and how such strengths and weaknesses affected the way they approach problems in their world. In the first phase sixty children from six different day-care settings were observed. From this sample, five children were selected for more intensive observation in the second phase of the study. Participant observations in the day-care settings, in children's homes, at church, and on field trips were used to gather the data. Interviews were also conducted with the day-care providers and the family caregivers. Finally, the children were engaged in one-on-one assessment activities with the researcher. The findings indicated that each of the five children had differing abilities across the seven intelligence domains, with four of the five demonstrating an outstanding strength, and three demonstrating a weakness, in at least one domain. The study concluded that Gardner's theory is a useful framework for viewing children in terms of their strengths rather than their deficits.

Fischer (1997) undertook qualitative research focusing on Howard Gardner's Theory of Multiple Intelligences. A cross-case survey was conducted to answer 'Does teaching to a student's individual intelligence as defined by Howard Gardner have an effect on student's progress?' Progress was defined as steady improvement or advancement in a particular area. The variables that influenced the relationship between matching individual intelligence to a particular type of instruction were examined. The overall effect of Gardner's theory on the learners in each population was also examined. A complete literature search was conducted and finally eight relevant studies were pinpointed for the review and analysis. It was found that the use of Gardner's Theory in school did serve to heighten student's progress in an indirect way. It was found that the use of Gardner's theory enabled educators to create learning environments that enabled all types of students to learn better.

Harms (1998) studied the self-perception of multiple intelligences among selected third-, seventh-, and eleventh- grade students in randomly selected South Dakota schools. Survey instruments developed by 'New city School Faculty in St. Louis' was used to gather data from 202 third- grade, 212 seventh- grade and 230 eleventh grade students in randomly selected schools. Five point Likert, a type scale was used to measure respondents' perceptions of the dominance of each of the multiple intelligences.

Findings were: (1) Computation of item means and rankings indicated that respondents perceived naturalist and interpersonal intelligences to be their most dominant capacities and intrapersonal intelligence to be their least dominant capacity. (2) A one-way analysis of variance showed that there were significantly different perceptions ($p<0.05$) among students at the three grade levels of all intelligences. (3) A series of t-tests for independent means indicated that among all students, there were significantly different perceptions ($p<0.01$) between females and males regarding six out of the eight intelligences. (3) The t-tests revealed significant differences ($p<0.01$) in perceptions of multiple intelligences by females and males within each selected grade level.

Miller (1999) studied possible differences in innate abilities between local Chamorro students and Micronesian Chuukese students attending Guam's public schools using "Teele Inventory of Multiple Intelligences" (TIMI). This study was designed to identify areas of student learning strength then to compare these areas of strength.

Although there were many similarities in the survey preferences of the Chamorro and Chuukese students, there were also some notable differences. The intelligences selected most often by the Chamorro students were kinesthetic and visual-spatial. Mostly, the Chuukese students were interpersonal than bodily-kinesthetic intelligence.

Neville (2000) compared Native American students' self-perceptions regarding Gardner's multiple intelligence. The data was collected from 174 third grade, 122 seventh grade and 89 eleventh grade Native American students enrolled in Bureau of Indian Affairs Schools in South Dakota. A five point Likert scale was used to measure respondents' perceptions of the predominance of each of the multiple intelligences. Findings were as under.

(1) The respondents perceived naturalist, visual intelligences, and musical to be their least predominant intelligence. (2) There were significantly different perceptions. ($p < 0.05$) among Native American students at the three grade levels of all intelligences. (3) Among all Native American Students, there were significantly different perceptions ($p<0.01$) between females and males regarding five of the eight intelligences. (4) The significant differences ($p<0.01$) in perceptions of multiple intelligences by females and males within each selected grade level were found.

Aldhahri (2004) explored the feelings, thoughts, behaviors and/or experiences of Saudi participants with regard to the major tenets of Multiple Intelligences (MI) theory as it related to the Saudi context. The purpose of this study was (1) To investigate the emancipatory capacity of MI to cultivate a pluralistic understanding of intelligence with respect to the Saudi context. (2) To explore MI theory's strengths and weakness from the Saudi participants' perspectives. (3) To identify the expected obstacles and the opportunities for MI theory in the Saudi context. The participants were teachers, educational leaders, academics, and parents. The focus group interview method was used to ascertain the views of Saudi participants. A purposive selection based on snowballing was used. Constant comparative method was used to analyze the data.

The results of the study concluded that participants indicated: (1) MI theory created positive feelings, constructive emancipatory thoughts, and some positive preliminary experiences, (2) MI raised some concerns regarding its applicability and its assessment tools, and (3) MI faced potential obstacles such as complicated curriculum structure, untrained teachers, and a resistant teaching culture.

Uysal (2004) determined seventh and tenth grade regular state school students' self-estimated intelligence dimensions in Ankara. The study investigated the effect of students' grade level, gender, age, socio economic status (SES), physics/science achievement, and branch in high school (science-math/literature-math/social sciences /literature) on students' self-estimated intelligence dimensions. The population of the study included all seventh and tenth grade regular state schools' students in Turkey. The sample size was determined as 2850 students. Stratified cluster random sampling and convenience sampling were used to obtain a representative sample of the population. The Multiple Intelligence (MI) Inventory used in this study was adapted in Renaissance Project with the permission of Sue Teele and Anne Biro. Findings of the study showed that seventh grade students perceived themselves higher on verbal-linguistic and logical-mathematical intelligences, and tenth graders perceived themselves higher on the remaining five dimensions of intelligences. Seventh grade female students perceived themselves to be higher than male students in verbal-linguistic, visual-spatial, musical, bodily-kinesthetic and interpersonal intelligences. Similarly, tenth grade female students perceived them to be higher than male students in all of the intelligence dimensions except the logical-mathematical intelligence. The result of the study indicated significant differences on verbal-linguistic intelligence of tenth grade students coming from different branches namely science-mathematics, literature-mathematics, and literature-social sciences branches. The study also revealed significant positive correlation between science achievement and interpersonal intelligence of seventh graders.

2.2.1 Implications - Multiple Intelligences in General

There were total eight studies falling under the category of "Multiple Intelligences in General." **Armstrong (1987)** suggested that educators use Gardner's model as a way of assessing strengths especially for the students who are labeled as "learning disabled." This was also somewhat similar with what **Vialle (1991)** concluded that Gardner's theory was a useful framework for viewing children in terms of their strengths rather than their deficits. **Fischer (1997**) found that the use of Gardner's theory enabled educators to create learning environments enabling all types of students to learn better.

Miller (1999) employed "Teele Inventory for Multiple Intelligences" (TIMI) for Chamorro and Chuukese students. **Aldhahri (2004)** mentioned that MI theory created positive feelings, constructive emancipatory thoughts, and some positive preliminary experiences. **Uysal (2004)** revealed significance positive correlation between science achievement and interpersonal intelligence of seventh graders.

2.3 Studies Conducted in the Area of Multiple Intelligences at Elementary Education

Doss (1992) explored understanding of low achievers' abilities using Howard Gardner's (1985) theory of multiple intelligences. The focus of the study was to study the relationship between bodily-kinesthetic intelligence and low achievement. The fifty subjects for this study were selected from two metropolitan school districts. Criteria for selection were: (a) Student must have scored nine months or more below grade level in the areas of mathematics and language arts on a standardized achievement test, (b) Student must not have been diagnosed as learning disabled or emotionally disturbed, and (c) Student must not be enrolled in special education classes. Lincoln-Oseretsky Motor Development Scale was administered individually to each subject. The t-test analysis showed no significance at the 0.05 level except for one small sub-group, which was judged an anomaly. Chi-square showed significance of 9.9 at three degrees of freedom which was significant at 0.0194. An inverse or negative relationship was established for these subjects between their verbal and computational achievement scores and motor ability scores. It was found that low achievers as a group identified by their achievement test scores, scored above the mean on a measure of motor ability. It was reported that it was prudent to explore strengths of students in other areas of intelligence who were struggling to achieve in school. The study suggested further research in the areas of high and average achieving students' motor abilities.

Teele (1994) studied the relationship of multiple intelligences to the instructional process. The objective was to describe a school where teachers were actively engaged in providing instruction based on multiple intelligences. It was a qualitative study which used interviews and observations to gather the data. Documents gathered from students, teachers, parents, principal, school board and district office to respond to an instructional environment were analyzed.

The findings were: (1) there was a strong relationship between multiple intelligences and the instructional process. (2) Four domains - physical setting, organizational factors, human aggregate and social climate were identified as elements which were prominent at the school under study and can be utilized to provide a common framework, (3) The four domains have key aspects that focus on how to provide a positive and personalized learning environment where all students can and will learn and develop extensive and intensive interpersonal relationship, and (4) It was found that the emerged model defining relationship between multiple intelligences and the instructional process was interactive with the students.

Carson (1995) attempted to determine whether teaching mathematical problem solving through the multiple intelligences approach made any difference in the problem solving competencies of individual students, or groups of students with diverse learning abilities and cultural backgrounds. A proportional stratified random sample was used. The control group was taught the problem solving processes in a traditional manner, while an experimental group was taught the same through various intelligences. There were fifty-nine students in both the control group and the experimental group of fifth grade from bilingual center elementary school in Orange County, Florida. The experiment consisted of a six-week and followed a pretest-problems-analysis-intervention-observation-posttest design. Two classes were taught problem solving using traditional approaches. Other two classes were taught using multiple intelligences approach to problem solving. The students' behaviors were observed and recorded before and after the instructions. A split-plot analysis of variance was used to determine a significant difference between the experimental and control groups from pre-to-post-period. It was found that the experimental group students demonstrated significantly higher performance than those of the control group. The improvement was also seen in the number of problems attempted and in the accuracy of the responses of the experimental group.

Mueller (1995) undertook the study to research social interactions and acquisition of content knowledge within a heterogeneous multiple intelligence cooperative group and a homogeneous multiple intelligence cooperative group based on Howard Gardner's theory of multiple intelligences and the Johnson and Johnson cooperative learning strategy. A science unit on the human body designed by David Lazear was used to teach twenty-two fourth graders of Metcalf Laboratory School, Normal, Illinois during the 1994-1995 year. The study was a quasi-experimental design and focused on eight students chosen from the fourth grade class. Based on the assessment tools like checklists, observations, and interviews, four students were assigned to the homogeneous multiple intelligence group and four students were assigned to the heterogeneous multiple intelligence cooperative group. Assessment tools including observations, field notes, written journal entries, interviews and a questionnaire were used to examine social interactions. It was found that the homogeneous logical-mathematical group was able to complete the project more efficiently than the heterogeneous group. It was found that the heterogeneous group had a more difficult time attending to the task and taking of responsibility for their assigned roles. All students in the class made a gain from the pretest to the posttest Human Body content acquisition test. It was reported that the division of cooperative learning groups by multiple intelligence strengths was not detrimental to the students' learning of content knowledge.

Scott (1996) conceptualized that an assessment instrument based on Howard Gardner's multiple intelligences (MI) theory, "Teele Inventory of Multiple Intelligences", (TIMI), might assist in meeting PA (Pluralistic Assessment) goals and a possible alternative to traditional intelligence and achievement tests for identifying gifted African-American students. Specifically, it sought to determine, through cross-validation of a multiple intelligences instrument, whether the subscales of MI instrument could identify a statistically significant greater number of potentially gifted African-American urban fourth grade students than the subscales of a general intelligence (g) instrument. The TIMI and the Otis-Lennon School Ability Test (OLSAT), the (g) factor instrument were used in this study. This study found that there was no statistically significant difference in the ability of the TIMI or OLSAT to identify gifted students in general. However, the TIMI consistently identified more gifted students than the OLSAT. Also, there was a statistically significant difference in the ability of the TIMI's TIMI 3 subscale (intrapersonal intelligence) and the OLSAT to identify gifted African-American students and to identify gifted students as a function of race. The statistically significant difference in the ability of the TIMI's, TIMI 4 (visual-spatial intelligence) and TIMI 6 (bodily-kinesthetic intelligence) subscales and the OLSAT to identify gifted students as a function of sex was found.

McGraw (1997) evaluated the effectiveness of reinforcing strategies based on Gardner's theory of multiple intelligences on students' learning of mathematical concepts. The study also compared the students' learning when reinforcing strategies were differentially aligned with strengths and weaknesses with respect to the seven intelligences. The study randomly assigned six seventh grade mathematics classes to treatments. The post-test scores of the top and bottom one-third groups were compared for each of the seven intelligences when concepts were reinforced using strategies based on that same intelligences. In the third part of the study, post-test scores were correlated with multiple intelligence subscale scores. The findings were as under.

(1) There was no significant difference in students' learning of the mathematical concepts when reinforced using multiple intelligences in a non-aligned manner. (2) A binomial probability analysis indicated that six out of seven such groups had higher post-test scores at a 0.0625 level of significance. (3) The post-test scores did not correlate highly with that student's perceived strength in that intelligence when a student was reinforced with intelligence.

Baum (1998) compared the use of art as a pre-writing strategy by thirty average, spatially oriented students and the use of standard prewriting process strategies of thirty additional spatially oriented students. Fifteen girls and fifteen boys in a treatment group and the same number of students in a control group continued the study for twelve days. The treatment group was taught by art illustration and think-aloud strategies while the control group was taught using standard writing process skills as brainstorming, mapping, and webbing to prepare for the writing assignment. The data was gathered by pre-writing, first draft, and revision protocols. "Teele Inventory of Multiple Intelligences" (TIMI) was used to determine the visual-spatially oriented students. Individual descriptions of twenty-four writing pieces were analyzed.

It was found that girls and boys used different strategies. The girls reasoned more than the boys. The boys generated more ideas. The use of art illustration and the adult interaction helped the treatment group in making use of reasoning in their writing while the control group was stronger in their use of the strategy of generating ideas. The findings illustrated that students can learn to write in a variety of genres if the conditions to facilitate learning are present.

Rosenthal (1998) studied the impact of teaching to Gardner's theory of multiple Intelligences on student's self esteem. The selected sample contained one hundred forty one fourth graders in eight classrooms. The MI theory was taught to the experimental group of four classes. Spatial, Musical or Kinesthetic experiences were provided at least twice in a week, and ample opportunities were given to students to reflect on their intelligences whereas no such exposure was given to control group of four classes. A pretest using Brown and Alexander's self-esteem Index and posttest were administered. A sample t-test was calculated. ANOVA was calculated on each of the sub scores of the SEI (self-esteem Index) to determine the effect of gender on self-esteem measures.

The analysis showed a drop in self-esteem in the classrooms that did not incorporate Gardner's theory in teaching. The results of the ANOVA suggested that gender was not affecting variable to the pattern of change in self-esteem. The results indicated that Gardner's theory of MI might be one viable instrumental strategy for teachers to enhance self-esteem of students.

Feeney (1999) studied the impact of Howard Gardner's theory of multiple intelligences (MI) on change in Middle school Language arts Curriculum where four broad domains were of the prime focus namely student performance, pedagogy, curriculum and assessment. The questionnaire consisted of total twenty-eight questions used to gather findings. This study included observations and interviews also to support findings.

Following conclusions were drawn: (1) the highest level of change was seen when MIs was implemented in the area of student performance, (2) Pedagogy stood second in the change while assessment on third rank, (3) Curriculum got third rank, and (4)

Multiple Intelligences theory did affect change in the classroom in the four domains in relation to teacher's levels of implementation rated as low, medium and high.

Franzen (1999) took up the study to know the self-perceptions of Multiple Intelligences among the students from a middle school in the Mid-west. A survey instrument developed by the New City School in St. Louis and Dr. Gary Harms was used to collect data from 407 fifth, sixth, and seventh grade students.

It was found that—(1) Independent t-tests identified significant differences between students' and teachers' perception in three multiple intelligence areas. (Verbal/linguistic, logical-mathematical, and intrapersonal), (2) Dependent t-tests indicated significant differences between what students perceived to be valued in school and their perceptions of multiple intelligence predominance within themselves in five multiple intelligence areas including: verbal / linguistic, visual / spatial, musical / rhythmic, interpersonal and naturalist, (3) An analysis of variance (ANOVA) showed significant differences among fifth, sixth, and seventh grade students in five multiple intelligence areas, (4) Independent t-tests indicated significant differences in multiple intelligences predominance based on gender.

Martin (1999) developed a Multiple Intelligences inventory for middle school students that teachers can use to identify and assess students' growth in seven identified intelligences compatible with a poetry unit in Language Arts. The intelligences addressed in each inventory included linguistic-verbal, musical-rhythmic, logical-mathematical, visual-spatial, bodily-kinesthetic, interpersonal and intrapersonal. The study included three sixth grade classes of approximately twenty-five eleven-year-old students in the spring of 1998. One class, termed the Experimental Group, and another, designated the Experimental Entry Group participated in a poetry unit in Language Arts while a third class, called the Comparison Group, did not. Each group was administered a pre- and post- inventory. Pre/post-test design was employed to see if the inventory accurately assessed the presence of certain intelligences in students and to see whether there were gains in understanding within the intelligences in the groups participating in the poetry unit. The study indicated the degree that parent-recognized behaviors matched the respective student-indicated behaviors regarding intelligence domains.

Beam (2000) compared the two modes of instruction, the theory of multiple intelligences and traditional textbook-teacher instruction in social studies for fifth grade students. The study was conducted in a public school setting. The sample consisted of twenty-four fifth grade students and the study continued for five-weeks. At the end of the five-week period, a t-test was used to analyze the mean scores.

No significant difference in the achievement level of the control group and the experimental group was found. But, the examination of one's multiple intelligences and the correlation to teaching and learning styles made the researcher aware of an obligation of educators to distinguish the abilities and intelligence of each students. It was mentioned that instructional methods should correlate to facilitate learning of every child after determining his/her strengths and weaknesses of a gamut of intelligences in the classroom.

Ford (2000) conducted the quasi-experimental study with a purpose to test the effectiveness of integrating multiple intelligence techniques and Integrated Thematic Instruction (ITI) in improving student achievement for seventh grade students in Junior High school. The seventh grade students of one Junior High School located on a military base were systematically divided into two groups. One group was taught by traditional instruction and the other group was taught by the instruction which integrated multiple intelligences and ITI in their Mathematics, English and Social Studies classes. The Iowa Test of Basic Skills (ITBS) was used as the pre and posttest with twenty-nine weeks of treatment of ITI and MI in the experimental group.

Significant differences were found in relation to instructional group membership as students in the traditionally instructed classes had higher pre to post test gains in Reading Comprehension than students in the MI / ITI instructed classes. It was found that the students in the MI / ITI instructed classes had higher pre to post test gains in Language Totals than the students in the traditionally instructed classes. Students' scores on ITBS pre and posttest were not greatly affected by their parents' rank in military and ethnicity of the students. Officers' children got significant higher scores on every ITBS test integrated for both pre and posttest. The same was true with white students' scorings significantly higher than non-white students.

Muehlbauer (2000) studied the effects of an arts- infused Multiple Intelligences program on Mathematical Achievement wherein teachers' perceptions of students' mathematical achievement was also sought. Students of grade - three and four of the elementary schools enrolled in the program of "Different ways of Knowing." (DWoK) were compared in mathematical achievement of grade - three and four students in four non-program schools. Ten teachers from the DWoK School took part in the teacher perception survey. To analyze the data, t-tests and descriptive statistics were used.

No statistically significant effects of the arts-infused, multiple intelligences program on students' mathematical achievement was found. Grade-3 results showed a statistically significant difference in conceptual understanding of the students in the non-program schools. More students of grade-4 in the DWoK schools met the achievement standard compared to the non-program schools.

Nguyen (2000) conducted the study to see differential effects of multiple intelligences curriculum on student performance. The Fuller School with its diverse population in Gloucester, Massachusetts was taken up to test the use of multiple intelligences as a foundation for its curriculum.

The results of California achievement Tests/5 (CAT/5) for grade 5 showed no differences between the students in multiple intelligence and the traditional school programme. But, the two report card outcomes at the sixth grade level – Mathematics and Physical Education- and an interaction of Programme- type with Home - language on Music were found to be significant. Even though the magnitude of these differences was not large enough to conclude that the multiple intelligence treatment was effective in producing larger standardized test scores than students in the non-multiple intelligence program.

Schirduan (2000) examined to determine how ADHD (Attention Deficit Hyperactivity Disorder) students fared in Schools Using Multiple Intelligences Theory (SUMIT). The conceptual framework of the theory of multiple intelligences, predominant intelligences, self-concept and achievement level of students were studied. A purposeful sample of eighty-seven students with ADHD in grades 2 through 7 in 17 SUMIT sites was drawn. Information was collected using nine sources of data: The Multiple intelligences Development Assessment Scales (MIDAS), the Piers Harris Children's Self-concept Scale (PHCSCS), Teacher Perception of Achievement Level in students with ADHD Survey, Teachers' interviews, Students' interviews, Parents' interviews, a Principal's Interview, Documents and Contextual Information. Qualitative data were triangulated and validated using coding technique. Quantitative data were analyzed statistically.

The analysis showed that more than half the students with ADHD reported to possess the naturalist and spatial intelligences as their predominant intelligence. Students with ADHD in SUMIT sites scored average self-concept and average achievement level. It was reported that multiple intelligence theory may be the curricular response needed to further the goal of having students with ADHD live up to their fullest intellectual and emotional potential.

Arnold (2001) took up the causal-comparative study to determine the relationship between implementation of Gardner's theory of multiple intelligences and fifth graders' attitudes toward school. The students of 300-mile radius of Kingsport, Tennessee constituted the population. Data were collected from five schools identified as implementing multiple intelligences theory, five schools identified as partially implementing multiple intelligence theory, and five schools identified as not implementing multiple intelligences theory in educational planning. Surveys were administered to students of fifteen elementary schools.

No significant difference in students' attitudes toward school among fifth graders attending schools implementing multiple intelligence theory, fifth graders attending schools partially implementing multiple intelligence theory and fifth graders attending schools not implementing multiple intelligences theory was found. No gender related differences were also found. The major conclusion was that institutions having good academic records, community support and a dedicated faculty and others identified in the review of literature could affect students' attitudes toward school and possibly contribute to the closeness of the means among the three implementation group.

Cobb (2001) studied the effect of multiple intelligence teaching strategies on the reading achievement of fourth grade elementary school students. The multisite case study was used to examine the effect of multiple intelligence theory (MIT) employed in teaching strategies of four Miami-Dade County elementary Public Schools. The sampling selection was obtained from sixteen teachers' who taught fourth grade during the 1997-98 school years. Pre-conference interviews of school site administrators and in-depth interviews of samples were conducted.

A twelve-week program using integrated multiple intelligence theory, academic and behavioural strategies were employed. It was found that all the twelve students showed increase in reading and behavioural skills as a result of multiple intelligence theory strategies.

Dobbs (2001) examined the relationship between implementation of the Multiple Intelligences Theory in the curriculum and student academic achievement at a seventh grade at risk alternative school. The three-year comparative study employed forty-five randomly selected students (15 students for each year of the study) and six core subject teachers as project participants. The students' results from three standardized tests, responses to a multiple intelligence survey administered to students, and a multiple intelligence survey administered to selected core subject teachers were analyzed.

Findings indicated a significant relationship between multiple intelligence theory implementations in the curriculum and academic performance in Mathematics, reading and writing, but not in other core subject areas. For experimental group II, no statistically significant difference in the academic growth in any one-subject area was found but a second measure reflected a statistically significant difference in the academic growth in mathematics and reading for experimental group II. It was recommended to replicate the curricular, instructional and assessment practices used in mathematics, reading and writing during implementation of the multiple intelligence theory in the curriculum for all core subject areas to improve student academic achievement at the project alternative school.

Walker (2001) studied how multiple intelligences were used to provide a differentiated instructional program in a middle school structure. It included a total of fourteen participants, three eighth grade students, five teachers, co-coordinator of the districts' special education program, mothers of each of the students, and the father of one of the students.

The major results of the study reflected that (1) three young adolescent participants liked learning about multiple intelligence and they had clear ideas about how they would prefer to show their learning. (2) Multiple Intelligences was consciously used by the two out of the five teachers.

Cutshall (2003) conducted the study in eastern Tennessee eighth grade science classroom in which ninety nine students participated. A project-based assignment was designed and assigned to students to address their innate multiple intelligences. Students were asked at the end of each project unit to express their integration of project base unit in one of eight ways in the intelligence menu. The focus of the research was to study how the middle school science students conceptualized to integrate their project based science unit and its relationship to unique multiple intelligences. The project based unit helped students to learn either in linear or non-linear way based on their choice in personally diverse modalities. The result of Multiple intelligences Development Assessment Scales (MIDAS) did not show better evidence for the integration of skills. It was found that more number of students selected spatial intelligence for the integration of skills.

Davis (2004) attempted to improve the academic achievement of fourth grade students of a rural elementary school exhibiting low academic achievement in science for the period of total three months. The multiple intelligences (MI) theory and brain-based learning were utilized to develop the IMPACT strategy. The one-group/pretest-posttest research design model was used. Twenty students completed and they did the science class work assignments daily. They exhibited appropriate behavior for learning during science. The parents of the twenty students also reported an improvement in the students' behavior at their home as well. A positive attitude about learning in science was found to be developed. The significant improvement in students' achievement, behavior, and self-esteem was found. The study recommended that more input regarding learning activities should be provided along with monthly parental involvement, and in-depth study for above mentioned strategy. It was mentioned that teachers could use this strategy to increase students' academic achievement and to enhance their own professional development.

Dillihunt (2004) examined the effects of multiple intelligence and direct instruction on third and fifth grade students' achievement, task engagement, and students' motivation and teacher's efficacy. Results suggested increase in the performance of students of multiple intelligences classes' on post intervention in mathematics. The students' motivation did not increase, but students' task engagement did increase in the multiple intelligence classrooms. Teacher efficacy showed no increase. It was mentioned that the teachers should develop various strategies to accommodate various intelligences of their students and place all students at promise for academic success.

Fortner (2005) examined pedagogical practices through brain-based learning in multiple intelligences theory. It was a quantitative correlation study. In which, relationship between middle school English teachers' instructional practices and students' achievement was studied. A questionnaire for demographic information was used to gather data. An instructional practice survey developed by the researcher to measure pedagogical practices related to brain-based learning in multiple intelligences theory was also used to gather required data. Pearson R test was used to determine the correlation existed between brain-based learning in multiple intelligences theory instructional practices and students' achievement. After the interpretation of data, the department chairpersons at each school were interviewed to validate the inferences drawn from the findings. Results suggested application of multiple intelligences theory into instructional practices as a means to improve students' achievement.

Peoples-Marwah (2005) examined the effects of visual/spatial and musical intelligences on sixth grade Ohio proficiency test (OPT) mathematics scores. The sample constituted students of grade seven and MIDAS-KIDS was employed to gather information regarding students' individualized interest in musical as well as visual ability. The study covered three traditional schools and one multiple intelligence based school. The result showed musical intelligence (instrumental) had a positive effect on mathematics OPT scores. The students of MI based school showed higher performances on the mathematics OPT. Hence, suggestion was given with a policy relation for the implementation of MI within school curriculum provided that it might be valuable and beneficial in the establishment of producing stronger academic skills and testing performance.

Sarrazine (2005) utilized aspects of multiple intelligences theory in both the classroom and planetarium setting to create an increase in students' learning about the moon and lunar phases. The study made use of free-response questionnaire and pre-test/post-test design. The study identified middle school students' misconceptions and measured increases in students' learning about the moon and lunar phases. The study covered two semesters and contained six treatment groups which consisted of both the single and multiple interventions. One group only attended the planetarium program, and two groups attended one of two classes a week after the planetarium program. The most rigorous treatment group received a class both a week before and after the planetarium program. It was found that all six groups demonstrated statistically significant gains in knowledge at 0.05 level. No significant differences were found between students who attended only a planetarium program and who attended a single classroom program. The students who attended either a pre-planetarium class or a post-planetarium class did not show a statistically significant gain over the planetarium situation. Both the groups: pre-planetarium class groups and post-planetarium class groups exhibited equivalent effects on student learning. It was therefore, determined that the treatment of the second intervention did not have a significant impact on student learning. A decrease in learning was observed with the addition of a third intervention. It was, mentioned that further instruction and testing hindered students' learning perhaps due to fatigue of the students.

Walker (2005) studied the effect of MI over increasing verbal participation of gifted females. The objectives were to identify causations of the girls' reticence to demonstrate verbalization skills which were commensurate with those of their male counterparts and to develop strategies to promote increased female verbal participation in classroom discourse. All the gifted learners were observed daily. The frequency noted down with respect to which each gender communicated verbally and initiated verbal contact. They were offered higher-level query, and engaged in dialogue with teachers. All students were interviewed four times during the study. The

Bar-On Emotional Quotient-Inventory: Youth Version was administered to collect the pre- and posttest data.

Little significant change in female students' emotional quotient above the mean was found out. Tallies on the observational sheets documented an increase in verbal participation by the female learners. However, the females' frequencies of self-initiated speaking and responses to higher-level inquiries did not increase to the levels projected. It was recommended to establish positive and non-competitive learning environments which would focus on increasing verbal participation by all reticent students.

Hilyer (2007) developed and implemented intervention strategies for underachieving and at-risk middle level students. The interventions included hands on approach, MI instruction, emphasis on student organizational skills, differentiated instruction, and specific communication techniques. The experimental group comprised of thirty-nine at-risk and underachieving grade VII students while the control group had total fifty-three students with varied behaviour histories. This study made use of quasi-experimental design to measure the changes in students' academic performance, attendance, behaviour, and self-esteem. A paired-samples t-test and a t-test for independent distributions were employed. It was reported that improvements might be due to the active and engaging strategies provided by the treatment. It was further stated that this improvement might help more students to find success at the middle level and reduce the number of drop-outs from school before their graduation.

Taylor (2007) studied the effects of multiple intelligence self-assessment intervention on adolescents' career decision self-efficacy. The MIDAS and Career Decision Self Efficacy Scale (CDMSES) were employed to gather the required data for the study. The sample covered seventy-one adolescents (grades 6-8) attending a rural middle school in south central Alabama. A randomized controlled trial was used to make equivalent comparison groups in which one group underwent the MI based intervention. The control group did not undergo any type of intervention. ANCOVA was used to examine the between-group differences on the posttest CDMSE scores. No difference was found between the experimental and the control groups on the posttest CDMSES. It was mentioned to undertake more researches to examine the applicability of the MI theory in enhancing adolescents' career development. It was suggested to apply the MI theory to understand how individuals made important career decisions and at what ages these decisions could be influenced by parents, educators, and counselors.

Bellflower (2008) conducted case study with a mixed method approach to study the perceived benefits of multiple intelligences instruction to examine its impact on students' learning for fifth grade students in social science subject. Two fifth grade classes in a rural, Georgia school were instructed using a twelve-week Civil War unit. The pre-test means were compared using a t-test. It was confirmed that the two groups were similar with respect to their test scores at the onset of the study. The posttest results showed statistically a higher gain than the control group in achievement. A likert scale questionnaire of four declarative statements was administered to the treatment group following each multiple intelligence lesson. The questionnaire offered responses from strongly agree to strongly disagree alongwith open-ended questions pertaining to the lesson. The results of questionnaire showed that participants were motivated and had positive attitudes towards the multiple intelligences lessons which stimulated their learning.

Cooper (2008) examined the impact of multiple intelligences and meta-cognition on the students' achievement in mathematics. The study used mixed-method, quasi-experimental research design. The treatment was continued for the period of eight-week. The total sixty-four students: thirty-four were in the treatment group and twenty-nine were in the comparison group were drawn as a sample. MIDAS was used to collect the quantitative data to assess the multiple intelligence development. The qualitative data was collected using Mathematics inventory (MI), Meta-cognition Awareness Inventory (MAI), and interviews. It was found the MIDAS treatment group outperformed the comparison on the posttest on a greater number of dimensions. For MAI, even though no significant difference was found between the two groups on this instrument, the treatment group performed slightly higher on the five of eight dimensions.

Fink (2008) conducted study with a purpose to examine the use of Howard Gardner's Multiple Intelligences theory in the classroom and its implications for classroom use in movement education. (Dance). The archival data including lesson plans, videotapes, teacher-designed assignments, and workshops throughout previous school years were used to describe instructional practices and students' learning styles. The interviews with administrators and vignettes describing students' experiences with dance and authentic performances were also the part of the data. It was concluded that there existed a connection between dance, improved academics, and the eventual closing of the achievement gap for many diverse students' populations. It was mentioned that role of the teacher in MI theory was to discover and nurture intelligences of students and excitement, creativity, and learning outcomes were well worth for the effort.

Gibson (2008) investigated the effect of adding drill and skill practice using spatial, kinesthetic and musical intelligence, with Connected Mathematics Project on mathematics achievement of the sixth grade students**.** Total one hundred eighty five, sixth grade students at a middle school in the Midwest region of the US were taught using Connected Mathematics Project (CMP) + drill and skill (MI) or CMP + drill and skill (traditional paper and pencil). A 2 X 2 ANCOVA showed that scores on a mathematics common assessment improved over time for both the groups but the CMP + drill and skill (MI) group improved more. It was found from the results that five of seven dominant intelligence groups improved more when taught using CMP + drill and skill (MI). The finding further suggested that CMP + drill and skill (MI) was a potentially effective way to teach mathematics. It was further stated that educators might use the MI theory to create classrooms meeting the needs of all students by allowing them to utilize their dominant intelligence(s). This could lead them to more success on standardized assessment, stronger relationships with educators and peers, and a decline in high school dropout rates.

Mussen (2008) designed and implemented a quantitative research study to compare the effect of multiple intelligence pedagogy and traditional pedagogy on grade five students' achievement and attitudes towards science. Due to low state standardized test scores in the district for science, students' achievement and attitudes towards learning science were evaluated on a pretest, posttest, essay question and one attitudinal survey. ANCOVA suggested significant difference in students' attitude towards learning science for MI (experimental) group. On the contrary, no statistically significant difference was found in students' achievement on the posttest, delayed posttest or the essay question test.

O'Connell (2009) conducted a case study to investigate how communal support, teacher rapport, and learning styles influenced students' underachievement in two urban middle schools in northeast Ohio. The study investigated the influence of Gardner's theory of multiple intelligences, communal support, and teacher rapport on academic performance. Six students were specifically selected to take part in the study. The data from observations, interviews and journals were analyzed to determine the influence of communal support, learning styles and teacher rapport on student underachievement. The triangulated data were individually coded using a matrix and then, these were collectively coded on a template to identify commonalities and form interpretations surrounding student engagement and motivation. It was found that students' achievement was enhanced by using student-centered learning styles, increased communal support in schools, enhanced teacher rapport, and increased student understanding of resiliency and its effects on student learning. The researcher recommended that educators need to adjust their teaching styles to match learning styles of their students, increase communal support in schools and motivate students to actively engage themselves in lessons to increase their desire to perform academically.

2.3.1 Implications - Studies Conducted in the Area of Multiple Intelligences at Elementary Education

Following observations are drawn on the basis of total thirty five studies reviewed so far in the area of multiple intelligences at Elementary Education.

Teele (1994) emerged model-defining relationship between multiple intelligences and the instructional process which was found interactive with the normal students. **Carson (1995)** obtained the statistically significant higher gain result in favour of experimental group for fifth grade students of bilingual center elementary school in Orange County, Florida and reported that the number of problems attempted, the elegance of solutions, and the accuracy of responses in the experimental group was improved upon for mathematical problem solving. **Mueller (1995)** reported that the division of cooperative learning groups by multiple intelligence strengths was not detrimental to the students' learning of content knowledge for learning of human body content. Hence, one can say that MI based groups can be formed by teachers. It can be inferred from the study of **Rosenthal (1998)** that Gardner's theory of MI may be one viable instrumental strategy for teachers to enhance self-esteem of students of fourth grade. **Beam (2000)** found no significant difference in the achievement level of the control group and the experimental group. **Muehlbauer (2000**) found no statistically significant effects of the arts-infused, multiple intelligences program on students' mathematical achievement but grade-3 results showed a statistically significant difference in conceptual understanding of the students in the non-program schools while more grade-4 students in the DWoK (Different Ways of Knowing) schools met the achievement standard compared to non-program schools. **Nguyen (2000)** expressed that magnitude of difference was not large enough to conclude that multiple intelligence treatment was effective in producing larger standardized test scores than with students in the non-multiple intelligence program. **Schirduan (2000)** reported that multiple intelligence theory may be the curricular response needed to further the goal of having students with ADHD live up to their fullest intellectual and emotional potential.

Arnold (2001) discovered no significant difference in students' attitudes toward school among fifth graders attending schools implementing multiple intelligence theory, fifth graders attending schools which partially implementing multiple intelligence theory and fifth graders attending schools which did not implement multiple intelligences theory. **Cobb (2001)** reported all the twelve students showed increase in reading and behavioural skills as a result of multiple intelligence theory strategies. **Dobbs (2001)** found significant relationship between multiple intelligence theory implementation in the curriculum and academic performance in Mathematics, reading and writing, but not in other core subject areas and recommended to replicate the curricular, instructional and assessment practices used in mathematics, reading and writing during implementation of the multiple intelligence theory in the curriculum for all core subject areas, to improve students' academic achievement at the project alternative school.

Davis (2004) used multiple intelligences (MI) theory and brain-based learning which was utilized to develop the IMPACT strategy to improve the academic achievement of fourth grade students in science. A positive attitude about learning in science was found to be developed. The significant improvement in students' achievement, behavior, and self-esteem was also found. **Dillihunt (2004)** examined the effects of multiple intelligence and direct instruction on third and fifth grade students' achievement, and found an increase in the performance of the students of multiple intelligences classes and suggested that teachers should develop various strategies to accommodate various intelligences of their students to place all students at promise for their academic success. **Fortner (2005)** suggested application of multiple intelligences theory into instructional practices as a means to improve students' achievement. **Feeney (1999)** also indicated a highest level of change in students' performance when multiple intelligences theory was implemented.

Mueller (1995) found that making of students' groups based on MI was not wrong for science teaching. **Cooper (2008)** examined the impact of multiple intelligences and Metacognition on the achievement of mathematics students and found that the multiple intelligences treatment group outperformed the comparison on the posttest on a greater number of dimensions. **Mussen (2008)** found significant difference in students' attitude towards learning science for MI (experimental) group but no statistically significant difference was found in students' achievement on the posttest, delayed posttest or the essay question test. **Ford (2000)** found the traditional class attained higher gain in reading comprehension but lower in language total than the experimental group. **Peoples-Marwah (2005)** found positive results for teaching of mathematics based on MI. **Dillihunt (2004)** and **Gibson (2008)** also found increase in achievement in mathematics.

There were also scattered studies with reference to variables like self-esteem, attitude of students towards school, students with respect to race and age wise grades of students. Two researchers employed TIMI, while one attempted to construct MI inventory with a special importance to teaching of poetry. It became apparent that the researchers were interested to study the contribution of MI to an academic performance either as a whole or in a particular subject. Looking to the studies, it is evident that there is dearth of MI based studies in teaching science at the elementary level in India. Irrespective of specific discipline, MI is generally found to bring positive impacts on academic performance, but it is too early to generalize in lacuna of good number of studies and that too, in Indian context. Without further falling into debate about what is good number as such it is not the aim to discuss, the reviews helped the researcher to conduct an experimental study in Elementary Education.

2.4 Studies Conducted in the Area of Multiple Intelligences at Secondary and Higher Secondary Education

Weber (1994) conducted the study to develop an interactive curriculum development model involving high school students and teachers, which drew upon a constructivist and Howard Gardner's view of learning. This study continued for ten-month period during one school year. Along with other research questions, it was attempted to know the role of teachers in the development of the multiple intelligence Theory Application Model. Sample constituted eight grade ten students and four grade ten teachers.

Findings revealed that the change within the curriculum content, consistent with both constructivist and multiple intelligence views of learning would enable students to develop further their individual differences and particularly the high school student participants endorsed such change.

Adamus (2000) conducted qualitative case study which described how high school students exposed to the multiple intelligences theory altered their perceptions of reality as a result. The sample of this study was Alpena High School in northeast Michigan. Six eleventh graders, three boys and three girls were randomly selected to serve as participants in this three-week study who completed a self inventory of their multiple intelligences strengths and weaknesses. Following major results were found.

(1) The multiple intelligences helped participants to recognize and tolerate others' multiple intelligences profiles. (2) Participants used multiple intelligences theory to heighten relations with friends and family to evaluate their chosen career pathways.

Shalk (2002) investigated the relationship between multiple intelligences and achievement as measured by Delaware Student Testing Program (DSTP) Scores in reading, mathematics and writing. A population of one hundred thirty-two high school sophomores completed both the 'Multiple Intelligences Developmental Assessment Scales (MIDAS), state tests in reading, writing and mathematics in the spring-2000. Findings were as under.

(1) Results substantiated the existence of distinct profiles of intelligence in relationship to state test scores. (2) For reading scale score, linguistic and interpersonal intelligences emerged as the key profile intelligences. (3) For mathematics scale score, logical-mathematical, linguistic and interpersonal were the profile variables. (4) The percentage of the explained variance was low indicated that the relationship between multiple intelligence and standardized test achievement was present but weak, at least as defined within the parameters of this study. The results suggested that the usefulness of multiple intelligence profiles as predictors of achievement on standardized tests were limited.

Hardy (2005) conducted qualitative ethnographical study to examine how three secondary students learnt focusing particularly on what happened when they were empowered to use their academic strengths to resist traditional practices of the dominant culture. The writings of the students, and interview were examined under the theoretical constructs of multiple intelligences and a critical theory. The data was also collected using the results of MI test, classroom visits, lunchroom observations, and focus group discussions. It was found that the student's awareness of their learning strengths should be integrated into instructional practices because their academic achievement was severely limited when students' optimal way of learning was different from the instructional mode of the teacher. The findings of the study suggested multiple intelligences theory as a viable way for students to confront to instruction. It was necessary to recognize a wider range of academic strengths beyond mathematics and verbal skills for the educational environment to become equally optimal.

Hodge (2005) synthesized the literature in order to assess and quantify the relationship between MI instructional approaches and student Achievement indicators in secondary school classrooms (grades 6-12).

This study concluded that (1) A very limited amount of research focusing on the relationship of MI instructional approaches and student achievement indicators in secondary school classrooms existed, (2) The studies included in this research synthesis failed to prove causation in the relationship of MI instructional approaches and student achievement indicators in secondary school classrooms. (3) Substantial evidence existed showing that multiple intelligences theory contributed positively to students' learning and development. (4) Further research was needed to quantify the relationship between MI instructional approaches and academic achievement indicators in secondary classrooms.

Trevino (2005) compared the influence of Gardner's multiple intelligences on at-risk limited English proficient (LEP) students on high achieving Hispanic high school students. It was found that eleven of the thirteen students of LEP group showed the linguistic intelligence as dominant and met the state standard. Five of the ten students showed other dominant intelligences met the standards. For non-LEP high achieving group, twenty-two of the twenty-five students showed a dominant linguistic intelligence which met with the standard. In mathematics, nine out of the twenty-three students having math as the dominant intelligence passed and only one of the two showing 'other' dominant intelligences met the state standard. For non-LEP High achievers' group, nineteen of the twenty-three with math as the dominant intelligence met the standards. Also, 100% of the students with 'other' dominant intelligences met the standards. It was recommended to incorporate multiple intelligences teaching and training for schools and universities.

Shuhan (2006) adopted an interdisciplinary approach to secondary mathematics class activities in which the influence of multiple intelligences inspired tasks on students' learning of geometric concepts was studied. The study sought to see how multiple intelligences inspired multidisciplinary tasks contributed to improve test scores in a high school geometry class. It was the first study to examine the impact of MI inspired tasks in a traditionally scheduled high school geometry class. The instrument used to generate MI profiles was the teen MIDAS by Shearer in 1996. Students' experiences revealed an elevated level of engagement in the learning process. The 96% of a sample of forty-six geometry students demonstrated an increase on an objective peer-reviewed publisher provided chapter-test.

Daniel (2007) conducted study at ICSE school of Namchi, the south district of Sikkim with the objectives: (1) To map the Multiple Intelligences Profiles (MIPs) of teachers as well as that of the students. (2) To enable teachers to carry out the instructions using the MI instructional strategy. (3) To assess the achievement of students following instructions in the multiple intelligence way, and (4) To assess the teachers' instructional behavior as the result of the training in the theory of Multiple Intelligences. Major findings were as under.

(1) The motivation level of students was increased and they became better motivated towards their studies. (2) Self-perception and self-confidence of the students were improved, (3) Improvement in academic achievement of students was seen, (4) Knowledge of the MIPs of learners helped teachers to know their learners in a better manner and the teachers learnt to challenge gifted students more while they learnt to treat the slow learners compassionately. (5) Parents showed greater concerns for the education of their children and they assisted them in their studies at home, particularly, in their project works.

Willimas (2009) explored teachers' perceptions of intelligence of eleventh grade black male students and how students perceived their own intelligence in the light of the Howard Gardner's theory of multiple intelligences. The study made use of qualitative research methods to gain novel understanding of the students' and teachers' feelings, and perceptions. Twenty-six students from a large urban school district in the Southeast section of the United States took part in online survey of Gardner's multiple intelligences. From these, seven black male students were selected and interviewed along with ten of their teachers. It was found that despite the negative stereotypes toward Black males by society, the Black male students interpreted intelligence to be multifaceted. The Black male students were resilient in debunking the idea that Black males were not considered intelligent in a society where negative black male stereotypes abound. It was found that the teachers of the Black male students perceived them as intelligent and interpreted intelligence to be multifaceted.

2.4.1 Implications - Studies Conducted in the Area of Multiple Intelligences at Secondary Education and Higher Secondary Education

Studies in the field of MI at Secondary Education were less in numbers compared to the studies in Elementary Education. There were nine studies were reviewed at Secondary and Higher Secondary Education. Generally studies attempted to understand the impact of MI over academic performance. Nonetheless, studies were few in numbers and quite scattered to synthesize in a particular subject. **Adamus (2000)** reported MI theory helped randomly selected six eleventh graders; three boys and three girls to develop relations with friends and family at higher level which helped them to evaluate their chosen career pathways. **Shalk (2002)** used MIDAS and suggested linguistic and interpersonal intelligences as the key profile intelligences for reading scale score while logical-mathematical, linguistic and interpersonal were the profile variables for mathematics scale score. **Shalk (2002)** found weak relationship between Multiple Intelligence and standardized test and pointed out that the use of Multiple Intelligence profiles as predictors of achievement on standardized tests limited. As such, there was no such other study to substantiate findings of **Shalk (2000)**, educational researchers must take initiative to conduct MI based instruction to test in particular subjects in depth either implementing MI across the curricular subjects or the implementation for a particular subjects so that meta analysis can be made possible to explore the predictability of MI profiles to achievement in standardized test.

Hardy (2005) suggested that multiple intelligences theory may be a viable way for students to confront to instruction. **Hardy (2005)** further emphasized to recognize a wider range of academic strengths beyond mathematics and verbal skills for educational environment to become equally optimal. **Hodge (2005)** found out substantial evidence for multiple intelligences theory that it contributes positively to students' learning and development. It was mentioned by **Hodge (2005)** that further research was needed to quantify the relationship between MI instructional approaches and academic achievement indicators in secondary classrooms. **Trevino (2005)** recommended for schools and universities to incorporate multiple intelligences in teaching and training. **Shuhan (2006)** implemented secondary mathematics class activities to examine the impact of MI inspired tasks in a traditionally scheduled high school geometry class and reported increase in state standardized test scores.

Daniel (2007) conducted study at ICSE school of Namchi, the southern district of Sikkim, India, and used MI inventory of **Armstrong (2000). Daniel (2007)** reported an increase in the motivation, and self-confidence of the students was improved. Moreover, improvement in academic achievement of the students was also seen.

2.5 Studies Conducted in the Area of Multiple Intelligences at Teacher Education

Rivera (1996) developed a Multiple Intelligences Inventory for teachers and attempted to validate an instrument which teachers could use to assess learners' abilities in the seven intelligences areas. The final version of the "Multiple Intelligences Inventory for Teachers" consisted of ninety-two behaviour descriptors of the seven intelligence areas. A Likert scale was provided for teachers to rate the students. Fourth and fifth grade teachers completed the inventories on target students randomly selected from their classes. R-technique factor analysis was used to analyze the three hundreds and six completed inventories. Reliability of the instrument was also examined through Cronbach's alpha test and found to be sufficient. The results of the factor analysis, however, failed to support the a priori constructs of the instrument. The results provided insight for further instrument refinement and analyses for future research studies.

Burke (1998) investigated the relationship between pre-service teachers' multiple intelligences profiles as defined by the work of Howard Gardner (1983) and the levels of complexity in their computer-based concept maps. The sample covered pre-service teachers (N = 20) enrolled in science methods course at a northeastern university graduate program. An initial questionnaire to determine pre-service teachers' computer and academic background was administered. Students were taught using instruction on how to develop concept maps and on how to create concept maps using the computer-based concept-mapping tool, Inspiration Circler. MIDAS instrument to determine their individual intelligence profiles was used. A unit on the 'Phases of the Moon' was taught after which the subjects took paper-and-pencil test and then prepared computer-based concept maps of their understanding of the material. The findings substantiated the hypothesis that strengths in multiple intelligences were predictive of success in concept mapping. Musical-rhythmic intelligence was found to be significantly correlated ($r = 0.54$, $p > 5.05$) with the level of complexity in the pre-service teachers' concept maps when Pearson product-moment correlation was calculated. Emerging finding suggested ascertaining students' MI profiles could increase teachers' understanding of their cognitive abilities.

Borrego (1998) examined environmental modifications implemented in the classroom by special education interns enrolled in a university in northern California. The study also explored the use of the seven multiple intelligences within the classroom and the teachers' background knowledge in multiple intelligences. Pre and post surveys were administered to twenty special education teacher interns. Pre- and post- survey percentages were calculated and compared. Following conclusions are drawn.

(1) Pre and post test comparisons indicated a marked increase (85%) in the number of books and articles read by interns regarding multiple intelligences, and (2) Results indicated that training provided in the multiple intelligences enhanced special education interns' ability to implement this strategy effectively in the classroom.

Chisholm (1998) assessed students' dominant levels of multiple intelligences in Gardner's list of total seven intelligences. It was a statistical study carried out in two parts. The first part included twenty teachers and comparative analysis was carried out on their scores on tests namely self-assessment, and "Teele's inventory of multiple intelligences" (TIMI). The experiment in multiple intelligences showed some significant results in the areas of sex, and grade that would be useful for educators and curriculum developers in designing curriculum changes to meet the needs of all students.

Hansen (1998) tried (1) To assess the distribution of Gardner's multiple intelligences within a pre-service teacher education population, and (2) To develop methods for inclusion of Gardner's multiple intelligences theory in a teacher preparation program. The sample was drawn from the elementary education classes taught at Ricks College in Rexbury, Idaho. The multiple intelligences Developmental Assessment Scales (MIDAS) developed by C. Branton Shearer were used to ascertain the distribution of intelligences in the population.

An informal survey of educators including teacher educators was conducted where respondents were asked to complete researcher-designed survey indicated the percentage of each of the eight intelligences in which a successful teacher should possess strength. They all were generally agreed that distributed strength in all intelligence was required for having success in elementary school but the agreement was much less in the secondary school subjects.

Engstorm (1999) studied teachers' perception of their professional growth needs in translating multiple intelligence theory into practice.

Findings were: (1) Motivation for ongoing professional development was derived from an internal source and was also influenced by the other school improvement efforts recently advocated in the district, (2) Teachers implemented classroom practices at a gradual; comfortable pace. They typically developed routine classroom practices based on initial implementation efforts, (3) Teachers' preferred support mechanism included collegiality with peers, collaborative endeavours between the district and the local university, and the district's staff development program options, and (4) Obstacles found to continue professional development included lack of time available, lack of support structures at the building level and ongoing follow-up and support.

Picanco (1999) evaluated a portion of a gifted and talented inclusion program. The focus was on student and teacher perceptions of curricular differentiation in an inclusion program based on Gardner's theory of Multiple Intelligences and the professional development needs of the teachers. Questionnaires and focus group interviews were used to collect data from the fourth and the fifth grade students and teachers.

Major results were: (1) Teacher was differentiating the aim according to the Multiple Intelligences for at least some of the time in the classroom, (2) Students and teachers both agreed that the verbal-linguistic, logical-mathematical, visual-spatial and interpersonal intelligences were accommodated for more often than the other intelligences, (3) Teachers most often used methods like projects, flexible groups, interest groups, contracts and multi-modal activities to accommodate student needs, and (4) Students told they felt challenged in school, liked learning and felt good about their abilities very often in school.

Goodnough (2000) conducted a qualitative case study to explore Howard Gardner's theory of multiple intelligences and its merit for making science teaching and learning more meaningful. The audio taped action research meetings, field notes, semi-structured interviews, journal writing and concept mapping were used for data collection. The researcher attempted to provide a forum for teachers to engage in critical self-reflection about their theory and practice in science education.

Many positive outcomes resulted from the study on areas such as curriculum development, teacher development, and student learning in science. Through the process of action research, the participants became more reflective about their practice. Thus, participants enhanced their pedagogical content knowledge in science, gained a greater understanding of how they learn, and experienced a science curriculum that was more relevant to them.

Campbell (2001) attempted to study the beliefs about intelligence, students and instruction held by those teachers who were familiar with the theory of multiple intelligences. The second purpose was to explore participants' beliefs about students' intelligence. The sample included six elementary and five secondary teachers who were the proponents of Gardner's theory of multiple intelligences. There were two interviews of the teachers including two observations and questionnaires.

It was found that upon learning about MI, ten of the eleven teachers reported that their beliefs about intelligence changed. It was found out that differences existed among elementary and secondary teachers' beliefs about intelligent students. The elementary teachers cited intrapersonal qualities while the secondary educators cited thinking skills as indicative of intelligent students. The impact of MI theory upon instruction also differed among elementary and secondary teachers. MI theory affirmed elementary teachers' instructional practices while secondary teachers said it altered their instruction. An unexpected finding was the participants' uncertainty that education could develop intelligence. This study suggested the need to increase teachers' exposure to theories of intelligence.

Vivona Fedina (2001) tested the null hypothesis that there were no significant differences in the perception of teachers on the impact of multiple intelligences classes vs. gifted education on the motivation, curriculum and academic achievements of gifted students. The sample was composed of thirty teachers of the gifted education on a middle school level, from twenty-four school districts in a northern New Jersey county. A survey entitled *'Fedina Perceptions of Teachers on the Implementation of multiple intelligences Curriculum on Gifted Students'* was developed to examine the perception of the teachers. Survey instrument was a self-administered twenty-items Likert format questionnaire where five response options were available.

The findings indicated that the teachers of the gifted education perceived that multiple intelligences programs did not have a more significant impact on the motivation, curriculum and academic achievement of gifted students than gifted programs'.

Weiner (2001) investigated the commonalities among those elementary school of United states which implemented the theory of multiple intelligences. In this qualitative study, the research design made use of survey method. Two cross-sectional surveys were used as tools. Twenty school participants were involved in the study through completing a phone interview questionnaire survey. To focus further upon the information given by the principals, teacher questionnaires were sent to two or third or forth grade teachers per school. To analyze the data of principal interviews and teacher questionnaires, content analysis was carried out and data was triangulated through an ethnographic study of three elementary schools selected out of twenty participating schools.

Some of the most common guidelines observed were: monthly in-service days for teacher collaboration on multiple intelligence curricular ideas, incorporation of an integrated arts program enhanced an multiple intelligence curriculum, computer assisted instruction and multiple intelligence learning centres as instructional methods. The encouragement of students to recognize and identify their different intelligences, incorporation of the eight intelligences with understanding and depth and the use of authentic based assessments were also some of the most common guidelines observed by the researcher. The investigator recommended research to examine the achievement factors in MI schools and to compare the results to non-MI schools. The researcher also recommended using multiple intelligences in the classroom and to view each student from a strength perspective in multiple intelligences.

Gold (2002) undertook the case study of teachers' knowledge and attitudes toward utilization of Multiple Intelligences in classroom practice. The purpose of this study was to describe classroom teachers' awareness of Gardner's theory of Multiple Intelligences, their use of the knowledge of these theories in their classrooms, and relation to the instructional environment.

The analysis of the data revealed themes in five areas: teachers' role and their responsibility, teacher demographic factors; school demographic factors, classroom practices, and classroom environment. These areas reflected issues surrounding teachers' infusion of Gardner's Multiple Intelligences theory into their classroom practices.

Gonzalez (2002) investigated the extent of commitment to Multiple Intelligences Theory (MIT) as perceived by principals in public elementary schools in Region I of Texas. A literature based panel-reviewed survey utilizing nine administrative categories in Texas as a framework was constructed and administered to a pilot study group of elementary school principals. The Pilot study results were used to revise the survey which was again subjected to a panel review producing the study survey. The same was administered to the study - elementary school principals. In survey, ten questions were asked to the principals encompassing the perceptions of the principal, superintendent, community and school board in the nine Texas administrative areas, and the area of school budget input. School demographics and principals' comments were also the part of the survey.

It was found that there were some statistically significant differences in the principals' perceived commitments in all the above areas except field trips. It was recommended to include the use of Multiple Intelligences theory into teacher and school administrator preparation programs, and to render training to the school personnel and college professors regarding multiple intelligences.

Toth (2002) conducted the study aiming to know the perceptions of teachers and implementation of multiple intelligence centered instruction in an elementary school of Connecticut.

It was found that: (1) Participating teachers' definition of multiple intelligence centered teaching was consistent with that of Gardner and agreed upon the fact that the use of multiple intelligence centered teaching strategies was helpful in their classroom, (2) The teachers varied in their implementation of multiple intelligence-centered teaching but inclined to focus their instruction toward the linguistic and logical-mathematical intelligences, (3) The findings also suggested that the teachers were increasing their understanding of how to incorporate the use of additional intelligence into their instruction.

Gannon (2005) examined the influence of a teacher's dominant multiple intelligence on classroom instruction, planning, and assessment. The study focused on five teachers employed at a Catholic elementary school in a large metropolitan area. It was found out that all five participants had different multiple intelligences. The researcher examined classroom instruction, teaching style, classroom environment, plan books, and student portfolios. The results of this study indicated that the teacher's experience and the school/archdiocesan requirements had more influence on instruction, planning and assessment than the dominant multiple intelligence of the teacher. This study also suggested a need for consideration of current assessment tools being used by teachers in classrooms and allowances for students to address different multiple intelligences.

Parrington (2005) investigated dominant intelligences and significant differences among multiple intelligences, if any including relationship between candidates' profiles and leadership. The study used quantitative method. Convenient sampling was used to draw the sample of the students (seventy students) of Denver Principal Preparation Program during the academic year 2004-05. The MIDAS was employed to know the multiple intelligences. There were significant differences between candidates' profiles of MI and linguistic, inter- and intra- personal intelligences were found to be dominant with a significant correlation with all three leadership variables. High correlation between leadership and linguistic along with interpersonal intelligence was found. The innovation was moderately correlated to linguistic intelligence and weakly correlated with interpersonal intelligence. It was recommended to undertake further research in Multiple Intelligences and leadership and application to educational leadership standards.

Iyer (2006) examined the instructional practices of teachers in schools running programs based on multiple intelligences (MI) theory. The research compared the instructional practices of the teachers at the Schools which used MI Theory (SUMIT) using categories established in a study by the National Center of Education Statistics (NCES) in the year 1994-95. The data from a total hundred teachers were collected from five SUMIT schools. The MANOVA results indicated significant difference in the instructional practices for elementary SUMIT and NCES teachers in the area of Classroom and Homework. MANOVA results did not indicate significant difference in the instructional practices of secondary and elementary SUMIT teachers.

The results provided empirical evidence that the teachers in SUMIT schools used identified instructional practices more frequently in their everyday teaching than do the NCES teachers. The results also showed that the secondary SUMIT teachers engaged students in higher order thinking skills, discussions, cooperative groups, and interactions with the teacher and other students more frequently than the NCES teachers. Consistent but small statistical significance was found in the Classroom and Homework between the NCES and SUMIT groups for elementary teachers.

Sellers (2006) studied the relationships among multiple intelligences and leadership styles of administrators in Kentucky child care facilities within directors, and those in training to become directors. "Teele Inventory of Multiple Intelligences" (TIMI) based on research by Howard Gardner was employed. The survey of ninety-eight participants from eight early childhood courses in the Kentucky Community and Technical College systems was conducted. Keeping into mind the small size of fifteen directors, the study did not support the significant relationship between multiple intelligences and leadership styles within aspiring directors of child care facilities in Kentucky. Reviews of the descriptive statistics indicated a viable relationship between interpersonal intelligence and an individual consideration leadership style.

Daniels (2008) conducted case study for middle school teachers with relation to multiple intelligences. The study used qualitative paradigm of research with a purpose to determine how four middle school content teachers joined their understanding of multiple intelligences theory with their application of multiple intelligences based activities in their respective content area classrooms. The research questions focused on an examination of theory understanding, lesson implementation, and teacher reflection on the effectiveness of multiple intelligences based activities. The social studies, mathematics, science, language arts were taken into consideration for this study. The semi-structured interviews, classroom observations, reflective interviews, and example documents that had been used in classrooms were used to gather the data. The key findings indicated teachers would benefit from additional training in multiple intelligences theory and that time and collaboration with colleagues would aid the development of application lessons. It further indicated that positive social change could occur when middle school teachers with a strong understanding of multiple intelligences theory and classroom application would use activities and techniques to create an instructional design for meeting the needs of their diverse student population.

Richen (2008) used a mixed methodology to study the third and fifth grade teachers practices and perceptions for the reading achievement at at-risk students in a title I elementary schools. The study involved twelve educators from a Metropolitan Atlanta Title I elementary school in the state of Georgia. A survey was carried out to determine how frequently a set of instructional and assessment strategies was implemented during reading instruction to teach at-risk third and fifth grade students. The study examined at-risk third and fifth grade students' reading scores on the Georgia Criterion Reference Competency Test (CRCT). The results indicated that 705 of the students scored proficient on the CRCT in reading because teachers implemented a variety of assessment and instructional practices in reading which addressed the multiple ways of learning. The results were found to be statistically significant and consistent with the multiple intelligences theory, Vroom's expectancy theory, and self-fulfilling prophecy.

Smith (2008) conducted quasi-experimental study and integrated MI (multiple intelligences) and AM (andragogical model) into a learner - centred classroom (treatment group) and compared the results to a traditional teacher-centred method. There were total fifty-eight pre-service teachers in the treatment group and fifty teachers in the control group. Pretest and posttest were used to measure knowledge acquisition along with the Principles of Adult Learning Scale to evaluate participants' preferences toward future instructional practices. The treatment group performed significantly better than the control group on the pretest-posttest difference measuring knowledge acquisition. But, the treatment did not result in statistically significant differences regarding influence toward future instructional practices. The social implication of this study is that by providing alternative methods which apply MI (Multiple Intelligence) and AM to accommodate adult learners, educators are more likely to improve both the learning outcomes and satisfaction of the adults in their classrooms.

2.5.1 Implications - Studies Conducted in the Area of Multiple Intelligences at Teacher Education

Total twenty one studies were reviewed in the area of multiple intelligences at teacher Education. **Burke (1998)** suggested ascertaining students' MI profiles could increase teachers' understanding of their cognitive abilities. **Hansen (1998)** reported that teacher educators generally agreed that distributed strength in all intelligence was required for having success in elementary school. But, much less agreement was observed in the secondary school subjects. It is therefore, evident that relationship of MI profiles of the teachers and curricular transaction along with academic achievement need to be studied. A large number of experimental studies need to be carried out for teaching various topics for pre-service teachers, too, including their lesson planning. **Goodnough (2000)** found that through the process of action research, the participants became more reflective about their practice. **Goodnough (2000)** reported that the participants enhanced their pedagogical content knowledge in science, gained a greater understanding of how they learn, and experienced a science curriculum that was more relevant.

Campbell (2001) suggested the need to increase teachers' exposure to theories of intelligence. **Weiner (2001)** recommended using multiple intelligences in the classroom which supported teachers in identifying students' strength intelligences and the opportunity to view each student from a strength perspective in multiple intelligences. **Gonzalez (2002)** recommended to include the use of Multiple Intelligences theory into teacher and school administrator preparation programs, and to render training to school personnel and college professors regarding Multiple Intelligences.

Smith (2008) integrated MI (multiple intelligences) and AM (andragogical model) into a learner –centred and discovered that the treatment group performed significantly better than the control group on the pretest-posttest difference measuring knowledge acquisition but the treatment did not result in statistically significant differences regarding influence toward future instructional practices. **Parrington (2005)** used MIDAS for eight intelligences and recommended to undertake further research in Multiple Intelligences and leadership and application to educational leadership standards. **Iyer (2006)** found out that the secondary SUMIT teachers were engaging students in higher order thinking skills, discussions, cooperative groups, and interactions with the teacher and other students more frequently than the NCES teachers.

Chisholm (1998) employed "Teele Inventory of Multiple Intelligences" (TIMI) to identify multiple intelligences of the teachers. **Sellers (2006)** also employed "Teele inventory of Multiple Intelligences" (TIMI). **Daniels (2008)** pointed out that positive social change can occur when middle school teachers with a strong understanding of multiple intelligences theory and classroom application use activities and techniques to create an instructional design for meeting the needs of their diverse student population. The study of **Richen's (2008)** was specific as it explored the third and fifth grade teachers' practices and perceptions for reading achievement at at-risk students in a title I elementary schools and found results statistically significant and consistent with the multiple intelligences theory, Vroom's expectancy theory and self-fulfilling prophecy.

2.6 General Implications for the Present Study

Generally, experimental and survey type studies were found to be in practice. Some studies also used qualitative and case study approach but were less in number. Some studies have used some of the intelligences given by Howard Gardner or originally seven intelligences only. Seven intelligences were considered by Armstrong (1987), Baum (1998), Chishom (1998), Sweeny (1998), Scott (1996), Miller (1999) Uysal (2004), and Sellers (2006). Majority of the studies were carried out at the elementary education but which are still not sufficient to arrive firmly about the effectiveness of MI based teaching method over the traditional methods of teaching in various curricular subjects. The experimental studies included academic achievement as a dependent variable. In survey type study, gender and race were the two variables observed as a dependent variable. Interview, opinionnaire and attitude scale were generally used for experimental, a quantitative paradigm of enquiry. Observation, students' records were a part of data for case study, qualitative paradigm of enquiry. The MIDAS (Multiple Intelligences Development Assessment Scale) and "Teele Multiple Intelligences Inventory" (TIMI) were used to know the multiple intelligences of the students. Scott (1996), Baum (1998), Chishom (1998), Miller (1999), Sellers (2006) used the TIMI inventory.

The t-test and other statistical tests such as ANCOVA were used by researchers to study the pre-test and post-test means score. Irrespective of level of education, generally, majority of the studies reported gain in academic achievement in a particular subject while a few studies suggested no statistically difference between control and treatment groups. There were a very few studies in the field of MI at elementary science teaching. But a good number of studies conducted in humanity based subjects especially reading aspect in language. There were some studies which applied MI theory in mathematics teaching. It was also found that students preferred MI based instruction in class. There were studies which reported limited predictability of MI based instruction to a standardized test. Hence, the relationship of MI based instructional strategy needs to be explored in detail in Indian situation also. There is need to confirm that whether MI application succeeds to reduce dropout rate. There were a few studies which recommended employment of the MI based instruction from the policy perspective and pointed out MI theory as a viable tool to enhance the self-esteem of the students. Except Daniel's (2007) study in India, there were few studies in the field of MI, and that too, at Elementary Education in India. Few studies were found for elementary science teaching based on the theory of multiple intelligences that suggested the need to conduct research in teaching of science using the theory of multiple intelligences as a broader framework.

CHAPTER - III

METHODOLOGY

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3.1 Introduction

The methodology provides complete panoramic view of the technicalities such as population, sampling, tools and techniques of analysis which is mentioned as under in subsequent sections. These details of the methodology assist reader to comprehend the procedure of the entire study.

3.2 Population

All the English medium private schools having standard 1 to 7 of Surat city constituted as population for the present study. There were total 91 English medium schools which have Standard 1 to 7 as per DEO, Surat record of 31/10/07. The list of all the English medium Schools is mentioned in appendix III.

3.2.1 Sample

One school was selected randomly. There were four divisions for the Standard V in the school. Out of these four divisions, one division of standard-V was assigned randomly as an experimental group while one division of standard V was also assigned in the same way as a control group.

3.3 Variables

The independent variable was the researcher developed Multiple Intelligences (MI) based instructional strategy for teaching science. The dependent variable was the standard V students' academic achievement in Science and Technology subject. The process skills for learning science such as observation, measurement, classification, inference, prediction and communication were also considered as dependent variables to study the process of learning science in experimental group students. The MI profile of the experimental group students as per Teele Inventory of Multiple Intelligences (TIMI) was considered as dependent variable.

3.4 Indicators of Process Skills

The researcher adopted science process skills indicators given by Fraser-Abder (2011) for the present study which are mentioned as under.

1. **Observation**

   Students are observing when they can

- identify the properties of objects (such as colour, size and shape) by using any or all of the senses and can answer this type of question: What do you notice about these objects?
- state noticeable changes in objects or events and can answer this type of question: What changes do you notice?
- state noticeable similarities and differences in objects or events and can answer this type of question: How are they alike? Different?

2. **Measurement**

   Students are measuring when they can

- arrange objects in sequence by length (shortest to longest), weight (lightest to heaviest), volume (least to greatest), chronologically (beginning to end), numerically (in ordinal order.)
- use standard tools – such as the meter stick, yardstick, ruler, clock, balance and protractor – to find quantity.

3. **Classification**

   Students are classifying when they

- group objects or events by their properties or functions, and can answer questions such as: In what ways could we group these objects?
- arrange objects or events in order by some properties or value, and can answer questions such as: How could we put these objects in order?

4. **Inference**

   Students are inferring when they

- understand that their explanations of an observation may be reasonable but may or may not be correct.

5. **Prediction**

   Students are predicting when they

- think systematically and logically about what might happen next.
- begin to think about planning ahead.

6. **Communication**

   Students are communicating when they

- describe objects or events, and can answer this type of question: How can you describe this____________ so someone else knows what you mean?
- make charts and graphs, and can answer this type of question: How can you make a chart or graph to show your findings?
- record data as needed, and can answer this type of question: How can we keep track of our observations?
- construct exhibits and models, and can answer this type of question: How can we show someone how this works?
- draw diagrams, pictures, and maps, and can answer these types of questions: What can we draw to explain what happens? What map can you draw or someone else can find the place?

3.5 Tools and Techniques

The researcher constructed pre test and post test, opinionnaire and focus group interview for the study. The Teele Inventory of Multiple Intelligences (TIMI) (2002) was adopted to know the MI profiles of the students. The researcher maintained the researcher's diary to keep record of the students' learning. The details of the tools and techniques are mentioned under.

3.5.1 Pretest Posttest

The objective 2 was, "*to study the effectiveness of instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V in terms of academic achievement*". An achievement test was constructed which was used as pre- and post- test in the present study. The achievement test was constructed by the researcher keeping in mind all the lessons that were taught using the developed multiple intelligences based instructional strategy for teaching science at Standard V. The weightage given to each lesson in academic achievement test was decided based on the content analysis of the lessons, referring competencies prescribed in the *'Science and Technology'* textbook prescribed by the Gujarat State Board of School Textbooks, Gandhinagar. The pretest posttest was modified as per the experts' suggestions. The test comprised of different types of items: multiple choice questions, essay type questions, short questions, and very short questions appended in the appendix IV.

3.5.2 Opinionnaire

The objective 4 was, *"to study the opinion of experimental group students for implemented instructional strategy for learning science based on the theory of Multiple Intelligences"*. The opinionnaire to know the opinion of the students towards implemented Multiple Intelligences based instructional strategy for teaching science at standard V was devised by the researcher. In early phase of construction of opinionnaire, as many as statements with respect to MI based instructional strategy were written. It was decided to keep three different options such as 'Agree', 'Undecided', and 'Disagree'. The different books on multiple intelligences were also referred to construct the statements for the opinionnaire. The statements were constructed as per the abilities and sub-abilities of the multiple intelligences given by the Baum et al (2005). The researcher developed opinionnaire was given to the experts in the field of education and necessary modifications were made as per experts' suggestions. Thus, it was face validated. There were total thirty-two statements in the final draft of opinionnaire. The eight multiple intelligences: Linguistic, Logical-mathematical, Visual-spatial, Musical, Bodily-kinesthetic, Interpersonal, Intrapersonal, and Naturalist intelligence were considered for the present study. There were four statements for particular intelligence making total thirty two statements for all eight intelligences in the final draft of opinionnaire. The opinionnaire employed for the present study is mentioned in appendix V.

3.5.3 Focus Group Interview

Focus group interview technique was employed to serve the objective 4. In the earlier draft, there were twenty-nine questions. This draft was given to the experts in the field of education and was modified according to their suggestions. The final draft of the focus group interview contained only four major questions. The focus group interview was used to probe further into students' views on developed MI based instructional strategy. These focus group interview questions are mentioned in the appendix VI.

3.5.4 Teele Inventory for Multiple Intelligences (TIMI)

The Teele Inventory for Multiple Intelligences (TIMI) developed in 1992 by Sue Teele to study the dominant intelligences of students in kindergarten through the twelfth grade was used by the researcher to know the students' profiles of multiple intelligences. It was revised in the year 1993-1994, 1995, 1997 and 2002. The TIMI was administered to the students at the pre-school level through elementary, secondary, community college and institutions of higher education. This instrument which has proven to be reliable through test - retest studies is currently being used in over four hundred and fifty different public and private school settings in the United States as well as six other countries throughout the world. The TIMI is culture-fair instrument to identify the students' or teachers' multiple intelligences. The TIMI is a forced choice pictorial inventory. There are total 28 items in TIMI. Each item in TIMI offers two alternatives for selection, thus, encompassing total fifty-six pictures of panda bears representing characteristics of each of the seven intelligences. Teele (2000) mentioned that seven intelligences as primary and naturalist intelligence as secondary intelligences giving the reason that naturalist intelligence appears to possess overlapping characteristics of several of the primary intelligences, and demonstrates unique characteristics. Students were asked to select one of the two choices that they feel is the most like them. There is no right or wrong answer. Scoring Teele Multiple Intelligences Inventory (TIMI) is easy and presents a profile of the responses enabling the students and teachers to determine the students' most dominant intelligences as indicated by the highest scores. The highest score in particular intelligence is 8 in TIMI. There are total 28 items in TIMI making 28 as total score in TIMI. The first four intelligences with the higher score can be easily identified as student's dominant intelligences.

The results for students indicated a higher reliability of the inventory with five of the intelligences with an interval for two weeks. Compared to the four week interval, logical-mathematical, linguistic, spatial, musical and interpersonal intelligences were higher while intrapersonal and bodily-kinesthetic were not, as mentioned by Teele.

3.5.5 Activity Sheets

The researcher made activity sheets which were given to the experimental group students for reporting the activities done.

3.5.6 Researcher's Diary

The researcher maintained the diary to keep the record of the students' learning. The researcher's diary was used to note down the specific observations pertaining to the activities done by the students. The difficulties faced by the students, their observations and the questions raised were denoted in the researcher's diary.

3.6 Design of the Study

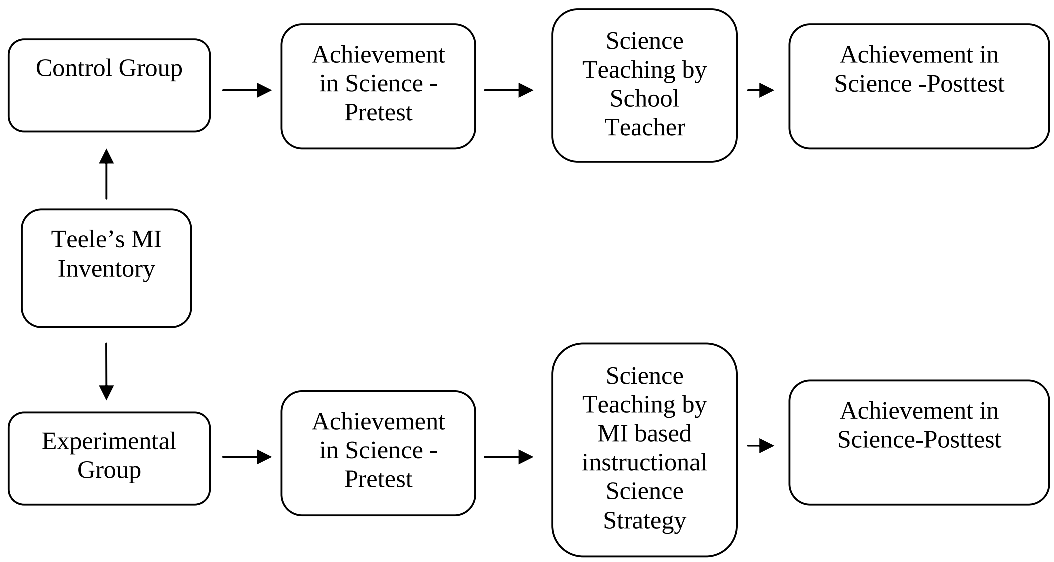
The quasi-experimental-pretest-posttest design was adopted for the present study mentioned as below in the notation form.

O_1 X O_2 O_1 O_3 = Pretests, X = exposure of a group to MI based instructional strategy

O_3 C O_4 O_2 O_4 = Posttests, C = exposure of a group to the traditional teaching

The reason for using the quasi-experimental design was the difficulty in randomly assigning the students to either of the groups by matching with respect to achievement due to the administrative difficulty. The reason behind for selecting control group within a same school was to ensure the students of the almost same level of socio-economic strata, including the similar level of exposure to learning experiences provided in the early years of schooling. The complete design including the use of Teele's MI inventory is mentioned as under in figure 4.

Figure 4 Design of the Study



3.6.1 Control of the Experimental Validity

The threats to internal experimental validity are maturation, history, testing, unstable instrumentation, statistical regression, statistical bias, interaction of selection and maturation, experimental mortality and experimenter's bias. It was expected that students of the same school usually have similar level of psychological maturity due to the similarity in learning experiences provided in all the subjects. The control and experimental groups were drawn from the same school so the anxiety produced by any periodical/unit test of any subject and effect of maturation was counterbalanced. Testing also influences the students to work hard and makes them sensitized towards learning. The present study covered two groups who were randomly assigned to control and experimental groups to compare so the effect of testing was, thus, nullified. Unstable instrumentation are also the another aspect that poses the threats to external validity of the program or strategy. The present study made use of face validated tools and techniques for collection of the required data such as achievement test, opinionnaire and focus group interview. Interaction of selection and maturation threat to experimental validity was controlled by the researcher as divisions were randomly assigned to control and experimental group. The researcher was not a regular teacher in particular school so it was not known to him about the individual performance and particular behaviour of any of the students of the experimental group. The experiment was therefore; carried out without having any bias or prejudice while implementing the developed MI based instructional strategy or scoring the responses of the students.

There are other threats to the external experimental validity such as interference of the prior treatment, artificiality of the experimental settings, interaction effect of testing, interaction of selection and treatment and the extent of treatment verification. There were two groups for comparing the performance. The impact of MI based instructional strategy was studied with respect to academic achievement and science process skills. The study used two groups: Control and Experimental groups. Therefore, there was no scope for the interference of prior treatment. The teaching was carried out in normal classroom set up. As all the classes in the school were well equipped with LCD facility, there was no need to equip the class with some specific techno-gadgets. Thus, the artificiality of the experimental setting was avoided. The researcher implemented the designed MI based instructional strategy for teaching science at standard V. The researcher remained present during school hours at the school and participated in staff-meetings and particular occasions such as sports day and celebration of national festival -15th August. Such participation helped the researcher to present himself as a regular school teacher to both experimental and control group students.

3.7 Plan and Procedure of the Study

The plan and procedure of the present study is described briefly as under. The study was carried out in three phases namely design and development of MI based instructional strategy and development of related tools, the implementation of the designed and developed instructional strategy for teaching science at standard V, and the analysis of the data.

3.7.1 Phase I Design and Development of Instructional Strategy for Teaching Science based on the Theory of Multiple Intelligences and Development of the Tools

MI based instructional strategy for teaching science at standard V was carried out step by step. The researcher worked as a lecturer in Primary Teacher's Training College (P.T.C.) Surat for three years. During his tenure as lecturer, the researcher provided guidance to student-teachers design the lesson plans in Environmental Science at standard II to IV and Science and Technology subject from standard V to VII. This academic responsibility helped the researcher to gain insight for designing lesson plans effectively. The researcher also observed the P.T.C. students' science and environmental science lessons in real classroom situation. This helped the researcher to know and understand the difficulties of the school-students in learning concepts of science. The classroom interaction also helped the researcher to learn about the classroom dynamics and students' psychology and learning behaviour with regard to science. The P.T.C. students' mistakes while delivering the lesson plans, the school students' discussion and their participation helped the researcher to know how the content of science could be sequenced and delivered using various modes of presentation. Thus, the academic responsibility helped the researcher to learn how the content should be presented to sustain the students' interest in learning science. The researcher thereafter, analyzed the Science and Technology content of the standard V as prescribed by the 'Gujarat State School Textbook Board', Gandhinagar, and studied the textbooks of Environmental Science of Standard III and IV along with the textbooks of Science and Technology of standard VI and VII. The exercise was carried out to ensure the width and depth of the learning experiences as per the content of Science and Technology textbook of standard V. There were total eleven lessons to be taught in the experimental school from June 2009 to November 2009 therefore; these lessons were selected to design MI based instructional strategy. These lessons were: Lesson 2 Learn Preparing Groups, Lesson 3 Living Non Living, Lesson 4 Let Us Know the Soil, Lesson 5 Seed and Its Germination, Lesson 6 Water and Its Importance, Lesson 7 Observation of Living World, Lesson 9 Food and Health, Lesson 11 Air, Lesson 12 Light and Its Properties, Lesson 14 Measurement of Length, and Lesson 16 Energy. In order to develop the MI based instructional strategy all the chapters were content-analyzed. The competencies listed in the Science and Technology textbook were studied to understand the learning outcome. The content of Science and Technology subject of standard V was analyzed into major and minor concepts to ensure the systematization of learning experiences. The scope of designing multiple intelligences based learning experiences was studied and listed. The general and specific instructional objectives were written with reference to the competencies stated in the textbook. It was also taken care that the instructional objectives would reflect the competencies and helped to achieve the laid competencies. Various references books on teaching of science and multiple intelligences were studied to design the activities at par with the students' abilities and interest. The reference books on teaching of science by Blough and Schwartz (1964), Kuslan and Stone (1968), Llewellyn (2007), Trojcak (1979), Victor (1967), Ward et al (2005), Ward (2007), Williams and Veomett (2007) and were referred. The books on multiple intelligences such as Armstrong (2000), Arnold (2007), Bellanca (1997), Campbell (1996), Campbell, Campbell and Dickinson (2004), Lazear (2003), Silver, Strong and Perini (2000), and Teele (2000) were referred to design the MI based instructional strategy for teaching science at standard V.

The nature of science subject and how students learn using multiple intelligences was also studied. The activities were, then, designed by keeping in mind the instructional objectives of the sub-topics and the larger size of the Indian classroom. Gardner expressed in his interview with Checkley (1997) that it is equally nonsensical to say that everything should be taught using seven or eight ways and it is not the point of the MI theory. But, the point is to realize that any topic of importance from any discipline can be taught in more than one way. Hence, depending upon the nature of the content, various activities were designed to ensure that different multiple intelligence based activities would make learning process in science enjoyable, interesting and learning would not be stretched unnecessarily to address only different intelligences. The multiple intelligences based instructional strategy comprised activities that involve multiple intelligences of the students. Sometimes, there may be one intelligence specific activity which was also included depending on the scope of the content. The due emphasis was given to ensure that students would be engaged in doing, writing, experimenting, drawing, and singing activities. The activity sheets were designed by studying the different workbooks/journals in science at standard V published by Evan-Moor Corp. (2006), Viva Education (2008) and NavNeet. It was also kept in mind that students would make use of different process skills such as observation, measurement, classification, inference, prediction and communication depending upon the scope of the content to incorporate.

Wolfinger (1984) considered student of nine to twelve years of age as the intermediate grade student. Wolfinger's views were taken into consideration while designing and developing MI based instructional strategy for teaching science at standard V which are mentioned as under.

- Students of nine and ten years of age are better able to handle a variety of techniques than the younger children. They tend to be decisive and responsible, dependable and reasonable.
- The students of nine and ten years of age find it hard to accept others with the different idea but they are beginning to realize that a number of differing opinions can exist and that all may be equally valid.
- The movement toward abstract thought that begins to develop among students of eleven and twelve years of age needs careful nurturing. Therefore, enough scope was provided to present content of science through concrete to abstract ways of presentation.

The researcher took care that the MI based instructional strategy would be cost-effective and could be practised at larger platform. It was also ensured that there would not be unnecessary burden on the part of the students and activities offering the scope of various science process skills as per the prescribed Science and Technology textbook of Gujarat State and School Textbook Board, Gandhinagar.

The developed MI based instructional strategy offered following opportunities / components to students in the science class.

- Intelligences specific ways of learning science (for science instruction)
- Demonstration of learning by drawing, writing, making charts, model, doing experiments
- Active engagement – process skills (Observation, classification, communication, measurement, inference and prediction) required in learning science
- Reflection (Thinking back – internalization)

The components of developed MI based instructional strategy for teaching science at standard V met the below mentioned objectives of teaching science through which a learner can construct knowledge.

- Engaging learner in learning science through familiar experiences, moving from simple to complex, and offering hands-on experiences to nurture the curiosity and to develop scientific understanding.
- Utilization of activities and experiences to help learner to understand and explain the scientific concepts.
- Providing group activity, discussion with peers and teacher to help them to learn basic skills and concepts.
- Organization of data and displaying learners' activities to provide opportunity to reflect, and appreciate.

The instructional strategy thus designed was in line with the theory of Multiple Intelligences propounded by the Prof. Howard Gardner. The developed MI based instructional strategy for teaching science was shown to the experts (elementary school science teacher and the teacher educators familiar with the theory of multiple intelligences). The suggestions of experts were studied, discussed with the guide and the MI based instructional strategy was modified accordingly. The MI based instructional strategy was also shown to the English language expert to avoid grammatical mistakes. Thereafter, the instructional strategy was finalized with reference to the guide's valuable suggestion. The final implemented MI based instructional strategy for teaching science at standard V is given in the CD, Folder –

MI based instructional strategy. The compact disc (CD) also contains the files of small movie clips and PowerPoint Presentations (PPTs) in lesson-wise folders - Lesson 3, Lesson 4, Lesson 5, Lesson 6, Lesson 7, Lesson 9, Lesson 14, and Lesson 16. The folder – guidelines in the CD contains the two small movie clips to be used for teaching the concept of pollination. The designed and developed MI based instructional strategy is mentioned along with the analysis of the process of learning science among experimental group students in chapter 4 Analysis and Interpretation. The developed and face-validated multiple intelligences based instructional strategy for teaching science was implemented in the year 2009. The achievement test, opinionnaire and focus group interview questions were developed and they were given to the experts in the field of education. The tools and focus group questions were modified according to the experts' suggestions. Thus, they were validated. The related details of tools and techniques were discussed briefly in section 3.5 Tools and Techniques and given in appendices IV, V, VI and VII.

3.7.2 Phase II Administration of Tools and Implementation of Instructional Strategy based on the Theory of Multiple Intelligences

The administration of tools and implementation of developed MI based instructional strategy is mentioned in subsequent sections as under.

3.7.2.1 Administration of Teele Inventory for Multiple Intelligences (TIMI)

The Teele's Multiple Intelligences (MI) inventory was administered prior to pre-testing the students' achievement in science and before implementation of MI based instructional strategy for teaching science. Teele Inventory for Multiple Intelligences (TIMI) was administered to students of both the control and experimental group on the same day with the proper instruction to mention the choice in the answer sheet. Teele's MI inventory was administered in the month of June 2009 and it took 45-60 minutes to complete. The students were conveyed that it was not the test for them. The students were also instructed to write the names and division on the answer sheet. It was also mentioned by the researcher to select only one alternative from the two different pictures of panda bear at a time keeping in mind what they liked most by careful observation of the picture. The researcher took round in the class, and instructed them whenever necessary.

3.7.2.2 Administration of Pretest

After, the implementation of MI inventory, the pretest was administered to both the control and experimental group students for two hours simultaneously. The pretest consisted of 50 marks, total 5 main questions. Two hours were given to the students for writing answers.

3.7.2.3 Implementation of Instructional Strategy for Teaching Science at Standard V based on the Theory of Multiple Intelligences (MI)

The developed MI based instructional strategy (CD, Folder – MI based instructional strategy) was employed by the researcher himself from June 2009 to December 2009 excluding the *'Diwali'* vacation and other holidays. The students were informed to remain present and not to take any leave in between without any unavoidable reason during the implementation of MI based instructional strategy by the researcher to control the experimental mortality. The schedule of implementation of developed MI based instructional strategy is mentioned as under in table 4.

Table 4 Schedule of Implementation of Instructional Strategy based on the Theory of MI

Sr. No.	Months in which Lesson Taught	Lesson
1.	June - July 2009	Lesson 2 Learn Preparing Group
2.	June 2009	Lesson 3 Living - Non Living
3.	October - November 2009	Lesson 4 Let's Know the Soil
4.	July 2009	Lesson 5 Seed and Its Germination
5.	November 2009	Lesson 6 Water and Its Importance
6.	November 2009	Lesson 7 Observation of Living World
7.	July - August 2009	Lesson 9 Food and Health
8.	August 2009	Lesson 11 Air
9.	September 2009	Lesson 12 Light and Its Properties
10.	August - September 2009	Lesson 14 Measurement of Length
11.	September 2009	Lesson 16 Energy

3.7.2.4 Administration of Opinionnaire

After completing the implementation of MI based instructional strategy, the opinionnaire was administered to know the opinions of the students of the experimental group regarding the implemented MI based instructional strategy for teaching science at standard V. The opinionnaire was administered in the month of December 2009. Proper instructions such as select only one option from ‘Agree’, ‘Cannot say’, and ‘Disagree’ was given by the researcher. They were also instructed to write the name and division in the opinionnaire. The students were informed that it was not their test, and their opinions were not going to influence their performances. Enough time was given to each and every student to complete the opinionnaire. The students took almost 55-60 minutes to complete the opinionnaire.

3.7.2.5 Conducting Focus Group Interview

The focus group interview was conducted to know the opinions of the students in detail. The focus group interview session was held in the hall of the school. Each session was continued for at least 30 minutes. The focus group interview was conducted on the same day with 8-10 students in each group. The researcher himself worked as a moderator of the discussion. The students were informed well in advanced about the code and conduct of the focus group interview. The students were informed that it was a normal discussion session to know how they felt and perceived the teaching of science carried out in the last six months which would not be considered to score them. The students’ discussion during the focus group interview and their specific nonverbal expressions were noted down by the researcher.

3.7.2.6 Administration of Posttest

The posttest was administered by the researcher at the same time to the students of both the experimental and control group students in the month of December 2009 after the complete implementation of MI based instructional strategy. To control the experimental mortality rate of the students, time and schedule of post-test was announced by the researcher and school personnel well in advanced to the students of both the classes. The class teachers of both the groups were also informed to instruct students to remain present on the day of testing.

3.8 Phase III Data Analysis

At very first stage, the profiles of both the groups' multiple intelligences were found out using Teele's (2002) MI inventory and were studied whether both the groups were comparable in terms of multiple intelligences using descriptive statistics and Mann-Whitney tests. Both the control and experimental groups' pretest and posttest question papers were scored objectively by the researcher following the 'Science and Technology' textbook prescribed by the Gujarat State School Textbook Board, Gandhinagar. The scores in both the pre- and posttests were then analyzed using the Mann-Whitney test to study the status of the null hypothesis with a view to find out the effectiveness of the MI based instructional strategy for teaching science at standard V. The process of learning science among the experimental group students was studied by analyzing the students' activity sheets. The students' responses to questions asked in the activity sheets were read and studied to understand the meaning of the students' written responses. The students' responses maybe scientifically right or wrong, therefore, the content analysis was aimed to count how many students replied the right answer and what their responses were. The responses were presented into percentage and analyzed to understand how the experimental group students demonstrated different science process skills with regard to indicators of science process skills given by Fraser-Abder (2011). For instance, in observation science process skill, what the students observed and what was missed or poorly observed was analyzed. The interpretation was carried out to show how process skills were gradually developed among the experimental group students. The researcher's diary was also content-analyzed to understand the students' performance in particular activity. The data of the opinionnaire were analyzed into frequency and represented in terms of percentage. The written focus group interview data was analyzed using content analysis. The MI profile of experimental group students with respect to academic achievement was studied using the posttest mean values in relation to three groups – 'low', 'moderate' and 'high' based on their score in particular intelligence. The entire procedure of the present study is mentioned in figure 5.

Figure 5 Development and Implementation of MI based Instructional Strategy for Teaching Science at Standard V

Step I: Study of Environmental Science textbooks of standard II to IV and Science and Technology textbooks of standard VI and VII to study the scope of the MI activities at Standard V

Step II: Studying of the competencies given and formulation of the general and instructional objectives

Step III: Locating the scope of the involvement of multiple intelligences in science learning

Step IV: Designing the multiple intelligences based science learning activities with regard to cost, time, interest and age of the standard V students

Step V: Defining the role of teacher and students in classroom interaction (Oral participation, group work, daily log writing, working in pair, hands-on experiences, writing activity sheets)

Step VI: Gathering experts' opinion for validation of MI based instructional strategy for teaching science at standard V

Step VII: Development of final draft of modified MI based instructional Strategy for teaching science at standard V based on experts' opinions

Step VIII: Administration of Teele's MI Inventory (2002) and pretest to study the achievement in science

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Step IX: Implementation of designed and developed MI based instructional strategy for teaching science at standard V

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Step X: Administration of Posttest, Opinionnaire and Focus Group Interview

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Step XI: Analysis of Teele's MI inventory data, pre-post test data, opinionnaire and focus group interview data, activity sheets and researcher's diary

CHAPTER - IV

ANALYSIS

AND

INTERPRETATION

CHAPTER : IV - ANALYSIS AND INTERPRETATION

4.1 Introduction

The Chapter 4 - Analysis and Interpretation of data deals with the analysis and interpretation of the data with regard to the objectives to serve the purpose of the present study. The main function of the analysis and interpretation of data is to provide description of the phenomena for better clarity and to derive meaning of the quantitative as well as qualitative data. The analysis and interpretation of the data warrants discussion to provide reasons for the emergence of particular result under particular context. It is, therefore, present chapter discusses the analysis of the data under specified objectives of the study.

4.1.1 Comparability of Control and Experimental Groups in terms of Multiple Intelligences (MI)

Mann-Whitney, a non-parametric test was run to calculate the ranks which are shown in table 5.

Table 5 Mann-Whitney Test – Ranks for MI

Intelligence	Group	N	Mean Rank	Sum of Ranks
Linguistic	Control	41	42.13	1727.50
	Experimental	46	45.66	2100.50
	Total	87		
Logical-mathematical	Control	41	42.84	1756.50
	Experimental	46	45.03	2071.50
	Total	87		
Visual-spatial	Control	41	44.67	1831.50
	Experimental	46	43.40	1996.50
	Total	87		
Interpersonal	Control	41	42.20	1730.00
	Experimental	46	45.61	2098.00
	Total	87		
Intrapersonal	Control	41	46.29	1898.00
	Experimental	46	41.96	1930.00
	Total	87		
Musical	Control	41	45.33	1858.50
	Experimental	46	42.82	1969.50
	Total	87		
Bodily-kinesthetic	Control	41	46.20	1894.00
	Experimental	46	42.04	1934.00
	Total	87		

Table 5 indicated the control group gained little higher mean rank, a negligible difference in visual-spatial, intrapersonal, musical and bodily-kinesthetic intelligences. Mann-Whitney test statistics is shown in table 6.

Table 6 Mann-Whitney - Test Statistics for MI

Test Parameters	Linguistic	Logical	Visual-spatial	Inter-personal	Intra-personal	Musical	Bodily-kinesthetic
Mann-Whitney U	866.5	895.5	915.5	869.0	849.0	888.5	853.0
Wilcoxon W	1727.5	1756.5	1996.5	1730.0	1930.0	1969.5	1934.0
Z	-0.664	-0.409	-0.239	-0.641	-0.817	-0.473	-0.782
Asymp. Sig. (2-tailed)	0.507	0.683	0.811	0.522	0.414	0.637	0.434

a. Grouping Variable: GROUP

Table 6 indicted no statistically significant difference between intelligences of both the groups. Specifically, there was no significant difference between linguistic intelligence of both the control experimental groups (U= 866.5, z = -0.664, p = 0.507). No significant difference was found between logical-mathematical intelligence of both the control and experimental group (U = 895.5, z = -0.409, p = 0.683). There was also no significant difference found between visual-spatial intelligence of both the groups (U = 915.5, z = -0.239, p = 0.811). Both the groups did not significantly differ in terms of interpersonal (U= 869.0, z = -0.641, p = 0.522) and intrapersonal intelligences (U= 849.0, z = -0.817, p = 0.414). There was also no significant difference found between both the groups musical (U= 888.5, z = -0.473, p = 0.637) and bodily-kinesthetic intelligences (U= 853.0, z = -0.782, p = 0.434) respectively. It meant that both the groups were statistically comparable as they were almost similar in terms of multiple intelligences prior to the implementation of experimentation.

4.2 Effectiveness of Instructional Strategy in terms of Academic Achievement

The objective 1 was *"to design and implement instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V".* The instructional strategy based on the theory of multiple intelligences was designed and implemented on standard V students of Surat, Gujarat to study the Objective 2. The objective 2 was *"to study the effectiveness of instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V in terms of academic achievement".*

The null- hypothesis H_0 was: *There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.* In order to study the status of null hypothesis H_0, the Mann-Whitney test was employed.

4.2.1 Mann-Whitney Test

The Mann-Whitney Test ranks for control and experimental groups are mentioned in table 7.

Table 7 Mann-Whitney Test - Ranks

	Group	N	Mean Rank	Sum of Ranks
Pretest	Control	41	40.29	1652.00
	Experimental	46	47.30	2176.00
	Total	87		
Posttest	Control	41	35.17	1442.00
	Experimental	46	51.87	2386.00
	Total	87		

From table 7, it was found that the experimental group contained highest mean rank in both the pre-test and post-test. Mann-Whitney test statistics for pretest and posttest is mentioned in table 8.

Table 8 Test Statistics[a]

	PreTest	PostTest
Mann-Whitney U	791.000	581.000
Wilcoxon W	1652.000	1442.000
Z	-1.305	-3.082
Asymp. Sig. (2-tailed)	.192	.002
a. Grouping Variable: GROUP		

Table 8 indicated no significant difference between the control and experimental groups on pretesting (U = 791.000, z = -1.305, p = 0.192). It meant that both the groups were statistically comparable in terms of academic achievement. The experimental group showed the statistically significant difference than the control group on post test (U = 581.000, z = -3.082, p = 0.002). Therefore, the null hypothesis H_0 (H_0: *There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.*) was rejected and it was concluded that the experimental group was benefitted by MI based instructional strategy ($p = 0.002$). This means that the experimental group benefitted better than the control group at both the levels of significance namely 0.05 and 0.01. It indicated that the designed and implemented instructional strategy for teaching science at standard V based on the theory of multiple intelligences helped in increasing the academic achievement of the experimental group in comparison to the control group on post testing. The increase in academic achievement of the experimental group students can be explained due to MI based instructional strategy. The other factors of experimental validity such as maturity, history, testing, and artificiality of the experimental setting were controlled in quasi-experimental design. The researcher also maintained neutral attitude while scoring the test papers which led to infer that the instructional strategy based on multiple intelligences emerged as a causing factor for the increase in academic achievement. The experimental group-students encountered content of science in variety of ways in which opportunities were offered to them were: drawing, writing, doing activities and conducting small scale experiments. The experimental group students remained active as activities demanded the use of science process skills such as observation, classification, inference, communication, prediction and measurement. Their active involvement in activities, use of songs, movie clips, PPTs (PowerPoint Presentations), writing daily log, one-minute reflection, and thinking in images proved as a booster to science learning process. The writing practice provided by means of activity sheets might have also helped students to comprehend the concepts of science thoroughly and to respond properly. It could be said that the active involvement of experimental group students using different intelligences helped them to perform better in test.

The discussion with the control-group teacher indicated that the control group was taught by lecture method (telling), using ready-made educational software, and audio-visual presentation whenever the teacher got time. It was also found during discussion with the control group science- teacher that no input was given to the students to interact with the groups, peers, and it was not activity based learning. The control group students were not exposed to the hands-on experiences as mentioned in the textbook, and activities such as experiments or making of models were not carried out. Not only this but also the control group students were not given opportunity to write their answers in the activity sheets. The control group students were also not taught using the songs, reflection, and by involving them in writing daily log to note down their goals, objectives, and modification required in their behaviour in science class. It was found that the control group teacher did not focus attention to make use of process skills while teaching science. The control group students were not provided opportunity to use observation, classification, prediction, inference, communication, and measurement process skills which made the learning of science a passive process wherein the teacher taught and the students listened, replied and noted down answers in their notebooks. It means that control group students remained as passive recipients of learning which inhibited their active involvement in learning. On the other hand, experimental group students got opportunity to learn using writing, singing, hands-on experiences, reflection, group discussion and visual imagery which provided reason why the experimental group students performed better on testing.

4.3 Process of Learning Science with relation to Process Skills

The objective 3 was *"to study the process of learning science among the standard V experimental group students in relation to process skills"*. The science process skills such as observation, classification, inference, communication, prediction and communication were considered to study the process of learning science. The scientific enquiry makes it difficult to segregate the activities exclusively under particular process skills as students make use of combination of science process skills depending upon the nature of the activities. An attempt has been made here to club those activities together which predominantly call forth the use of particular process skill.

The students' responses to questions asked in the activity sheets were read and studied to understand the meaning of the students' written responses. The students' responses maybe right or wrong scientifically, therefore content analysis was aimed to count how many students replied the scientifically correct answer and what their responses were. The responses were presented into percentage and analyzed to understand how the experimental group students demonstrated different science process skills. The students' activity sheets were content-analyzed by considering the indicators of the science process skills given by Fraser-Abder (2011) to study the process of learning science. For instance, in observation science process skill, what the students observed and what was missed or poorly observed was analyzed. The interpretation was carried out to show how process skills were gradually developed among experimental group students. The researcher's diary was content-analyzed to understand the students' performance in particular activity.

4.3.1 Study of Process of Learning Science in relation to Observation - Process Skill

The activities which exclusively demanded the use of observation process skill were clubbed together and the students' responses were analyzed using activity sheets and classroom observation. This includes the brief description of the activity along with how students carried out particular activity and demonstrated the observation skill.

4.3.1.1 Lesson 3 Living - Non Living - Topic - Studying the Effect of Sunlight on Leaves

Instructional Objective

- Students will explain that plants are living after observing the effects of sunlight over the plants' leaves.

Description of Activity 3 Logical-mathematical and Naturalist

The students were asked to observe the school garden's plants' leaves and plants that they could observe in their nearer surrounding also. They were asked to gather different plants' leaves from garden of school and were instructed to keep them in direct sunlight for two days. They were asked to observe any change in the leaves after two days and report the same regarding any change in the condition of leaves. They were also asked to prepare the scrapbook for different leaves. The activity sheet contained questions: Which trees' and plants' leaves do you have? What was the colour of leaves before keeping it in the sunlight? What was the colour of leaves after keeping them in the sunlight? Do you find any change in a non-living thing after keeping it in sunlight for two days? How can you say that plants are living?

The students gathered different kinds of leaves such as the leaves of plants: basil, aloe vera, touch-me-not-plant, neem, *ardusi*, mango, banana, rose plant, *pipal*, coconut, jasmine, money plant, shoe flower and vinca. Majority of the students (89.13%)

mentioned that the colour of the leaves was green or dark green before keeping the leaves in sunlight which was a correct observation. Total (76.08%) students mentioned that the colour of the leaves got changed after keeping the leaves in the sunlight and mentioned that it became yellow. The rest of the students used different words such as light yellow or yellowish to indicate the colour of the leaves after keeping them in sunlight. The students also mentioned that the colour of the leaves became dull and leaves withered. Figure 6 shows student's work to study the effect of sunlight over the plant's leaves.

Figure 6 Effect of Sunlight over Leaves

All the students responded no change in the colour of the non-living after keeping them in the sunlight. It indicated that almost all students were able to point out that leaves became dried when kept in sunlight. The students provided various reasons to mention plants as living. Majority of the students (82.60%) provided reasons to mention plant as living were: Plants showed growth, they prepared food on their own, and they needed air and water. The other responses were: Plants showed sensitivity and they provided us food, medicine, fruits, vegetables and wood. The exceptional response of a student clearly mentioned that plant did not eat food so it was non-living. It was found that except one student, all (97.82%) had the idea that plants were living due to the characteristics such as growth and sensitivity. It suggested that the students linked the characteristics of the living with the plants after observing the effect of sunlight over the plucked leaves. It was also clear from the responses of the students that they did not mention that plants' leaves would wither after some time, and again new leaves would appear. No student in a group reported above-mentioned specific reason.

4.3.1.2 Lesson 5 Seed and Its Germination - Topic - Differences among the Seeds

Instructional Objective

- Students will name various seeds.
- Students will differentiate seeds on the basis of characteristics like size, smoothness, colour and ridges.

Description of the Activity 1 Naturalist, Bodily-kinesthetic & Logical-mathematical

The teacher asked the shapes, the size and the colours of different fruits such as apple, orange, mango to link the previous knowledge of the students. After this, the teacher provided various seeds to students and instructed them to observe the colour, texture of the seeds - smoothness, ridges and size with reference to peanut. Seeds of watermelon, mango, papaya, ladies-finger, neem, maize, gram, bottle gourd, cotton, *methi*, muskmelon, sapota, orange, black berry, lichee, peach, lemon, cherry and jack fruit were given to the students to observe and were asked to write their observations in the activity sheet given. The teacher initiated the discussion by asking what they mentioned about characteristics like size, smoothness, colour and ridges of a particular seed. The teacher assigned tasks to the students to prepare a scrapbook on varieties of seeds at home.

Initially, the teacher experienced that the students faced difficulty in identifying the ridges of the seeds and asked the teacher's confirmation for ridges they understood for seeds. After explaining again, they touched the surface of the seed and reported the smoothness and ridges of the seed in the given activity sheets. They did the activity rapidly after identifying 3-4 seeds on the basis of ridges and smoothness in the given activity sheets. It was observed that most of the students faced difficulty to arrive at conclusion whether the seed of peach had smooth or rough surface. The teacher had to instruct students to observe the seed of the peach carefully and touch the 'embossed lines' on it. Then, the students were able to state that the seed of peach had rough surface. The categorized responses are shown in the table 9. Percentage of the students who reported particular observation is mentioned in the bracket.

<u>Table 9 Students' Understanding of the Seeds</u>

Name of Seed	Is it larger when compared to peanut?	Is it ridged?	Is its surface smooth or rough?	Colour
Watermelon	No (100%)	Ridged (69.56%); Not ridged (30.43%)	Rough (100%)	Black (100%)
Mango	Yes (100%)	Ridged (91.30%); Not ridged (08.69%)	Rough (100%)	Brownish (86.95%); Yellowish (10.86%) Light Yellowish; Brown (02.17%)
Papaya	No (100%)	Not ridged (100%)	Smooth (100%)	Black (100%)
Ladies-finger	No (100%)	Not ridged (100%)	Smooth (100%)	White (54.34%); Off White (45.65%)
Neem	Yes (100%)	Not ridged (100%)	Smooth (100%)	Light Yellow (80.43%); Yellow (19.56%)
Maize	No (78.26%); Yes (21.73%)	Ridged (65.21%); Not ridged (34.78%)	Smooth (100%)	Orange (17.39%)
Gram (*Chana*)	No (100%)	Not ridged (100%)	Smooth (65.21%); Rough (34.78%)	Light brown (52.17%); Brown (47.82%)
Bottle Gourd (*Dudhi*)	No (100%)	Ridged (54.34%); Not ridged (45.65%)	Smooth (100%)	White (100%)
Cotton	No (100%)	Not ridged (100%)	Rough (100%)	Blackish-grey (91.30%) Brown (08.69%)

*Table 9 is continued on next page.

<u>Table 9 Students' Understanding of the Seeds</u>

Name of Seed	Is it larger when compared to peanut?	Is it ridged?	Is its surface smooth or rough?	Colour
Trigonella (*Methi*)	No (100%)	Ridged (71.73%); Not ridged (28.26%)	Smooth (80.43%); Rough (19.56%)	Brownish Yellow (91.30%); Brown (08.69%)
Muskmelon	No (100%)	Ridged (54.34%); Not ridged (45.65%)	Smooth (91.30%); Rough (08.69%)	White (100%)
Sapota (*Chiku*)	Yes (100%)	Ridged (95.65%); Not ridged (04.34%)	Smooth (100%)	Black (100%)
Orange	No (84.78%); Yes (15.21%)	Ridged (34.78%); Not ridged (65.21%)	Smooth (91.30%); Rough (08.69%)	Off White (82.60%); White (17.39%)
Blackberry (*Jambu*)	Yes (100%)	Not ridged (100%)	Smooth (65.21%); Rough (34.78%)	Black white (04.34%); Light violet (95.65%)
Lichee	Yes (100%)	Not ridged (100%)	Smooth (100%)	Brown (69.56%); Brownish red (28.26%); Cherry red (02.17%)
Peach	Yes (100%)	Ridged (100%)	Rough (100%)	Light Brown, Brown (78.26%); Reddish Brown (21.73%)
Lemon	No (100%)	Ridged (78.26%); Not ridged (21.73%)	Smooth (65.21%); Rough (34.78%)	White (26.08%); Off white (73.91%)

*Table 9 is continued on next page.

Table 9 Students' Understanding of the Seeds

Name of Seed	Is it larger when compared to peanut?	Is it ridged?	Is its surface smooth or rough?	Colour
Cherry	No (100%)	Ridged (65.21%); Not ridged (34.78%)	Smooth (67.39%); Rough (32.60%)	Off white (100%)
Jack Fruit (*Fanas*)	Yes (100%)	Not ridged (100%)	Smooth (100%)	Off white (82.60%); Brown (17.39%)

The table 9 clearly indicates that the students were able to differentiate the minute differences between colours between (white and off white) and (brown and brownish). It was found from the students' responses that almost all the students were able to use visual sense aptly to observe the ridges and smoothness of the surface, colour and size of the various seeds while comparing to the seed of peanut. A student's activity sheet is mentioned in the figure 7.

Figure 7 Student's Observation of the Seeds

Chapter 5 Seed and Its Germination

Activity Sheet for Activity 1

Student's Name: Kanungo Nurulain   Date: 9-7-09

Observe the seeds carefully. Write your observation in the given table.

Name of Seed	Is it larger when compared to peanut?	Is it ridged?	Is its surface smooth or rough?	Colour
Watermelon	No	No	Rough	Black
Mango tree	Yes	No	Rough	Light yellow Brownish
Papaya	No	No	Smooth	Black
Ladies-finger	No	No	Smooth	off white
Neem tree	Yes	No	Smooth	light yellow
Maize	No	No	Smooth	orange
Gram (*Chana*)	No	No	Rough	Light brown
Bottle Guard (*Dudhi*)	No	No	Smooth	White
Cotton Plant	No	No	Rough	Brown
Methi	No	No	Rough	Brownish yellow
Muskmelon	No	No	Rough	white
Sapota (*Chiku*)	yes	No	Smooth	black
Orange	yes	yes	Rough	of white
Blackberry (*Jambu*)	yes	no	Rough	light [illegible]
Lichee	Yes	No	Smooth	Cherry Red
Peach	Yes	Yes	Rough	Brown
Lemon	No	No	rough	off white
Cherry	No	No	Rough	off white
Jack Fruit (*Fanas*)	Yes	No	Smooth	off white

4.3.1.3 Lesson 4 Let Us Know the Soil – Topic - Gravels, Sand, Clay and Mud – Components of the Soil

Instructional Objective

- Students will state the differences in the texture of soil based on their observations.

Description of the Activity 2 Bodily-kinesthetic, Logical-mathematical and Interpersonal

This was a group activity to provide tactile experiences to enable students to notice the differences in the soil particles on sieving.

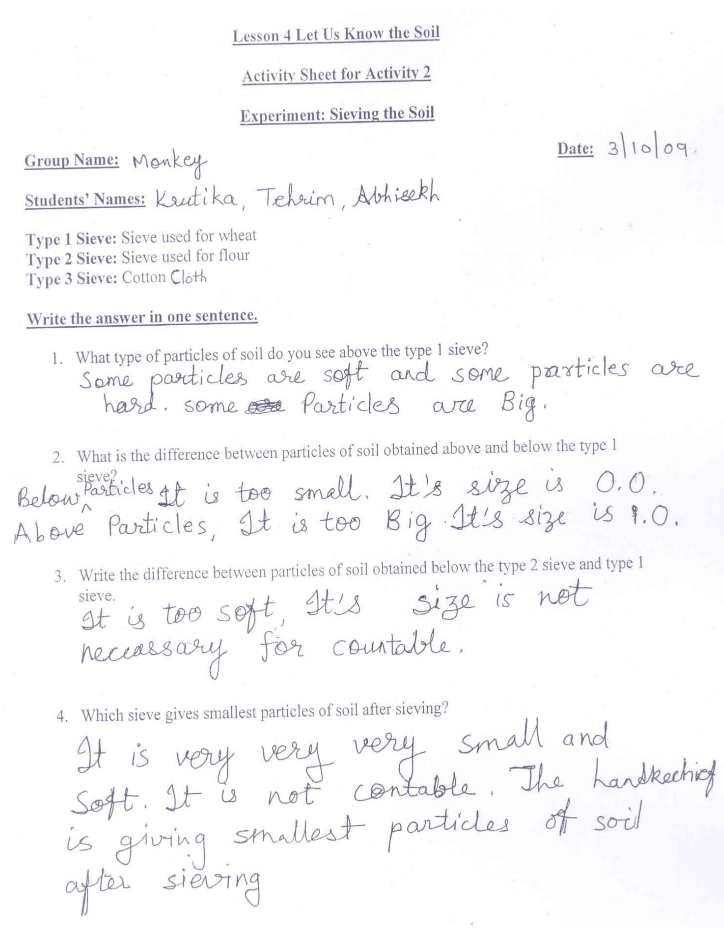
Type 1 Sieve: Sieve used for wheat

Type 2 Sieve: Sieve used for flour

Type 3 Sieve: Cotton cloth

A group's sample activity sheet is mentioned in figure 8.

Figure 8 Students' Observation of Particles of Soil based on Sieving



Lesson 4 Let Us Know the Soil

Activity Sheet for Activity 2

Experiment: Sieving the Soil

Group Name: Monkey

Date: 3/10/09.

Students' Names: Krutika, Tehrim, Abhisekh

Type 1 Sieve: Sieve used for wheat
Type 2 Sieve: Sieve used for flour
Type 3 Sieve: Cotton Cloth

Write the answer in one sentence.

1. What type of particles of soil do you see above the type 1 sieve?
   Some particles are soft and some particles are hard. some Particles are Big.
2. What is the difference between particles of soil obtained above and below the type 1 sieve?
   Below Particles It is too small. It's size is 0.0.
   Above Particles, It is too Big. It's size is 1.0.
3. Write the difference between particles of soil obtained below the type 2 sieve and type 1 sieve.
   It is too soft, It's size is not necessary for countable.
4. Which sieve gives smallest particles of soil after sieving?
   It is very very very small and Soft. It is not contable. The handkechief is giving smallest particles of soil after sieving

The students asked the meaning of 'particle' and 'sieving' though it was specified by the teacher. Some students asked the meaning of gravel too. This may be arisen as they might have come across these words for the first time. The students reported that the particles above the wheat sieve were hard, some were big, and some stone could not be broken. Fifty percent of the students of the class reported that some particles were smooth, some were rough, and some were brittle. The students at this stage were not able to use the word ‘brittle’ but when these students observed that bigger red coloured particles were broken while falling from the desk; they told in regional language that it was broken. One group of students (five students) went beyond this observation, and they measured the size of particles using the scale. The measurement was not perfect and precise but they were able to understand the difference in size of the particles of soil by measuring. Some students also reported that some particles of soil were red and grey in colour.

One group mentioned the size of particles above wheat sieve is 1.0 and below wheat sieve is 0.01 but they did not mention the unit. The remaining groups reported that the particles above wheat sieve were bigger, and the particles below the wheat sieve were smaller. This indicated that the majority of the students observed correctly the difference between the particles collected above and below the sieve for wheat in terms of size.

The students were able to point out the smooth texture of the particles of soil collected below the sieve for flour. They mentioned that particles above the wheat sieve were bigger in size and coarse while touching in compare to particles obtained below the type 2 sieve: Sieve used for floor. Except a few (10.86%) students, all were able to report that cotton cloth - sieve gave the smallest particles of soil on sieving. The responses and observation of the teacher indicated that the students demonstrated the reasonable high level of observation for above particular activity and the students were able to link the observed evidences to arrive at particular idea also.

4.3.1.4 Lesson 6 Water and Its Importance - Topic - Formation of Cloud

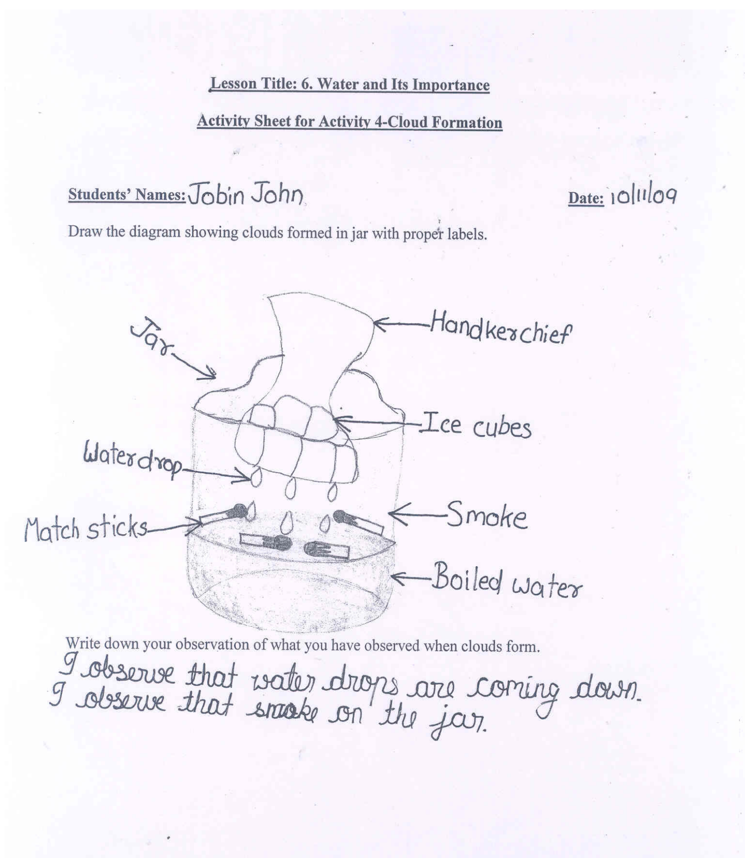
Instructional Objective

- Students will draw the picture of cloud formation with appropriate labels.
- Students will explain the process of cloud formation.

Description of the Activity 4 Visual-spatial and Logical-mathematical

The teacher instructed the students to observe the procedure of cloud formation carefully. The teacher demonstrated the cloud formation using a jar, matchsticks and ice cubes. The teacher poured the boiling water into the transparent jar made up of glass and lighted the matchstick and threw it immediately in it. The teacher covered the mouth of the jar with ice cubes wrapped in cotton cloth immediately. The teacher focused the light of the torch to the jar so that the students could see the cloud formation in the jar. The students were asked to observe and draw the diagram showing cloud formed in the jar with proper labels. The teacher asked the students to relate the observation they made with how actually the cloud gets formed in nature also. After the demonstration, the teacher asked several questions pertaining to what they observed and how cloud was formed in the jar. A student's sample activity sheet is mentioned in figure 9.

Figure 9 Student's Activity Sheet for Cloud Formation in Jar


Lesson Title: 6. Water and Its Importance

Activity Sheet for Activity 4-Cloud Formation

Students' Names: Jobin John **Date:** 10/11/09

Draw the diagram showing clouds formed in jar with proper labels.

Write down your observation of what you have observed when clouds form.

I observe that water drops are coming down.
I observe that smoke on the jar.

The analysis of the activity sheets indicated that majority of the students (89.13%) labeled the figure of cloud formation with ice cubes, water drop, boiling water, torch, smoke and matchstick. It was clear that that the majority of the students (89.13%) were able to observe the minute changes occurred in the closed jar during the cloud formation using visual sense appropriately.

4.3.1.5 Lesson 7 Observation of Living World - Topic - Diversity in Animals and Birds

Instructional Objective

- Students will write the diversity of animals and birds based on their daily observations.

Description of the Activity 1 Naturalist, Interpersonal and Logical-mathematical

Prior to the activity, the teacher discussed variations in animals and birds with respect to their food, colour, sizes, and habitats. The teacher showed the realia of the tailor bird's nest and the model of sparrow's nest for comparison. The teacher also explained the differences in legs of sparrow and flamingo. After discussing relevant examples of animals and birds, the teacher distributed activity sheets to the students and guided them how to work in pair. In this activity, the students were guided that one student in pair would ask question to other student in pair. The data collected using the activity sheets were mentioned in table 10. Percentage in table 10 indicates how many times particular observation was reported.

Table 10 Observation of the Students to Study the Differences in the Animal Kingdom

Sr. No.	Animal / Bird	Habitat	Food Habits	Colour	Other Features
1.	Tailor Bird	Trees – (100%)	Grain- (39.13%); Fruits- (26.08%)	Light Brown, Brown / Brownish – (100%)	It makes very beautiful nest. – (100%)
2.	Sparrow	Nest or tree – (95.65%); Behind the photo frame- (04.34%)	Grains, insects, fruits, cereals – (100%)	Brown or and white- (91.30%); Grey- (08.69%)	It makes small, beautiful nest.- (56.52%); It makes dirty nest.- (04.34%); It jumps and lays small eggs.- (08.69%)
3.	Fox	Jungle- (100%)	Meat/flesh, herbivores – (100%)	Brownish yellow- (100%)	It is less energetic. - (43.47%); It cannot fly. It is intelligent, wise. It eats grapes; It is less faster than cheetah. (26.08%); It is dangerous.- (13.04%); It runs speedily.- (17.39%)
4.	Shark	Sea- (100%)	Small fishes – (69.56%); Man- (04.34%) Flesh/meat and small insects- (17.39%)	Blue- (69.56%); Gray black, Blue black, Black- (13.04%) Grey – (08.69%)	It has sharp big teeth.-(78.26%); It is the king of water. - (04.17%); It swims fast, eats man, & smells a drop of blood. It is powerful, big and dangerous.- (17.39%)

*Table 10 is continued on next page.

Table 10 Observation of the Students to Study the Differences in the Animal Kingdom

Sr. No.	Animal / Bird	Habitat	Food Habits	Colour	Other Features
5.	Camel	Desert area-(100%)	Leaves and grass-(100%)	Brown-(34.78%); Yellow-(45.65%); Brownish yellow-(04.34%)	It carries load.-(100%); It runs fast in desert.-(04.34%); It uses little water. –(26.08%); It is big. –(08.69%); It does not eat for 2-3 days. Its backbone is big. –(04.34%); It eats plants.-(04.34%)
6.	Cow	Shed-(43.47%); Cattle-(52.17%); At agricultural place-(04.34%)	Grass, leaves, plants-(100%); Fodder-(17.39%)	Brown –(43.47%); White –(100%); Red, light brown –(04.34%)	It gives milk to us. -(100%); It is domestic animal. -(04.34%)
7.	Lion	Lived in forest /jungle-(82.60%); Den, Cave-(65.21%)	Flesh / meat-(100%) Animals-(73.91%)	Yellowish-(100%)	It can run fast.-(65.21%); It is powerful.-(08.69%); It is the king of jungle; it is a carnivore.-(60.86%)
8.	Lizard	House-(100%)	Insects-(100%); Ant-(04.34%)	Brown-(100%)	It can run fast to eat. -(100%); It climbs house. - (04.34%)

*Table 10 is continued on next page.

Table 10 Observation of the Students to Study the Differences in the Animal Kingdom

Sr. No.	Animal / Bird	Habitat	Food Habits	Colour	Other Features
9.	Rat	Holes-(100%); Railway station-(04.34%)	Insects-(100%); Cheese-(21.73%); *Roti*, Carrot-(04.34%); Cereals, grains-(73.91%)	Black-(100%)	It can jump high, It smells.-(04.34%); It harms human properties.-(34.78%); It runs fast-(21.73%)
10.	Ant	Holes-(100%) Homes, everywhere-(17.39%)	Sugar, rice, grains, cereals fruits-(100%)	Black and red-(100%)	It has sharp nose (quick at smelling, Very small, Runs fast, Red ant bites but black ant does not bite, It eats sugar very much, saves food. -(47.82%)
11.	Bat	Trees-(04.34%)	Insects-(82.60%); Fruits-(17.39%)	Coffee-(08.69%); Black-(91.30%)	It can see in darkness.-(17.39%); It flies in the night.-(41.30%)
12.	Dog	Home-(100%)	Cat-(08.69%); Flesh / meat-(43.47%) *Roti*-(17.39%); Cereals, or grains –(65.21%)	Black, white-(100%); Brown-(21.73%); Yellow-(08.69%)	It is faithful to us. - (82.60%); It is omnivores, it can bite us, and It has sharp teeth. -(13.04%); It is domestic.-(04.34%)

The above table 10 data clearly indicated that the students knew basic characteristics of the animals which helped them to differentiate a particular animal from other animals based on their prior observations. The students also knew the food habits of different animals, their habitats, and differences in colour too. The students' remarks noted down along with other features showed that they had prior conception regarding the animals based on their observation and stories they had heard (Such as stories related to rat, lion, camel, and dog) which guided them to write specific characteristic features of the animals. It indicated that the students were able to find out the similarities and dissimilarities existing among animals and birds.

4.3.2 Study of the Process of Learning Science in relation to Measurement - Process Skill

The activities, which exclusively demanded the use of measurement process skill, were clubbed together and the students' responses were analyzed using activity sheets and classroom observation. The brief description of the activities and how students carried out the same activities using measurement skill are discussed in the subsequent sections.

4.3.2.1 Lesson 3 Living - Non Living -Topic - Plant is living

Instructional Objective

- Students will explain that plants are living on the basis of their growth in sunlight.
- Students will explain that plants are living by measuring their growth under two different conditions.

Description of Activity 4 Logical-mathematical and Naturalist

The teacher brought two plants of same height in class and instructed the students to place one plant in a dark place without giving water (plant in Pot A). The teacher instructed students to keep one plant in sunlight, to water it regularly and to observe the changes daily of the plant kept in sunlight (plant in Pot B). The teacher asked students to measure the height of both the potted plants. After fifteen days, the teacher asked students to measure the height of the plants kept under two different conditions. The teacher asked questions like: How the plant in pot A looked after 15 days? How the plant in pot B looked after 15 days? And which plant grew better? The teacher asked students the height of both the plants and further probed that why plant in pot B grew better in comparison to plant in pot B?

Majority of the students (91.30%) mentioned that the plant kept in sunlight grew well as it got new leaves and flower too. They also added that the plant kept in darkness withered and looked dull. Initially, all the students measured the height of both the potted plants as 15 inches. After fifteen days, the students measured the height of the plant around 17 to 18 inches for the plant that was kept in sunlight and 15 to 16 inches for the plant, which was not exposed to sunlight. The measurement differed by the actual measurement by $\pm$ 1 inch.

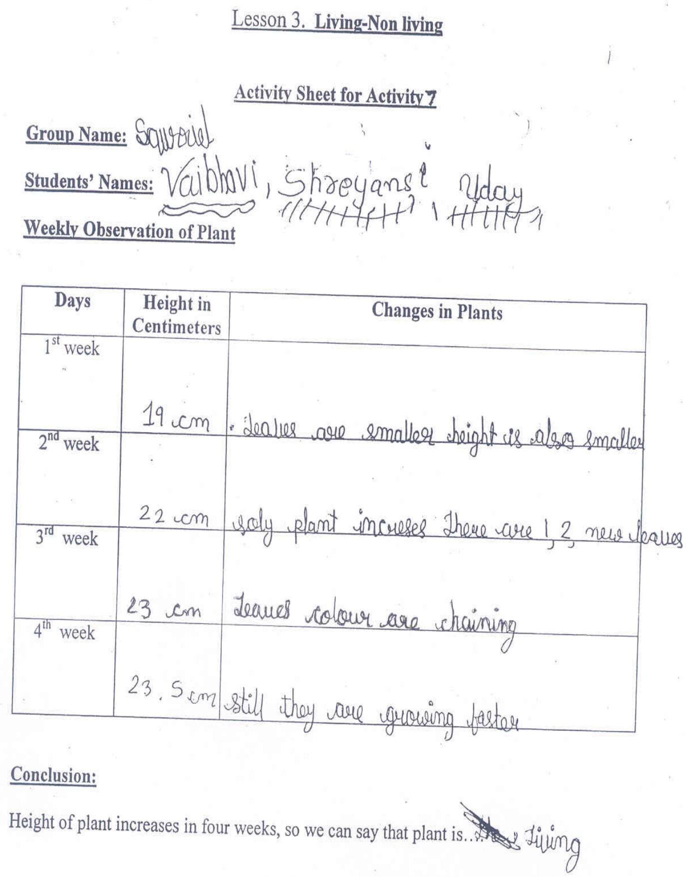
Instructional Objective

- Students will explain plants are living by measuring change in their height.

Description of the Activity 7 Logical - mathematical and Naturalist

It was the group activity wherein students in a group were asked to observe the potted plants and measure the height of the potted plants periodically for at least four consecutive weeks. The teacher gave a demonstration for how to measure the height of a plant using string and what care should be exercised such as stretching the string properly to measure plant's height accurately and small lines drawn on scale should also be considered while measuring. A sample of student's scanned activity sheet is mentioned in figure 10.

Figure 10 Student's Activity Sheet for Observation of Plants



Lesson 3. **Living-Non living**

Activity Sheet for Activity 7

Group Name: Sawrial

Students' Names: Vaibhavi, Shreyansi, Uday

Weekly Observation of Plant

Days	Height in Centimeters	Changes in Plants
1st week	19 cm	Leaves are smaller height is also smaller
2nd week	22 cm	daly plant increses There are 1, 2 new leaves
3rd week	23 cm	leaves colour are chaining
4th week	23.5 cm	still they are growing faster

Conclusion:

Height of plant increases in four weeks, so we can say that plant is.. living

There were (32.60%) students who made mistake while measuring the height of the potted plant which might be attributed to keeping string loose while measuring the plant's height. The other reason observed was not to consider the top most tip of the plant while measuring. The students did not notice to count the small lines between two consecutive inches on scale which obstructed them to measure the height of the plant accurately. All students reported the correct changes in the leaves of the plants such as small leaves were shot and leaves increasing in the size after a week or more days. They also reported that new small leaves were light green in colour in the beginning which later on turned into dark green in colour. They also reported that plants had more number of leaves at the end of fourth week. It was found that (100%) students were able to infer that plants are living. One group also mentioned that plants were living but they could not show any movement and reported that they gave us air and oxygen. This indicated that a few students were able to point out specific characteristics of the plant but majority of the students did not mention other characteristic features of the plants such as preparation of the food by photosynthesis, reproduction of the similar kind of plant, and plant's sensitivity towards sunlight and water.

4.3.3 Study of Process of Learning Science in relation to Classification - Process Skill

The activities, which required major use of classification process skill, were clubbed together and the students' responses were analyzed using activity sheets and classroom observation. The brief description of the activity along with how students performed particular activity and demonstrated the classification skill is discussed in the subsequent sections.

4.3.3.1 Lesson 2 Learn Preparing Groups - Topic - Concept of Group based on Similarities and Dissimilarities

Instructional Objective

- Students will identify the similarities and dissimilarities among various things / substances.
- Students will explain that the group has objects / substances showing at least one common characteristic.

Description of the Activity 1 Logical-mathematical

To introduce the concept of group, the teacher showed different objects / substances tennis ball, cricket ball, key-chain, key, cotton, ball pen, rubber, white chalk, and salt to the students. The teacher asked them to name the objects that they found similar in one or more aspects. The teacher asked the students to classify tennis ball, cricket ball, key-chain, key, cotton, ball pen, white chalk, and salt into group. After the students' arrangement of things / substances into group, the teacher asked the reasons for particular arrangement of the objects / substances into group and explained how groups could be formed based on similar or dissimilar characteristics of the objects / substances.

All the students grouped the cricket and tennis balls together and gave reason that both balls were used to play and were round in shape. They grouped key-chain with key. They mentioned rubber, ball pen and chalk were used to write so they could be placed together. They did not classify cotton and salt. It indicated that the students did not notice the similarities among cotton, salt and white chalk with regard to colour. It showed that the students were able to classify the objects and substances whose similarities could be easily identified.

4.3.3.2 Lesson 2 Learn Preparing Groups- Topic – Grouping into Manmade and Natural Objects

Instructional Objective

- Students will group the objects as manmade and nature's gift.

Description of the Activity 2 Logical - mathematical

The teacher showed different things to the students. Some things are naturally available and some were manmade. The students were instructed to classify the things from the manufacturing perspective such as whether things were available from the nature or things were manufactured by man. The teacher explained the naturally available things and manmade things after collecting the activity sheets. The format of the activity sheet with instruction is mentioned in figure 11.

Figure 11 Format of the Activity Sheet: Classification of Things

Lesson 2 Learn Preparing Groups

Student's Name: **Date:**

Activity Sheet for Activity 2

Classify the given below objects into manmade and nature's gift by putting the '√' or 'X' in given table.

Things / Objects: Glass, Plastic bowl, Bark of tree, Neem tree's leaves, Tooth brush, Football, Table, Boat, Rose, Jasmine, Bamboo, Wool and Jute

Objects	Manmade	Nature's gift
Plastic bowl		
Tooth brush		
Glass		
Neem tree's leaves		
Bark of tree		
Football		
Table		
Boat		
Rose		
Jasmine		
Bamboo		
Wool		
Jute		

The responses of the students were categorized as in the table 11.

Table 11 Students' Responses: Manmade Things

Objects	% of the Students who classified object as Manmade
Plastic bowl	100%
Toothbrush	97.82%
Glass	97.82%
Neem tree's leaves	02.17%
Bark of tree	02.17%
Football	97.82%
Table	97.82%
Boat	100%
Rose	02.17%
Jasmine	02.17%
Bamboo	02.17%
Wool	02.17%
Jute	02.17%

From the table 11, it is evident that there were very few students who failed to conceptualize that naturally occurring things were those which were not manufactured by man but were freely available in nature. The similar kind of mistake by a few students for not considering toothbrush, glass and football as manmade might be attributed to haste in doing the activity. It was clear from the above data that almost all students comprehended which things were manmade and which were naturally available. It indicated that except one student, all the students were able to classify the objects / things on the basis of manufacturing perspective correctly.

4.3.3.3 Lesson 2 Learn Preparing Groups- Topic – Objects Grouped from which they are made

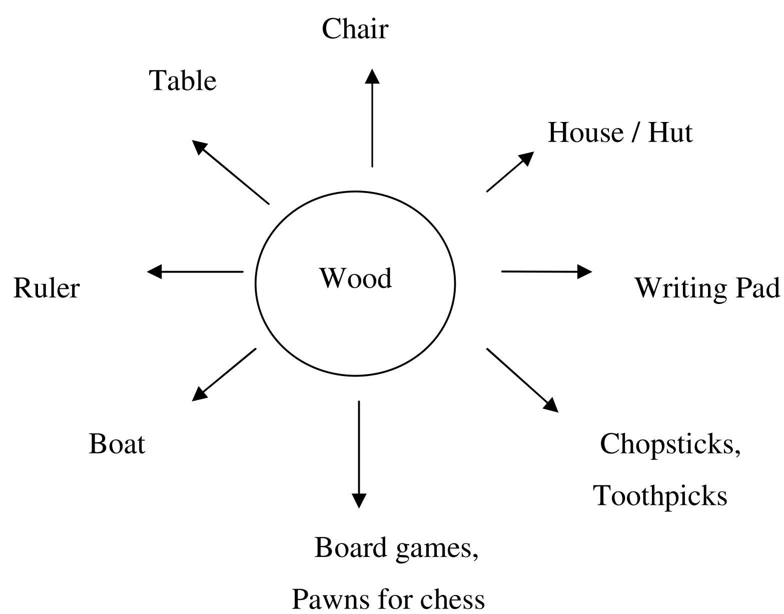
Instructional Objective

- Students will classify the objects into the material from which the objects are made.

Description of the Activity 3 Logical - mathematical

The teacher wrote the names of various objects on blackboard and asked from which material (like wood, paper, iron, glass and plastics) the objects were made up of. The teacher developed the schematic diagram of things made from wood which is mentioned in figure 12.

Figure 12 Schematic Diagram of Things Made From Wood



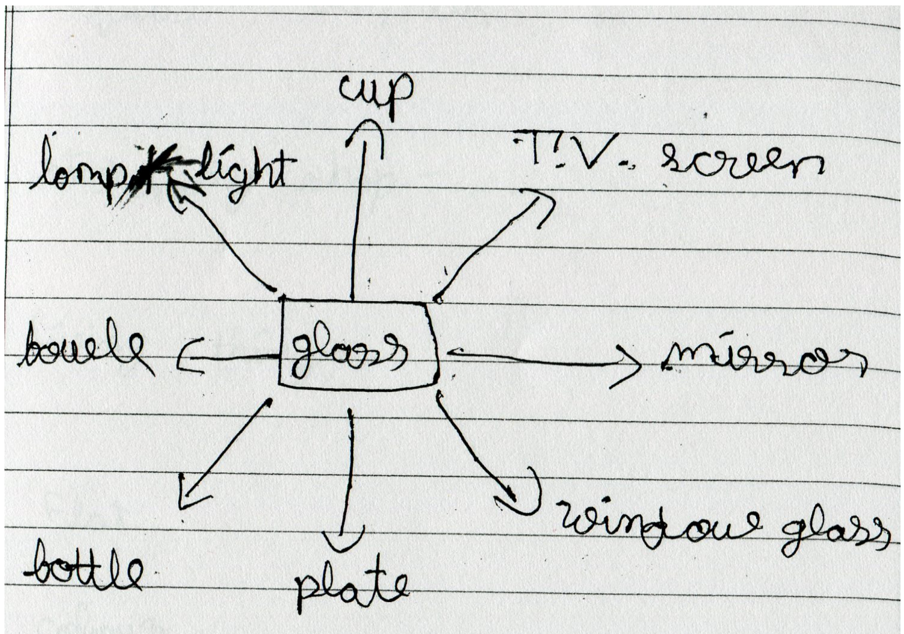
Following objects were given to the students for classification based on the material from which they were made.

Objects: chair, table, toys, belt, purse, cloth, notebook, newspaper, artificial flowers, glass, rod, nail, bars, measurement-weights, pencil, desk, duster and plastic bottle

It was found that generally all the students were able to classify the objects / things from the material they were made. The interaction and active participation of the students indicated that the students of this age were capable to understand various objects were made from different material. For instance, they classified chair, and table made from wooden material and notebook and newspaper made from paper.

This way, they further classified objects. A sample of student's schematic diagram of things made from glass is mentioned below in figure 13.

Figure 13 Student's Schematic Diagram of Objects Made from Glass



4.3.3.4 Lesson 2 Learn Preparing Groups - Topic - Classification of the Objects based on the Properties

Instructional Objective

- Students will display correct observations for the objects / substances under study.
- Students will classify the substances / objects on the basis of various characteristics.

Description of the Activity 5 Logical-mathematical, Musical and Interpersonal

The teacher explained the acronym- DCEFPTS where D dissolves in water? C= Colour, E=Edible, F=floats or sinks in water? P=Pressed? T= Transparent? and S= Shape. The teacher encouraged students to sing a song with clapping which is mentioned as under.

Song on Characteristics of Objects

"Different objects

So have different properties.

So Use DCEFPTS

To make group, group.

D means dissolving in water.

C means see the colour.

E means edible

F means float, float.

P means press, press.

T means see through the object.

S means see the shape, shape".

The teacher provided different substances / objects to each group of five students to study the characteristics based on observation. A student's sample activity sheet is mentioned in figures 14 and 15.

Figure 14 A Student's Activity Sheet: Classification of Objects / Things

Lesson 2 Learn Preparing Groups

Activity Sheet for Activity 5

Name of Student: Kanungo Nurulain Khan Mulasshir **Date:** 1-7-09

Study the things mentioned in table. Put '√' in the columns of the table where applicable. Put 'X' where the thing is not applicable. Write the name of colour and shape in respective columns.

Things	D= dissolves in water?	C= Colour	E=Edible	F=Can float?	S=Sinks in water	P=Can be pressed?	T= Trans-parent?	S= Shape
Oil	X	Yellow	✓	✓	X	X	X	X
Chalk	X	Blue	X	X	✓	X	X	X
Butter paper	X	White	X	✓	X	X	X	Rectangle
Plastic Material	X	-	X	✓	X	X	✓	Triangle
Sand	X	Black	X	X	✓	X	X	irregular
Cotton	X	White	X	X	✓	✓	X	irregular
Rubber Ball	X	Red	X	✓	X	✓	X	round Circel
Thermocol Ball	X	White	X	✓	X	✓	X	round Circel
Table salt	✓	White	✓	X	✓	X	X	X
Crushed paper	X	Purple	X	✓	X	X	X	X
Sponge	X	White	X	✓	X	✓	X	Rectangle

Now classify all above things in suitable groups as under.

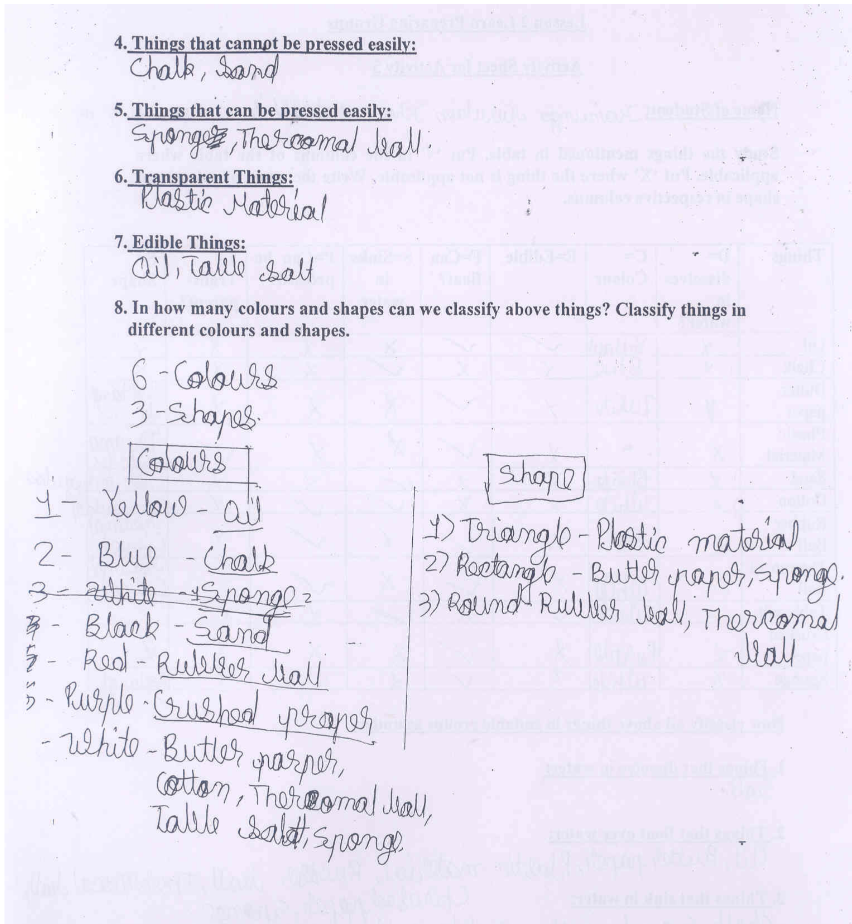
1. **Things that dissolve in water:**
Salt

2. **Things that float over water:**
Oil, Butter paper, Plastic material, Rubber ball, Thermocol ball, Chrused paper, Sponge.

3. **Things that sink in water:**
Chalk, Sand, cotton, Table salt

P.T.O

Figure 15 A Student's Activity Sheet: Classification of Objects / Things



4. Things that cannot be pressed easily:
Chalk, Sand

5. Things that can be pressed easily:
Sponge, Thercomal ball.

6. Transparent Things:
Plastic Material

7. Edible Things:
Oil, Table salt

8. In how many colours and shapes can we classify above things? Classify things in different colours and shapes.

6 - Colours
3 - Shapes.

Colours
1 - Yellow - Oil
2 - Blue - Chalk
~~3 - White - Sponge~~
3 - Black - Sand
4 - Red - Rubber ball
5 - Purple - Crushed paper
- White - Butter paper, Cotton, Thercomal ball, Table salt, sponge

Shape
1) Triangle - Plastic material
2) Rectangle - Butter paper, Sponge.
3) Round - Rubber ball, Thercomal ball

The students' observations were counted and mentioned as under in Table 12. Percentage in table 12 indicates the % of students who reported particular observation.

Table 12 Students' Observations: Characteristics of the Objects / Substances

Things	D= dissolves in water?	C= Colour	E=Edible	F=Can float?	S=Sinks in water	P=Can be pressed?	T= Trans-parent?	S= Shape
Oil	---	Yellow – (100%)	Edible- (100%)	Floats – (97.82%)	Sinks- (02.17%)	---	---	---
Chalk	Not dissolves fully- (100%)	Blue – (100%)	Not edible- (100%)	does not float- (100%)	Sinks (100%)	Cannot be pressed (100%)	Not transparent (100%)	---
Butter paper	---	White- (100%)	No- (100%)	Floats- (100%)	Does not sink- (100%)	---	Not transparent- (100%)	Rectangle- (100%)
Plastic Material	---	Colourless (100%)	No- (100%)	Floats- (100%)	---	---	Transparent- (100%)	Triangle- (100%)
Sand	---	Black- (08.69%)	No- (100%)	No- (100%)	Sinks – (100%)	No- (100%)	No-(100%)	Irregular- (02.17%)
Cotton	Dissolves – (06.52%)	White- (100%)	No- (100%)	Floats- (08.69%)	Sinks – (91.30%)	Yes- (100%)	No-(100%)	Irregular- (02.17%)
Rubber Ball	---	Red- (100%)	No- (100%)	Floats- (95.65%)	Sinks – (04.34%)	Yes- (100%)	No-(100%)	Circle- (97.82%) Round – (02.17%)

*Table 12 is continued on next page.

Table 12 Students' Observations: Characteristics of the Objects / Substances

Things	D= dissolves in water?	C= Colour	E=Edible	F=Can float?	S=Sinks in water	P=Can be pressed?	T= Trans-parent?	S = Shape
Thermocol Ball	No-(100%)	White-(100%)	No-(100%)	Floats-(95.65%)	Sinks –(04.34%)	Yes-(100%)	No-(100%)	Circle-(97.82%) Round –(02.17%)
Table salt	Dissolves-(97.82%)	White-(100%)	Yes-(100%)	No-(97.82%)	Sinks –(02.17%)	---	---	---
Crushed paper	No-(100%)	Purple-(100%)	No-(100%)	Yes-(100%)	No –(0)	Yes-(100%)	No-(100%)	Irregular-(100%)
Sponge	Dissolve –(02.17%)	White –(100%)	No-(100%)	Yes-(100%)	No-(0)	Yes-(100%)	No-(100%)	Rectangular-(100%)

The above data mentioned in table no 12 clearly indicated that the students used visual sense appropriately to report the objects' / substances' characteristics such as colour, shape and transparency. The students also observed correct observation for the floating and sinking of the substances or objects. There were very few students who were found to making mistakes to report characteristic of substances to dissolve completely in water.

The students suggested six different ways to classify the items based on the colour of the substances: yellow, white, red, purple, black, and blue. They indicated three ways to classify the objects based on the shapes namely rectangle, triangle and round. It showed the evidence of students' thinking to cover as many as possible ways to classify the objects / substances based on colour and shape.

4.3.3.5 Lesson 3 Living - Non Living - Topic – Differentiating Living from Non - Living

Instructional Objective

- Students will list down the names of various living and non - living from given word block.
- Students will classify living from non - living on the basis of their characteristics.

Description of the Activity 1 Linguistic, Logical-mathematical, Interpersonal and Musical

The students were given activity sheets wherein word block was given. On each cell of word block, English alphabet was written and the students had to make different names of objects, fruits, trees, and animals by encircling the cells of the word block and thus they had to find out the hidden names of various living and non-living and classify them into living and non-living. The word block given in activity 1 is mentioned as in figure 16.

Figure 16 Word Game: Living – Non Living

R	S	P	A	R	R	O	W	R	I	Q	B
S	O	D	R	R	D	I	N	O	U	S	A
R	F	G	S	W	I	O	P	R	S	M	I
O	D	H	H	M	C	A	K	O	B	N	K
C	L	B	O	A	T	S	R	A	O	A	S
K	I	T	L	N	R	H	I	T	O	B	A
E	O	G	Q	G	Z	O	N	L	K	S	K
T	K	J	P	O	C	K	Q	S	O	W	T
X	R	A	U	N	B	A	L	B	W	R	A
E	A	P	B	I	A	O	A	D	M	J	B
R	I	T	J	O	N	L	S	A	X	G	L
S	P	O	N	T	A	E	W	I	Z	E	E
I	N	B	S	R	N	O	A	K	Y	R	M
R	I	C	U	E	N	W	N	Q	U	S	A
I	O	L	T	F	W	S	T	R	N	V	C
P	A	P	P	Y	A	L	A	S	K	I	S
E	G	A	U	N	G	O	H	I	O	O	O
A	W	H	E	M	O	N	K	E	B	A	T

Except few, almost all (95.65%) students found out the names such as rocket, sparrow, man, table, bat, book, tree, ashoka tree, rock. The high success rate in doing this activity indicated that the students were familiar with the day-today world and surroundings. It also indicated that the students also had prior knowledge about different names of living and non-living which made easy for them to find out the same from the given word block. Thereafter, the teacher explained the characteristics of various living and non-living by giving examples and drawing the schematic diagrams of the same. The students' charts for the characteristics of living and non-living are mentioned in figures 17 and 18.

Figure 17 A Student's Chart of the Characteristics of Living

The students were instructed to recall the names of the living and the non-living that they have found out in the word block and mention the same in the table 1 in the given activity sheet. They were also given freedom to write the names of the living and the non-living other than that they found in the word block. The students in pairs were asked to differentiate the living from the non-living on the basis of their characteristics and classify them accordingly. The scanned activity sheet of one student is mentioned in the figure 18.

Figure 18 Students' Activity Sheet: Classification into Living and Non - Living

Lesson 3. Living-Non-living

Activity Sheet for Activity 1

Group Name: **Date:**

Students' Names: Abhi, Haren, Shailee

Recall the names of trees, objects, and animals that you have framed in earlier activity. Write those names in the given table. Now check their characteristics and classify them by writing 'Yes' or 'No' in below mentioned table.

Table 1: Classification into Living and Non-Living.

No	Things	Characteristics						Conclusion (Write Living or Non-living)
		Does it move by its own?	Has it sensitivity?	Does it take food?	Does it show respiration?	Does it Excrete?	Does it Reproduce?	
1	Bat	Yes	Yes	Yes	Yes	Yes	Yes	Living
2	Table	NO	NO	NO	NO	NO	NO	non living
3	bag	NO	No	No	No	NO	No	non living
4	book	NO	NO	NO	NO	NO	NO	non living
5	Lion	yes	yes	yes	yes	yes	yes	Living
6	man	yes	yes	yes	yes	yes	yes	Living
7	Cock	yes	yes	Yes	Yes	Yes	Yes	Living
8	Chair	NO	NO	NO	NO	NO	NO	non living
9	deer	yes	yes	yes	yes	yes	yes	living
10	Board	No	NO	No	NO	NO	NO	Nonliving

All (100%) students classified fish, monkey, spider, tree, man, birds, animals, plants, frog, lion, bear, tiger, sparrow, camel, deer and neem tree as the living. The students thus moved beyond the names they found out in previous activity and classified the living and the non-living with the help of their partner in pair. This showed the interest of the students in learning as well as their understanding regarding seemingly observed characteristics: such as movement, reproduction and growth which differentiated the living from the non-living. Objects classified as the non-living were: table, pencil, pen, chair, car, pad, bag, and rocket. It indicated that all the students reported the characteristics of the living and the non-living correctly and were able to classify them correctly. Thereafter, the teacher encouraged to sing the below mentioned songs with claps and bodily-movements.

Song on Characteristics of Living

"Plants and animals
are living
Living feels pain
Living takes food
Living shows growth
Living shows movement
Living reproduces and respires."

4.3.3.6 Lesson 5 Seed and Its Germination - Topic - Types of the Seeds

Instructional Objective

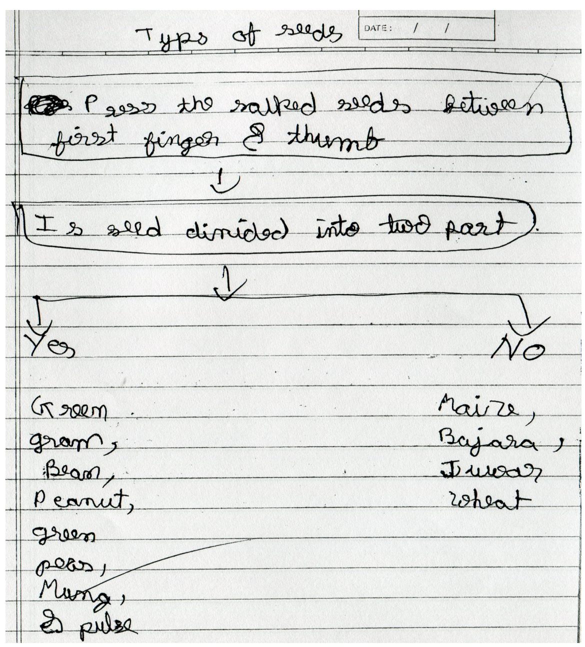
- Students will differentiate the seeds into monocot and dicot.

Description of the Activity 2 Logical - mathematical and Musical

The teacher showed various 8 to 10 seeds soaked for 8-10 hours in water to the students. The teacher called a student and asked him to press the soaked seed between first finger and thumb and asked questions: (1) What happened upon pressing the soaked seed? (2) Could it be easily pressed? (3) Could the seed be divided into two parts? The teacher instructed the students to note down their observation in activity sheets. Flow chart was prepared by the teacher to show the types of seeds: monocot and dicot. Thereafter, the teacher provided different kinds of seeds and asked students to do the activity by themselves and classify seeds into monocot and dicot based on their reported observations in the activity sheet.

Majority of the students replied in unison that the seed of maize was monocot without paying attention to what they observed while pressing hard the soaked maize seed. On the contrary, when soaked wheat seeds were given to them, majority of the students wrongly classified wheat seed as dicot. This was because they had observed the furrow on wheat seed and they did not attempt to split it by pressing. The teacher asked them to split the wheat seed again and explained that soaked wheat seed could not be divided into halves though we found a furrow on it. Except a few students, majority of the students identified seed of '*juwar'* seed correctly as monocot seed. Some students faced difficulty in classifying the *'val'* (beans) as dicot because they were not able to divide it into halves while pressing at first attempt. This situation might have arisen because some students got the dissimilar fragments of seed upon pressing due to inadequate pressure applied to split the *'val'* (beans). The teacher instructed them to attempt again to split *'val'* (beans) and asked them to report their observations in the given activity sheet. A student's schematic diagram for types of seeds is mentioned in figure 19 as under.

<u>Figure 19 Student's Diagram - Types of Seeds</u>



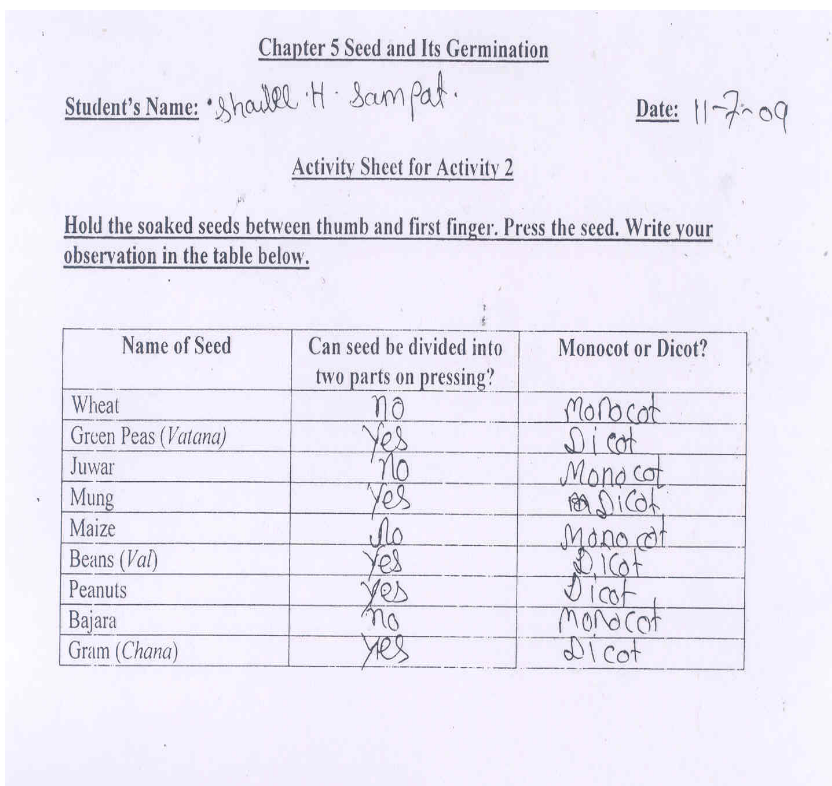
Analyzed written responses of the students were categorized and mentioned in the table 13. Number in the bracket in table 13 shows percentage of the students for particular observation.

Table 13 Students' Classification of the Seeds: Monocot and Dicot

Name of Seed	**Can seed be divided into two parts on pressing?**	**Monocot or Dicot**
Wheat	No (100%)	Monocot (100%)
Green Peas (*Vatana)*	Yes (100%)	Dicot (100%)
Juwar	No (93.47%)	Monocot (93.47%)
Mung	Yes (100%)	Dicot (100%)
Maize	No (100%)	Monocot (100%)
Beans (*Val*)	Yes (84.78%)	Dicot (84.78%)
Peanuts	Yes (97.83%)	Dicot (97.83%)
Bajara	No (100%)	Monocot (100%)
Gram (*Chana*)	Yes (100%)	Dicot (100%)

The table 13 data indicated that a few students had difficulty in classifying j*uwar*, beans *(val)*, and peanut. The classification of the seeds was based on their observation suggested that almost all students were able to classify seeds correctly as either monocot or dicot based on their hands-on experiences. A student's activity sheet is mentioned in the figure 20.

Figure 20 Student's Activity Sheet: Classification of Seeds



Chapter 5 Seed and Its Germination

Student's Name: Shallel H. Sampat. Date: 11-7-09

Activity Sheet for Activity 2

Hold the soaked seeds between thumb and first finger. Press the seed. Write your observation in the table below.

Name of Seed	Can seed be divided into two parts on pressing?	Monocot or Dicot?
Wheat	no	Monocot
Green Peas (*Vatana)*	Yes	Dicot
Juwar	No	Monocot
Mung	Yes	Dicot
Maize	No	Monocot
Beans (*Val*)	Yes	Dicot
Peanuts	Yes	Dicot
Bajara	no	Monocot
Gram (*Chana*)	Yes	Dicot

The teacher encouraged the students to sing the following mentioned song on the varieties of seed with claps after completing the activity.

<u>Song on Varieties of Seed</u>

“Seeds so wonderful
Big and small
Having different colours
Smooth and rough surfaces
Can be monocot or dicotyledon
So small
Plants grows from them
I am surprised! surprised!”

4.3.3.7 Lesson 16 Energy - Topic - Sources of Energy other than Sun

Instructional Objective

- Students will name various sources of energy other than the sun.
- Students will classify sources of energy into exhaustible and inexhaustible.
- Students will explain various sources of energy.

Description of the Activity 4 Visual-spatial

The teacher explained the terms 'exhaustible' and 'inexhaustible' and discussed the differences among the exhaustible and inexhaustible sources of energy using PowerPoint Presentation (CD, Folder 16 – File - energy sources). The teacher asked questions such as: What are the two major types of sources of energy? Give the examples of exhaustible sources of energy? Name the inexhaustible sources of energy. What is the difference between exhaustible and inexhaustible sources of energy? The teacher listed down various sources of energy such as petrol, kerosene, CNG, LPG, wind, sun and flow of water on blackboard and asked them to classify into exhaustible and inexhaustible sources of energy.

The students' responses indicated that all the students understood the difference between inexhaustible and exhaustible sources of energy and classified all the above given sources of energy correctly into inexhaustible and exhaustible sources of energy. All the students classified petrol, kerosene, CNG, LPG as exhaustible sources of energy and wind, the sun and flow of water as inexhaustible sources of energy.

4.3.3.8 Lesson 4 Let Us Know the Soil - Topic - Classification of Soil

Instructional Objective

- Students will classify the samples of soil on the basis of colour and the components present in them.

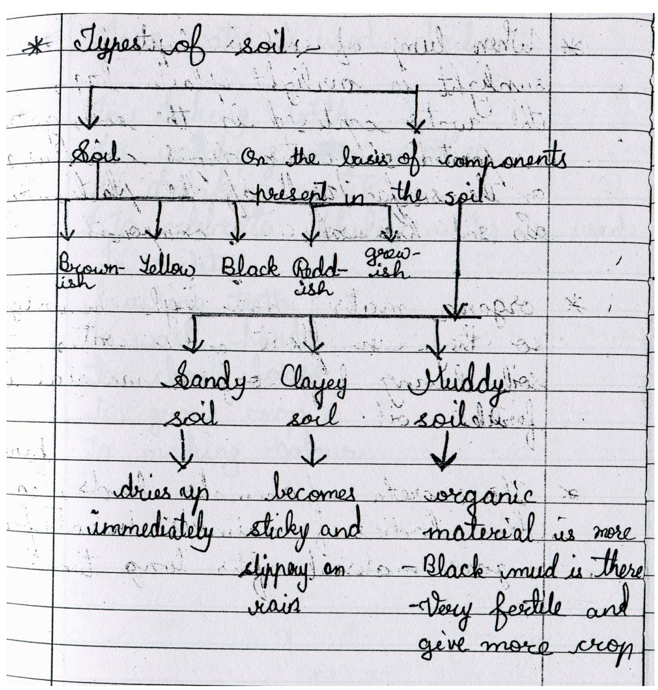
Description of the Activity 6 Visual - spatial and Logical - mathematical

The teacher showed the different coloured soil samples like black, red, and brownish and explained the different types of soil that vary in colour. The teacher explained the characteristics of sandy, clayey, and muddy soil briefly and noted down the same on blackboard in diagram. The teacher asked the questions noted below for making students to conceptualize different ways for classification of the soil.

1. In How many ways, can we classify the soil?
2. On the basis of components present in soil, what are three different types of soil?

It was observed during classroom interaction, that the students replied immediately that soil could be classified based on colour because they learnt in 'Lesson 2 - Learn Preparing Groups' that colour was also one of the properties of the object or substance to classify. When the students were asked to classify the soil into different types after explaining the characteristics of soil, majority of the students were not able to reply immediately that soil could be classified as sandy, muddy or clayey. It meant that the students did not comprehend that different soil samples contained varying degree of different proportions of the components and therefore, soil could be classified on the basis of proportions also. It indicated that though types of soil were explained, very few (21.73%) students were able to point out the classification of soil based on proportion of components present therein. A student's classification of types of soil is shown in figure 21.

Figure 21 A Student's Schematic Diagram of Types of Soil



4.3.3.9 Lesson 12 Light and Its Properties - Topic - Sources of Light

Instructional Objective

- Students will write down the names of various sources of light from the letters given.
- Students will classify the sources of light into manmade and natural sources of light.

Description of Activity 2 Linguistic and Logical-mathematical

Having explained the concept of sources of light with examples of natural and artificial / man-made sources of light, the teacher provided the activity sheets of word game in which the students were asked to make the names of the sources of light. The students, thereafter, were asked to classify the natural and manmade sources of light. The letters of alphabets provided to the students were as under.

L S W M N J T H P Q E R B U O A C I K D F X G Y T

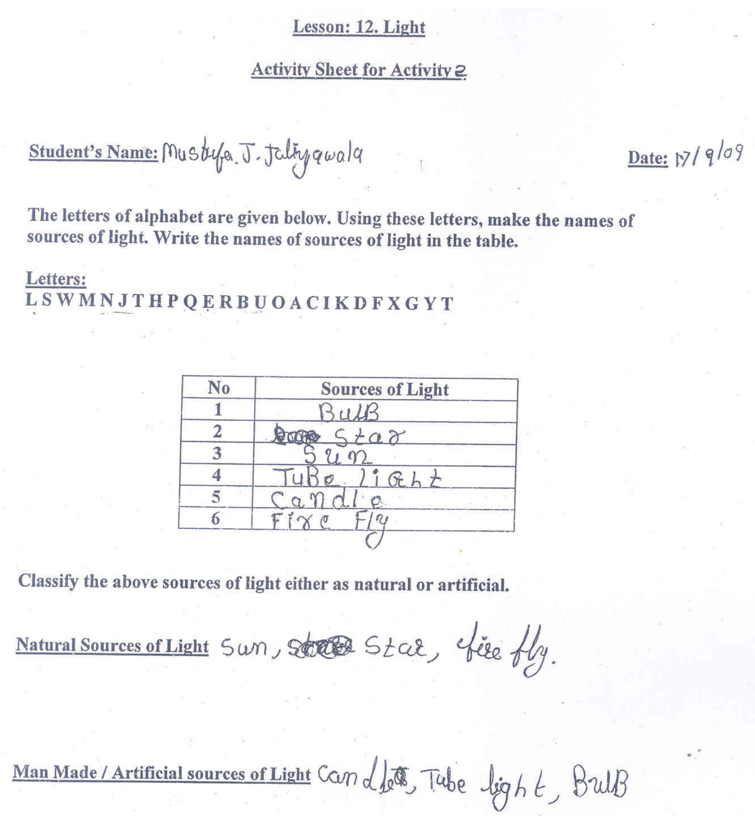
Table 14 shows the names of the sources of light made by the students using the given letters of the alphabets.

Table 14 Sources of Light as Found out by the Students

Sr. No.	Sources of Light	Percentage of the Students
1.	Bulb & / Electric bulb	86.95%
2.	Sun	95.65%
3.	Torch	63.04%
4.	Fire fly	34.78%
5.	Candle	71.73%
6.	Earth	08.69%
7.	Lantern	21.73%
8.	Lighter pen	34.78%
9.	Star	69.56%
10.	Tube light	39.13%
11.	Fire	21.73%
12.	Lamp	02.17%
13.	Moon	04.34%

The data from table 14 indicated that the students were able to generate large number of names for the sources of light. There were (08.69%) students who committed mistake to consider the 'earth' as source of light. The sample of the student's activity sheet is mentioned in figure 22.

<u>Figure 22 Student's Activity Sheet: Classification of Sources of Light</u>



Lesson: 12. Light

Activity Sheet for Activity 2

Student's Name: Mustafa. J. Jaliyawala **Date:** 17/9/09

The letters of alphabet are given below. Using these letters, make the names of sources of light. Write the names of sources of light in the table.

Letters:
L S W M N J T H P Q E R B U O A C I K D F X G Y T

No	Sources of Light
1	BulB
2	Star
3	Sun
4	TuBe light
5	Candle
6	Fire Fly

Classify the above sources of light either as natural or artificial.

Natural Sources of Light Sun, Star, fire fly.

Man Made / Artificial sources of Light Candle, Tube light, BulB

The students' classification into natural and artificial sources of light was as under in the table 15 and table 16 consecutively.

Table 15 Natural Sources of Light as Classified by Students

Sr. No.	Natural Sources of Light	Percentage of the Students
1.	Bulb	02.17%
2.	Sun	95.65%
3.	Fire fly	21.73%
4.	Lantern	04.34%
5.	Star	69.56%
6.	Fire	21.73%
7.	Lighter pen	04.34%
8.	Tube light	06.52%
9.	Torch	02.17%
10.	Venus	02.17%
11.	Mars	02.17%
12.	Jupiter	02.17%

The above table data 15 shows that majority of the students were able to classify the sun and star as natural sources of light.

Table 16 Artificial Sources of Light as Classified by Students

Sr. No.	Artificial Sources of Light	Percentage of the Students
1.	Bulb	56.52%
2.	Lantern	17.39%
3.	Fire	21.73%
4.	Lighter pen	30.43%
5.	Tube light	32.60%
6.	Electric Bulb	28.26%
7.	Candle	71.73%
8.	Torch	60.86%
9.	Lamp	02.17%
10.	Earth	08.69%

The data from table 16 showed that majority of the students classified the word 'bulb', 'electric bulb' and 'candle' as artificial sources of light. A very few students (02.17%) also made the names such as 'Venus', 'Mars' and 'Jupiter' from the letters and considered them as natural sources of light (Table 15). It was a misconception existing among a very few students that the planets were also the natural sources of light. It could be said that the sun, bulb, torch and candle were identified as sources of light and majority of the students classified the sources of light rightly into manmade and natural sources of light.

4.3.3.10 Lesson 7 Observation of Living World - Topic - Observation of Plant and Its Measurement

Instructional Objective

- Students will classify plants into herb, shrub, and tree.
- Students will explain the variation of different plants in terms of their height, colour of leaf and stem in their own words.
- Students will explain the differences in plants of the desert area, pond, hot humid area and aquatic plants.

Description of the Activity 2 Naturalist, Logical - mathematical and Musical

The teacher explained the concepts of herb, shrub, and trees. For this, the teacher drew the diagram on blackboard for classification of plants into herb, shrub, and tree. Thereafter, the students were asked to measure the height of the plants by means of measure tape and note down the height of the plants, colour of stem and leaves in the given activity sheets. The activity addressed the musical intelligence also as the students were encouraged to compose the song on classification of plants in their words and sing the same song with clapping which is mentioned as under.

Song Composed by the Students

A song on Classification of Plants

"Three types of plants.
First is herb, second is shrub
And third is tree.
Shorter in height are herbs.
Taller than herbs are shrubs
And tall are trees."

The teacher showed them the specimens of aquatic plants such as Pistia, Lemna, Cerratophyllum, and Lotus and asked them to observe the given specimens of the plants. The teacher also provided them leaves of various plants to observe. The students observed the leaves of various plants. The teacher discussed the differences in various plant specimens that they observed. The teacher discussed the differences between desert plants and aquatic plants along with coconut tree. The students noted differences in plants in the notebooks. The students indicated that Lotus has broad leaves and long petiole. They also indicated that size of Lotus flower is big. They gave the examples that Lemna has very small sized leaf. They indicated that thorny plants have thorn on the surface of stem and they have small sized leaves. The students were asked to write scientific reasons why all plants are not same in the activity sheet. The students' responses are categorized in table 17. The percentage shown in the table 17 indicated the percentage of the students who reported the particular observation.

Table 17 Students' Observation - Differences among the Plants

Sr. No.	Name of the Plant	Herb, Shrub, Tree	Height in inches	Colour of Stem	Thickness of Stem	Colour of Leaves	Size of leaves compare to leaves of rose plants
1.	Rose	Herb - (100% students)	15 inches - (100% students)	Green - (100% students)	Medium - (100% students)	Green- (100% students)	--
2.	Basil	Herb - (100% students)	13 inches - (100% Students)	Greenish - (04.34% Students); Brownish (04.34% students); Green with red tint / slightly reddish- (91.30% students)	Thin - (100% students)	Green with slight red - (100% students)	Little small- (100% students)
3	Vinca	Herb- (100% Students)	11.5 inches – (100%- Students)	Brown-(13.04% students); Yellowish- (19.56% students); Greenish Brown – (63.04% students); Green- (04.34% students)	Thin – (100% students)	Green- (39.13% students); Yellowish green- (60.86% students)	Big – (100% students)

*Table 17 is continued on next page.

Table 17 Students' Observation - Differences among the Plants

Sr. No.	Name of the Plant	Herb, Shrub, Tree	Height in inches	Colour of Stem	Thickness of Stem	Colour of Leaves	Size of leaves compare to leaves of rose plants
4.	Hibiscus	Shrub- (100% students)	34.5 inches- (100% students)	Brown – (84.78% students); Greenish-(06.52% students); Light brown- (04.34% students)	Very thick- (15.21% students) Thick – (76.08% students); Very thin- (02.17% students); Thin – (06.52% students)	Green- (100% students)	Big – (100% students)
5.	Lemon	Shrub- (100% students)	28 inches- (100% students)	Light green – (76.08% students); Greenish-(02.17% student); Brown –(13.04% students); Greenish brown- (08.69% students)	Thick – (73.91% students); Slight thick- (02.17% student); Thin – (23.91% students);	Green- (97.82% students); Light green- (02.17% student)	Big - (100% students)

*Table 17 is continued on next page.

Table 17 Students' Observation - Differences among the Plants

Sr. No.	Name of the Plant	Herb, Shrub, Tree	Height in inches	Colour of Stem	Thickness of Stem	Colour of Leaves	Size of leaves compare to leaves of rose plants
6.	Aasopalav	Tree- (95.65%) students Shrub (04.34% students)	480 inches- (95.65%) students, predicted; (02.17% Student) predicted 300-400 inches; (02.17% student) reported uncountable.	Brown-(17.39% students); Dark Brown- (82.60% Students)	Thick- (60.86% Students); Very Thick – (17.39% students); It cannot be pressed – (21.73% students)	Dark Green, Green – (100% students)	Big - (100% students)

The above data from table 17 suggests that the students learnt what to observe specifically with regard to colour of the leaves and stem as they mentioned the differences in colours of stem and leaves by using the words such as 'greenish', 'light green' 'light brown', and 'dark brown'. The students were also able to differentiate the differences in colours of leaves of different plants. The precision in measuring the height of the plants was also found to be consistent with the actual measurement carried out by the teacher. They (95.65% students) estimated height of '*Asopalav' as* about 40 feet and converted into inches correctly. Photograph 1 shows the students measuring the height of a plant.

Photograph 1 Students Measuring the Height of a Plant

Based on the observation, the students classified the plants into herb, shrub and tree correctly which showed that they observed and understood the common characteristics such as height of the plant and strength of the stem and classified them accordingly.

The students were asked to complete the statement mentioned below meaningfully.

“All plants are not same because…………..”

The analysed responses are mentioned as under.

There were total (78.26%) students who mentioned that plants were not same and they were different as some plants gave us fruits, and vegetable to eat, some gave us flowers. They mentioned that some plants were big and some were small. Slightly more than half of the students (52.17%) mentioned that plants were not the same as height of each plant was different when measured. Other reasons provided were: The stems of the some plants' stem were thick and of some plants' were weak and could be pressed easily. Students also mentioned that plants could be herb, shrub or tree. The colour of stems and leaves was also different as some leaves were light green, green or yellowish green. It indicated that the students demonstrated the ability to use the knowledge gained from the observation and measurement of the height of the plants. It was evident that the students linked knowledge while stating logically convincing reasons for the diversity among the plants. A student's sample activity sheet is mentioned in the figure 23.

Figure 23 A Student's Activity Sheet: Classification of Plants Based on their Characteristics

Lesson: 7. Observation of Living World

Activity Sheet for Activity 2

Student's Name: Grandhi Niyati S. **Date:** 18-11-09

Observe the plants and write proper details in the table given below.

Sr. No.	Name of the Plant	Herb, Shrub, Tree	Height in inches	Colour of Stem	Thickness of Stem	Colour of Leaves	Size of Leaves in compare to leaves of rose plants
1.	Rose	Herb	15 inches	Green	medium	Green	----------------
2.	Basil	Herb	13 inches	Brownish	Thin	Slight red, Greenish	Slight Small
3	Vinca	Herb	11.5 inches	Yellowish green	Thin	Yellowish green	Big
4.	Hibiscus	Serb	34.5 inches	Brownish	~~very~~ thick	Green	Big
5.	Lemon	Serb	~~35~~ 28 inches	Greenish Brown	Thick	lighte ~~green~~ green	Big
6.	Aasopalav	Serb	480 (about) inches	Dark Brown	Thick	Dark green	very much Bigger than Rose plant.

Conclusion:

Write 5-6 scientific reasons to complete the following sentence meaningfully.

All plants are not same because some plant are give food. some plant are herb and serb. Height in inches are diffrent. Different colour of stem. Some plants grows very fast. ~~[illegible]~~ some plants and Thin. Thick. ~~[illegible]~~ All leaves colour are different. Some size are bigger than the rose plant. All plants are leaves different. Some plants are very useful. Some plants are fragrance.

4.3.4 Study of Process of Learning Science in relation to Inference - Process Skill

The activities, which demanded the major use of inference process skill, were clubbed together and the students' responses were analyzed using activity sheets and classroom observation. This includes the brief description of the activity along with how students carried out particular activity and demonstrated the inference - science process skill.

4.3.4.1 Lesson 3 Living - Non Living - Topic – Experiment of Germination of Seed

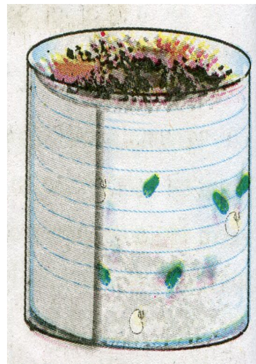
Instructional Objective

- Students will draw the picture of the germinated *'mung'* seed. (based on observation).
- Students will conclude germinated *'mung'* seed as a living. (based on observation)

Description of Activity 8 Visual - spatial, Logical – mathematical and Naturalist

It was the activity wherein the teacher showed a beaker to the students with its inner walls covered with the piece of paper from inside. The shallow space in beaker was created by putting the piece of paper inside the beaker. A lump of soil was kept inside the shallow space of the beaker. Sprouted seeds of *'mung'* were kept inside the inner wall of beaker touching to piece of paper. It was demonstrated that water was sprinkled on the lump of soil regularly and the students were asked to observe the seed kept between the piece of paper and the wall of the beaker after three days. The arrangement of the seeds in beaker is mentioned in figure 24.

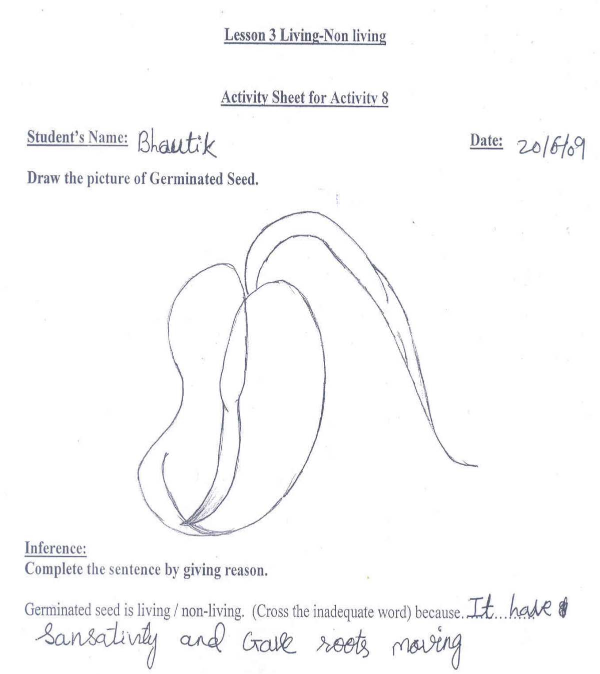
Figure 24 Studying Germination in Seed



(Source of Figure 24: Science and Technology, Standard V, Gujarat State Board of School Textbooks, Gandhinagar)

The sample of a student's activity sheet for germinated seed is mentioned in figure 25.

Figure 25 Student's Activity Sheet for Germinated Seed



Lesson 3 Living-Non living

Activity Sheet for Activity 8

Student's Name: Bhautik

Date: 20/6/09

Draw the picture of Germinated Seed.

Inference:

Complete the sentence by giving reason.

Germinated seed is living / non-living. (Cross the inadequate word) because. It have

Sansativity and Gave roots moving

The photograph 2 shows the participation of students in doing the activity.

Photograph 2 Participation of Students to Study Germinated Seed is Living

The figures drawn by all the students indicated that they correctly observed the shape and position of the germinated seeds and drew the sprouted roots pointing towards the lump of soil kept inside the beaker covered by piece of paper. All (100%) students mentioned that germinated seeds were living and gave reason that seeds showed germination and growth. It meant that the students were able to understand germinated seeds as living because they showed root pointing towards the downward direction showing the growth.

4.3.4.2 Lesson 3 Living – Non Living - Topic - Plants show respiration- An Experiment

Instructional Objective

- Students will explain plants as living based on the experimental evidence for respiration in plant.

Description of the Activity 9 Naturalist, Logical-mathematical, Intrapersonal and Musical

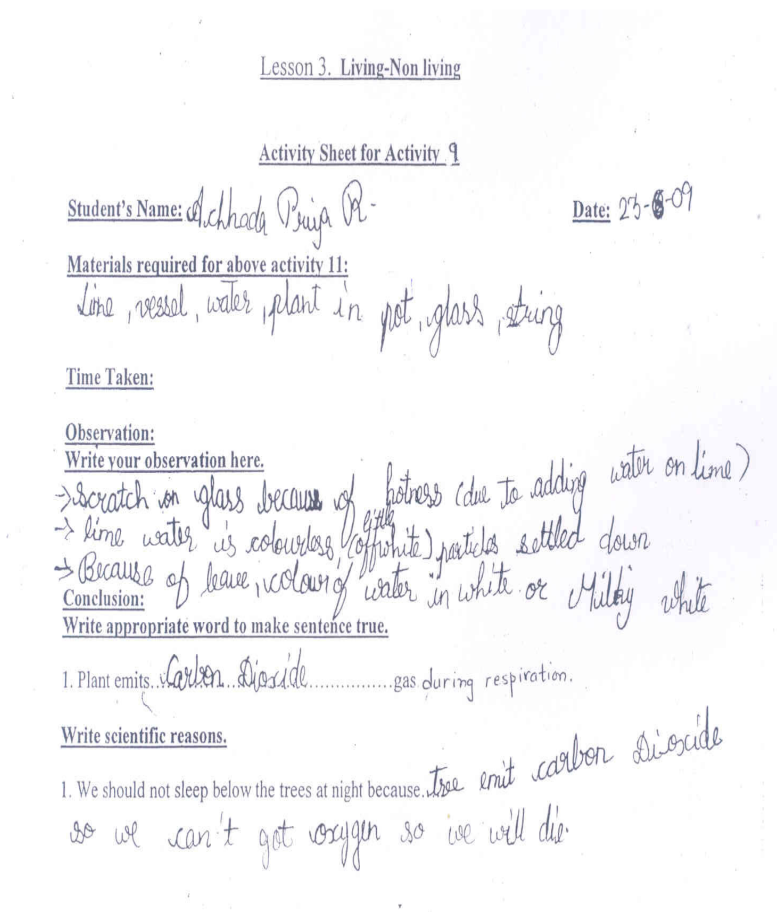
It was the activity in which the teacher showed the experiment that the plant released carbon dioxide gas. The teacher prepared the experiment well in advance. For this activity, teacher took a potted plant having broad and big leaves and tied a plastic bag filled with lime water to its twig and kept it in dark for a whole day. The teacher could not show limewater turned milky and explained that it was difficult to show lime water turns milky due to absence of air-tight apparatus. The teacher showed them the freshly prepared lime water and lime water turned milky after passing carbon dioxide gas through lime water. Thereafter, the students were asked to report the observation and to note down the conclusion in the activity sheet. The teacher encouraged to sing below noted sing with clapping after collecting the activity sheets. (Source: http://suzyred.com/plantsong.html)

The Plant Song

"I'm a little plant that grew and grew.
Photosynthesis is what I do.
Energy and water and CO_2
Help me make my growing food".

A scanned activity sheet of the student is mentioned in figure 26.

Figure 26 A Student's Activity Sheet of Respiration in Plant



Lesson 3. Living-Non living

Activity Sheet for Activity 9

Student's Name: Achhada Priya R.   Date: 23-8-09

Materials required for above activity 11:
Lime, vessel, water, plant in pot, glass, string

Time Taken:

Observation:
Write your observation here.
→ Scratch on glass because of hotness (due to adding water on lime)
→ lime water is colourless, (offwhite) little particles settled down
→ Because of leave, colour of water in white or Milky white

Conclusion:
Write appropriate word to make sentence true.

1. Plant emits Carbon Dioxide gas during respiration.

Write scientific reasons.

1. We should not sleep below the trees at night because tree emit carbon Dioxide so we can't got oxygen so we will die.

Total (89.13%) students mentioned that the plant emitted carbon dioxide gas. (84.78%) students mentioned with reason that they should not sleep under the trees as tree emitted carbon dioxide at night (as the process of respiration), otherwise they would die. From the students' responses, it was found that more than half of the students were able to notice and report milky colour of limewater and the majority of the students (84.78%) were able to give correct scientific reason for avoiding sleeping under trees at night.

4.3.4.3 Lesson 3 Living Non Living – Topic – Living respires

Instructional Objective

- Students will derive from their own experiences that living does respiration.

Description of Activity 10 Bodily-kinesthetic and Logical-mathematical

The teacher instructed the students to take deep breathe inside and stop inhaling and wait for a few seconds. The teacher told them to repeat the same exercise. The students repeated the exercise. Then, the teacher asked them what they experienced and how long they could stop breathing. The students replied in unison that they could not remain longer without taking breath for a few seconds. A few students (10.86%) indicated that they could stay some more few seconds longer without taking breath than other students but they also could not stay without taking breath. All the students mentioned that breathing is required as it gives oxygen and man requires air, water and food to sustain life.

4.3.4.4 Lesson 5 Seed and Its Germination - Topic - Conditions of Germination of Seed

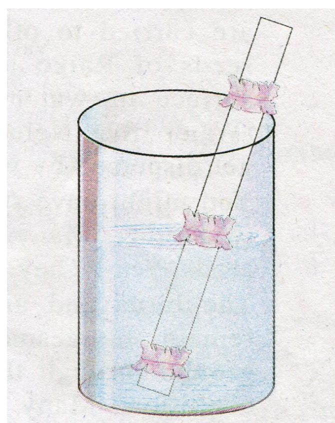
Instructional Objective

- Students will conclude conditions required for germination of seed in their own words based on the experiment.

Description of the Activity 3 Logical-mathematical, Bodily-kinesthetic and Visual-spatial

The teacher explained various apparatus required for the experiment of seed germination. The teacher demonstrated the experiment with the explanation of the position of the seeds at three different places on the ruler shown in figure 27. The teacher asked the students to observe the seeds kept at the top, middle and bottom part of the ruler. The instruction was given to record observation in the activity sheet and to conduct the experiment at home. The students were instructed to bring the seeds used in experiment to study after two days.

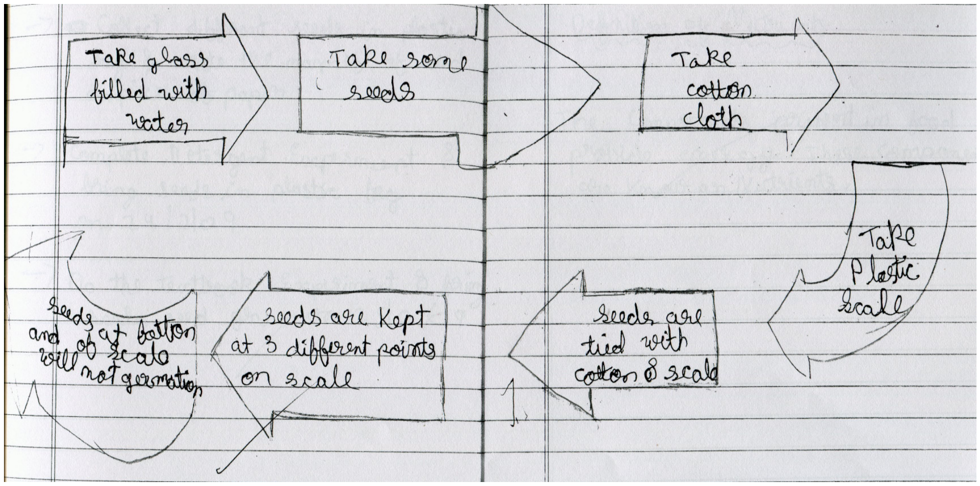
Figure 27 Seed Germination Experiment



(Source of Figure 27: Science and Technology, Standard V, Gujarat State Board of School Textbooks, Gandhinagar)

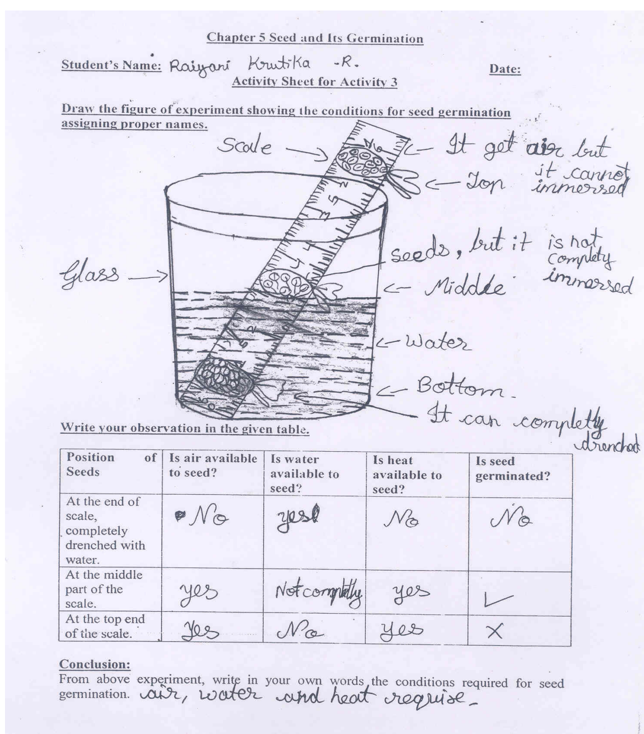
After two days, the teacher collected the activity sheets and showed them two small movie clips of seed germination. (CD, Folder -Lesson 5, File- bean sprout germination and File- Time lapse radish seeds sprouting, top and roots growing). The teacher discussed with the students regarding the steps of experimentation and conditions required for the seed germination. The student's schematic diagram for the experiment for the study of the germination of seed is in figure 28.

Figure 28 Student's Diagram for the Steps of Seed Germination Experiment



A scanned activity sheet of a student is mentioned in figure 29.

Figure 29 Student's Activity Sheet for Seed Germination Experiment



Chapter 5 Seed and Its Germination

Student's Name: Raiyani Krutika -R. Date:

Activity Sheet for Activity 3

Draw the figure of experiment showing the conditions for seed germination assigning proper names.

Write your observation in the given table.

Position of Seeds	Is air available to seed?	Is water available to seed?	Is heat available to seed?	Is seed germinated?
At the end of scale, completely drenched with water.	No	yes	No	No
At the middle part of the scale.	yes	Not completly	yes	✓
At the top end of the scale.	Yes	No	yes	×

Conclusion:

From above experiment, write in your own words the conditions required for seed germination. air, water and heat requise.

Photograph 3 shows the students showing germinated seeds.

Photograph 3 Students with the Seed Germination Experiment

Table 18 indicates the students' observation of the condition required for germination of seed. Number in the bracket in table 18 indicates percentage of the students for particular observation.

Table 18 Students' Observation for Conditions Required for Germination of Seed

Position of Seeds	Is air available to seed?	Is water available to seed?	Is heat available to seed?	Is seed germinated?
At the end of scale, completely drenched with water	No (100%)	Yes (100%)	Yes (02.17%) No (97.82%)	No (84.78%) Yes (15.21%)
At the middle part of the scale	Yes (93.47%) No (06.52%)	Yes (84.78%) No (15.21%)	Yes (97.82%) No (02.17%)	Yes (76.08%) No (23.91%)
At the top end of the scale	Yes (97.82%) No (2.17%)	No (80.43%)	Yes (80.43%)	No (80.43%)

From the table 18, it is evident that a few students (15.21%) reported that the seeds kept at the end of the scale completely drenched with water were germinated. There were (23.91%) students who reported that the seeds kept at middle part of the scale were not germinated while (80.43%) students reported that the seeds kept at the top end were not germinated.

There were (76.08%) students who reported that the seeds at the middle part of the scale showed germination. These (76.08%) students rightly mentioned that air, water, and sunlight were required for seed-germination. From the above experiment, (76.08%) students understood that air, water and sunlight are the pre-requisites for germination of seed.

4.3.4.5 Lesson 11 Air - Topic - Air (bubble) comes out

Instructional Objective

- Students will explain the reasons responsible for the production of bubbles while immersing a tilted glass into a bucket filled with water.

Description of Activity 3 Logical - mathematical

The teacher showed the empty glass to the students and instructed the students to observe the activity and to note down the observation in the activity sheet. The teacher demonstrated the activity by immersing a tilted glass in the bucket filled with water. Thereafter, the teacher provided opportunity to every student to do the same activity and instructed them to answer the questions asked in the activity sheet. After collecting activity sheets, the teacher discussed the reasons for appearance of bubbles in the bucket.

The questions asked in the activity sheets were: What did you see while immersing the tilted glass in the bucket filled with water? From where do the bubbles come out? Why do bubbles come out? All (100%) students reported that they saw bubbles / air / oxygen / air bubbles coming out while immersing tilted glass into the bucket filled with water. This showed the students' capability to notice the minute observation while doing the activity. There were (93.47%) students who reported that air came out from the bucket. There were (91.30%) students who gave reason that air trapped in the glass came out in the form of bubbles while immersing a tilted glass into a bucket filled with water. Why do the bubbles come out? These responses suggested that majority of the inferred correctly that air was everywhere, even in the glass and the air came out from the glass when the tilted glass was immersed in the bucket filled with water.

4.3.4.6 Lesson 11 Air - Topic - Air occupies space

Instructional Objective

- Students will explain that air occupies space.

Description of the Activity 4 Logical – mathematical, Musical and Interpersonal

This was a textbook activity. The teacher instructed students to sit in groups and distributed matchbox with balloons and strings. The teacher asked each group to count the number of balloons kept inside the balloons. The teacher instructed to blow only one balloon in each group and fasten it with string. Afterwards, the teacher asked the students to keep the blown balloon in the matchbox and asked the questions such as: Can you keep the blown balloon in matchbox? Why? What is inside the balloon? What can be said about the property of air based on this activity? It was observed that all the students replied that blown balloon could not be kept in the tiny matchbox as it is bigger in size and blown balloon contained air inside. This meant that the students inferred that blown balloon contained air as it was perceived from the increased volume of the balloon. The students were instructed to compose their own songs on the activity and sing the same with clapping. A student's song is mentioned as under.

Song Composed by the Students

A Song on Air occupies space

"Balloons Balloons Balloons
You are big big and big.
Small space is not enough for you.
We need more place to keep you.
So, we can say, air occupies space".

4.3.4.7 Lesson 9 Food and Health - Topic - Food Nutrients and Its Relation with Health

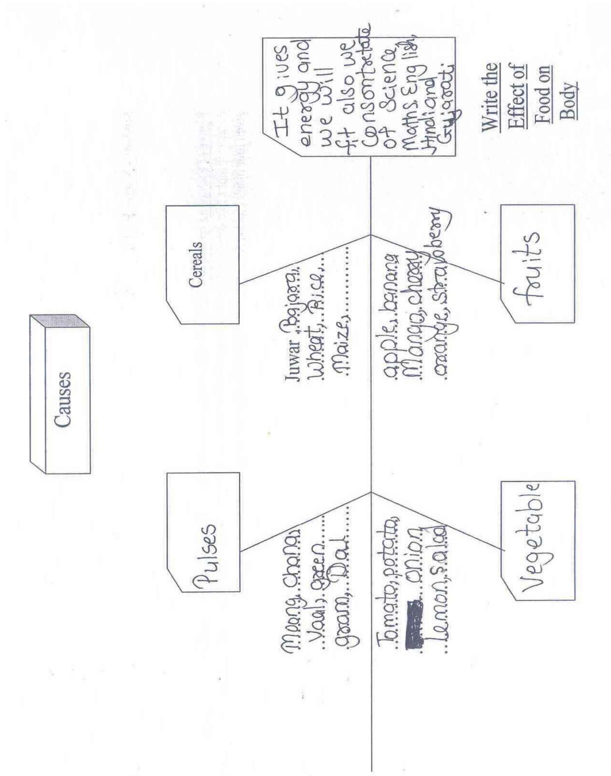
Instructional Objective

- Students will define the term ‘nutrient’.
- Students will explain the need of nutrients in food.
- Students will relate cause and effect relationship between food and health in fish - bone structure.

Description of the Activity 3 Visual - spatial and Logical - mathematical

The students were shown PowerPoint Presentation of balanced food and its effect on body in general (CD, Folder – Lesson 9, File -food activity 2) and the teacher explained the same accordingly. The teacher drew fishbone structure on the blackboard and explained why it was fishbone structure. The teacher initiated the discussion by asking the difference between minor and major causes (Food which is required to take up in small and in more quantity). The teacher discussed which type of food should be taken regularly (such as cereals, pulses, green vegetables, fruits) and what should be the quantity of different types of food items. The teacher distributed the activity sheet and asked them to complete the diagram by writing the major and minor causes in the fishbone structure. The figure 30 shows the student’s drawing of the fishbone structure showing major and minor causes of health in relation with the intake of food.

Figure 30 Student's Fishbone Structure Diagram for Food



It was found that the all students (100%) indicated dry fruits namely cashew nuts, almond, grapes, milk, cheese, yogurt, fruits and sweets as minor causes and cereals, pulses, wheat, *juar, tuar, roti*, and vegetables as the major causes. These indicated that the students understood that dry fruits, milk and milk related food items should be taken but should not be taken to replace the meal. The food items that were mentioned for the major items showed that the students had the idea that wheat, cereals, and pulses should be included in the meal regularly. In other words, it was said that the students were able to infer the relationship between food and health.

4.3.4.8 Lesson 9 Food and Health - Project Activity - Study of Nutrients' Value on Various Packaged Food, Biscuits and Bourn Vita

Instructional Objective

- Students will be able to explain which food is better based on nutrients and their nutritional value.

Description of Project Activity Logical - mathematical and Intrapersonal

The teacher instructed the students to collect the leaflet of '*Bourn Vita'* and such packaged food. The teacher discussed the importance of nutrients, good food habits and asked them to find out the nutritional values and energy obtained in K.cal.. The teacher indicated the nutritional value of a packaged food for clarity. The teacher asked students to report the nutrients' values of packaged food in the given project activity sheet by reading its leaflet and instructed students to study the reported nutritional values of food and asked them to infer which particular food should be taken. The teacher instructed the students to do this project activity at home. The students, though learnt in lower standards about the arrangement of numerals in ascending and descending order, they did mistakes while arranging the food items in the ascending order of energy-value of food items. They mentioned different nutrients for packaged food. They concluded '*Bourn Vita'* or *'Horlicks'* could be taken as they contained various nutrients which were useful for the growth of body and maintaining good health.

4.3.4.9 Lesson 14 Measurement of Length -Topic - Early Measures of Length- Span and Finger

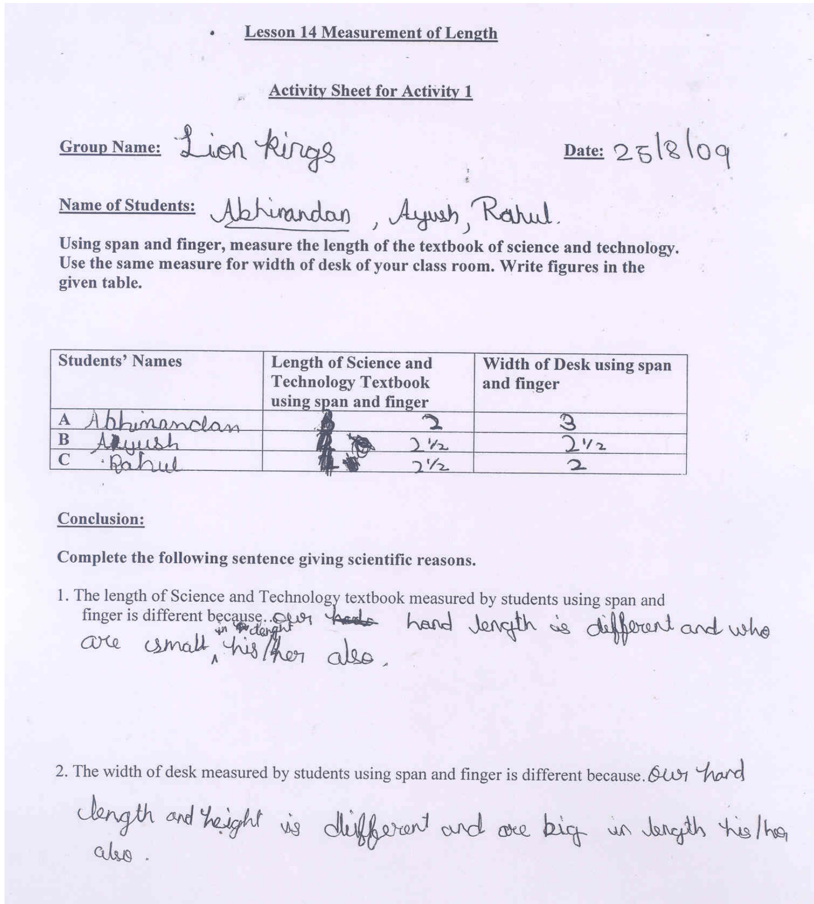
Instructional Objective

- Students will explain that span and finger are not the standard measures of length.

Description of Activity 1 Bodily-kinesthetic, Logical-mathematical & Interpersonal

It was a group activity wherein the students were instructed to measure the length of Science and Technology book by using span and finger. They were also asked to measure the width of desk used by them for keeping books. A student's activity sheet is mentioned in figure 31.

Figure 31 Students' Activity Sheet for Measurement Using Span and Finger



Lesson 14 Measurement of Length

Activity Sheet for Activity 1

Group Name: Lion kings **Date:** 25/8/09

Name of Students: Abhinandan , Ayush, Rahul.

Using span and finger, measure the length of the textbook of science and technology. Use the same measure for width of desk of your class room. Write figures in the given table.

Students' Names	Length of Science and Technology Textbook using span and finger	Width of Desk using span and finger
A Abhinandan	2	3
B Ayush	2½	2½
C Rahul	2½	2

Conclusion:

Complete the following sentence giving scientific reasons.

1. The length of Science and Technology textbook measured by students using span and finger is different because..our ~~hads~~ hand length is different and who are small in height his/her also.

2. The width of desk measured by students using span and finger is different because. our hand length and height is different and are big in length his/her also.

There were variations in the measurement of each group for the length of textbook and width of desk consecutively. For length of the textbook, the recorded measurements were found 1.5, 2, and 2.5 using span and finger. It was 1.5, 2. 2.5, and 3.0 using span and finger for width of the desk. All students completed both the incomplete sentences in the activity sheets by supplying logical reasons. The responses gathered made it clear that all the students had the conception that all students' hands varied in size and length of the finger was also not same. It indicated that they understood the unequal size of hands yielded different measures for length of the textbook and width of the desk.

4.3.4.10 Lesson 14 Measurement of Length - Topic - Measuring the Length and Width

Instructional Objective

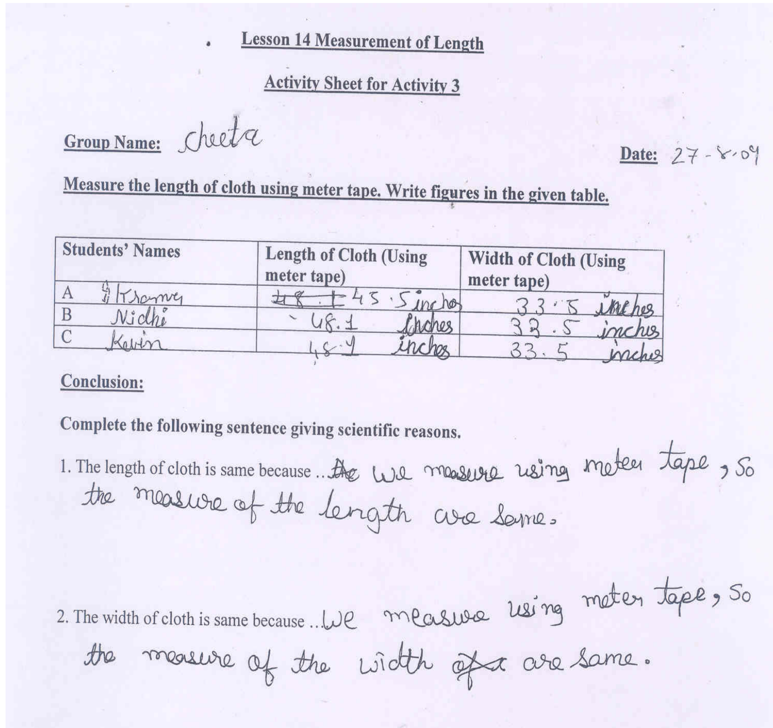
- Students will measure the length and width of given object in centimeters, inches and meter.

Description of the Activity 3 Bodily-kinesthetic, Logical-mathematical, Interpersonal

The teacher explained the correct method of measuring length using chart. The teacher assigned work to the students to measure the length and width of the textbook of Science and Technology and width of the desk in centimeters and inches. It was the group activity in which there were three students in a group.

The careful analysis indicated that the students in a group measured the length of the Science and Technology textbook in centimeters and inches but failed to measure accurately for the first time. One of the common mistakes to produce the same results was not holding the scale parallel to the textbook's length. Some students also did not match the zero figure of the scale with the upper most side of the textbook. This gave them wrong measurement of the length of the textbook. Also, some students did not understand the importance of single line stretched between two consecutive measures such as 5 and 6 inches. The teacher explained students again how to measure the length of given objects accurately using ruler. The students, thereafter, measured the length of Science and Technology textbook and width of desk accurately after repeated attempts. The responses of all groups indicated students' understanding that the ruler could give the same measurement for a particular object if proper care was taken. One group's activity sheet for measuring the length and width of the cloth is mentioned in figure 32.

Figure 32 Students' Activity Sheet for Measurement Using Meter-Tape in Inches



Lesson 14 Measurement of Length

Activity Sheet for Activity 3

Group Name: cheeta **Date:** 27-8-09

Measure the length of cloth using meter tape. Write figures in the given table.

Students' Names	Length of Cloth (Using meter tape)	Width of Cloth (Using meter tape)
A Shramy	~~48.1~~ 45.5 inches	33.5 inches
B Nidhi	48.1 inches	33.5 inches
C Kevin	48.1 inches	33.5 inches

Conclusion:

Complete the following sentence giving scientific reasons.

1. The length of cloth is same because .. ~~the~~ we measure using meter tape, So the measure of the length are same.

2. The width of cloth is same because .. We measure using meter tape, So the measure of the width ~~of~~ are same.

When a piece of cloth was given to groups of students, it was observed that some students committed mistake in identifying width and length of the cloth. They considered length as width to measure which was rectified by the teacher. It was observed that majority of the students did not hold the cloth tightly and stretch the meter tape appropriately for measurement. Such mistake made students report a wrong measurement which was corrected by the teacher. It was found that the students were able to measure the length (of Science and Technology textbook and cloth) and width (of desk and cloth) of given objects accurately after some attempts.

The students in groups provided the reason that the length and width of the cloth was same and they used the meter tape to measure. So, the same measurement was found out. This suggested that the students of groups had an idea that the meter-tape was same and the repeated measurements taken with care in a group would give almost the same result while measuring the length and width of the cloth. But, they did not mention clearly that repeated measurement brought systematization removing the scope of mistakes.

4.3.4.11 Lesson 16 Energy - Topic - Sun as a Fundamental Source of Energy

Instructional Objective

- Students will conclude the sun as the fundamental source of energy which continues the flow of energy.

Description of the Activity 2 Visual - spatial and Logical - mathematical

The teacher showed the movie clip of photosynthesis by plants (CD, Folder – Lesson 16, File -Photosynthesis song) and discussed with the students about how flow of energy continue simultaneously. The teacher asked questions such as food of herbivores and carnivores, photosynthesis process and how plants prepare food. During discussion, the students mentioned that plants prepare food by using sunlight. Human and animals use plants as food. The carnivores ate herbivore to get energy. They mentioned that plants could not prepare food without the sun. So, the sun was the fundamental source of energy. It was, therefore, found that the students inferred the sun as the fundamental source of energy because it maintained the flow of energy.

The teacher developed the schematic diagram on blackboard regarding the flow of energy with the help of the students which is mentioned as here. Sun → Plants → prepares food → Herbivore eats plants → Carnivore kills herbivore for food. The teacher asked the students to prepare the sequence chart to mention sun continues the flow of the energy.

4.3.4.12 Lesson 4 Let Us Know the Soil - Topic - Soil contains moisture

Instructional Objective

- Students will deduce the presence of water in soil.

Description of the Activity 3 Logical-mathematical and Visual - spatial

It was an activity in which the students were asked to observe the lump of soil kept in transparent colourless plastic bag which was kept in sunlight for more than one hour. The format of activity sheet is mentioned in figure 33.

Figure 33 Format of the Activity Sheet to study soil contains water

Activity Sheet for Activity 3

Experiment: Keeping Packed Soil in Sunlight

Student's Name: **Date:**

Observations:

Read the following statements carefully. Write your observation in one or two lines to make the statement meaningful.

The airtight plastic bag having lump of soil was kept in sunlight for more than one hour. When I observed the lump of soil by magnifying glass, I saw……………………….

Conclusion:

Therefore, I conclude soil contains …………………

Majority of the students (82.60%) mentioned the word 'water' to complete the incomplete sentence. The rest of the students mentioned the words 'moisture', 'water drops' and 'water droplet.' Some students also mentioned that lump of soil was brown in colour. A very few students mentioned that lump of soil became like stone. It showed that a few students used tactile sense to observe. A very few students reported water and minutes things were seen. This indicated that the majority of the students (82.60%) were able to point out the presence of water in the plastic bag. Some students observed minute change as they reported the water, or water drops /droplet, or moisture also. Though (82.60%) students observed drops of water deposited to the inner surface of the plastic bag, only (56.52%) students were able to infer that soil contained water.

4.3.4.13 Lesson 4 Let Us Know the Soil -Topic - Presence of Air and Organic Matter in Soil

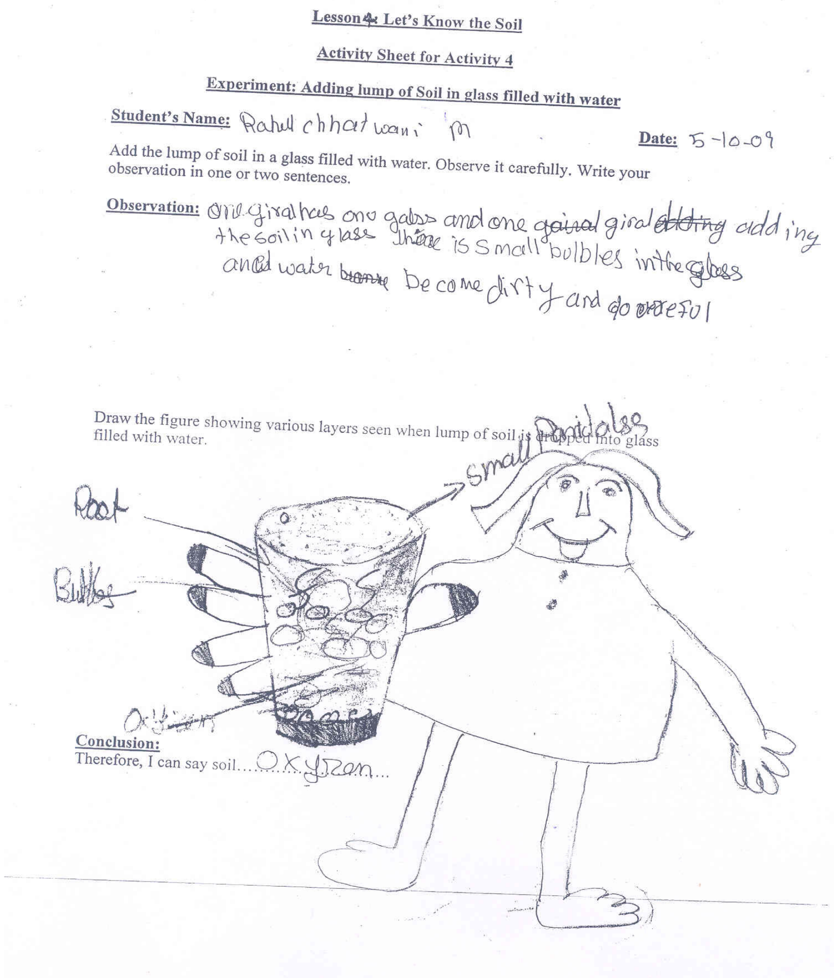
Instructional Objective

- Students will deduce the presence of air and organic matter while adding the lump of soil in water.
- Students will infer that organic matter is lighter than water so it floats.

Description of the Activity 4 Logical - mathematical and Visual-spatial

The teacher demonstrated the activity of adding lump of soil in glass filled with water and gave prior instructions to observe what happened while doing this activity. The teacher, thereafter, distributed the activity sheet to note down their observations. A student's activity sheet is mentioned in figure 34.

Figure 34 A Student's Activity Sheet Showing that Soil contains air


Lesson 4 Let's Know the Soil

Activity Sheet for Activity 4

Experiment: Adding lump of Soil in glass filled with water

Student's Name: Rahul chhatwani M Date: 5-10-09

Add the lump of soil in a glass filled with water. Observe it carefully. Write your observation in one or two sentences.

Observation: one giral has one galss and one ~~gairal~~ giral ~~adding~~ adding the soil in glass ~~there~~ is small bulbles in the glass and water ~~brown~~ become dirty and do ~~careful~~

Draw the figure showing various layers seen when lump of soil is dropped into glass filled with water.

Conclusion:
Therefore, I can say soil...Oxygen...

The observation during the activity 4 indicated that no one observed at first sight the coming out of air bubbles when the lump of soil was added to the glass filled with water. Some students also observed that the lump of soil settled down and pointed out rise in the level of water in the glass. But they did not notice an appearance of air bubbles, a minute change that occurred immediately at the first time. Except three students, all students (93.47%) wrote change in colour or water became dirty or brown coloured on adding lump of soil to a glass filled with water. There were (71.73%) students who reported that bubbles came out while adding the lump of soil into the glass filled with water when repeating the same demonstration. (56.52%) students also mentioned that soil contained water. The students' responses for this activity suggested that majority of the students (71.73%) were able to notice the appearance of bubbles when they observed the same demonstration twice or thrice.

These (71.73%) students mentioned thin garbage like material floating over the water and concluded soil contained air.

4.3.4.14 Lesson 4 Let Us Know the Soil -Topic - Differences between Field and Riverbed Soil

Instructional Objective

- Students will classify the sample of soils into clayey and muddy soil by experimentation.

Description of the Activity 7 Logical-mathematical, Interpersonal & Visual-spatial

The teacher explained different layers of the components present in the sample of soil by demonstration. For this purpose, the teacher used a plastic jar and called group of students one by one to observe. The teacher gave two samples of soil (field soil and river bed) to the students. The teacher instructed the students to do the activity in group and instructed them to write the observation in a group after discussion. The format of the group activity sheet was as under in figure 35.

Figure 35 Format of Activity Sheet for Types of Soil

Activity Sheet for Activity 7

Experiment: Adding Lump of Soil in Glass filled with Water to Study the Type of Soil

Group Name: **Date:**

Students' Name:

Observations:

No.	Sample of soil Taken	Are sand, gravels found maximum?	Is clay seen more?	Are organic matter and mud seen more?	Type of Soil
1	Field				
2	River Bed				

Conclusion:

The soil of field is different from river bed because ……………………………………………………………………………………………………

This was a group activity carried out by the students. The photograph 4 shows the student observing the layers of given soil samples of field and river bed.

Photograph 4 Students Observing the Layers of Soil

Majority of the students (97.82%) mentioned that sand was more in the riverbed-soil while a few students reported sand and gravels were more in the field-soil. Majority of the students (93.47%) in groups reported that field-soil sample contained more clay. But a few students reported that the sample of riverbed-soil contained higher amount of clay than the field-soil sample. Students of all the groups reported that the field-soil contained higher amount of organic matter than the soil of riverbed.

Majority of the students (93.47%) classified field-soil as clayey while a few students classified it as either field, muddy, sandy or dark. Majority of the students (97.82%) classified riverbed-soil as sandy. Only (02.17%) students classified the riverbed soil as a clayey soil. It indicated that the majority of the students classified the soil on the basis of components. The students' conclusion for how the field-soil was different from the riverbed-soil is mentioned as under.

The students mentioned that the field soil contained more garbage like matter than the soil of river bed. They reported that the riverbed-soil solution was light in colour and the field-soil solution was dark in colour. Very few (04.34%) students indicated that mud was seen more in the field-soil sample. It was found that majority of the students faced difficulty in pointing out the reasons for differences between riverbed and field-soil samples.

4.3.4.15 Lesson 4 Let Us Know the Soil - Topic – Moisture-holding and Filtration Capacity of Soil

Instructional Objectives

- Students will compare the filtration capacity of sandy, muddy and clayey soil.
- Students will infer sandy soil has highest, muddy soil has moderate and clayey soil has the least filtration power.

Description of Activity 9a Logical - mathematical and Visual- spatial

The teacher explained various apparatuses such as beaker, funnel and measuring cylinder and procedure of experiment. The teacher explained the meaning of hypothesis and asked the students to hypothesize which sample of soil would not absorb more water and instructed to write the hypothesis in the activity. The teacher demonstrated the entire experiment and instructed the students to observe experiment carefully. The students were given opportunity to measure the collected water in measuring cylinder. The format of the activity sheet was as under in figure 36.

Figure 36 Format of Activity Sheet for Filtration Capacities of Soil-Samples

Lesson 4 Let Us Know the Soil
Activity Sheet for Activity 9a

Student's Name: **Date:**

Hypothesis:
Write the type of soil, which you think, has the maximum filtration power.

Observation:
Take the sample of sandy, muddy, and clayey soil one by one and measure its filtration power in Milliliters. Note down your observation in given table.

Table - Study of the Filtration Capacity of the Different Types of Soil

No.	Type of Soil	Volume of Water Added (Millilitres)	Volume of Water Obtained after Filtration (Millilitres)
1.	Sandy Soil		
2.	Muddy Soil		
3.	Clayey Soil		

Question:

Write the answer in one sentence.

1. Which soil takes long time to filter? Why?

2. Which soil dries fast? Why?

Conclusion:

Fill in the blank with appropriate word.

1. The filtration capacity of …………………….soil is minimum.

2. The filtration capacity of …………………….soil is maximum.

Total (69.56%) students hypothesized that the sandy soil had highest filtration power. On the other hand, there were total (26.08%) students who hypothesized that muddy soil had highest filtration power. (04.34%) students wrote clayey soil had highest filtration power. It showed that the majority of the students had the idea that sandy soil was not able to retain water. (65.21%) students measured 31 ml filtrate for sandy soil sample. Some students (19.56%) measured 30 ml, while other students (15.21%) measured 29 ml filtrate. This showed that a very few number of students deviated from the real figure of filtrate to be measured.

Majority of the students (80.43%) reported 21 ml of water filtered over clayey soil, and some (10.86%) students measured 22 ml of water filtered over clayey soil sample. The rest students (08.69%) measured 26 ml of water filtered over clayey soil. It indicated that the majority of the students were able to measure the volume of filtrate collected for clayey soil correctly. Total (78.26%) students reported 25 ml of water filtered over muddy soil sample as a filtrate while (21.73%) students reported 24 ml of water as a collected filtrate. Majority of the students measured correctly the volume of filtrate collected water muddy soil. It suggested the increased awareness on the part of the students for using the apparatus systematically.

There were (65.21%) students who reported that clayey soil took more time for filtration while (34.78%) students mentioned that muddy soil took more time for filtration. All students reported that sandy soil dried fast. (15.21%) students reported that muddy soil had lower filtration power. The rest (84.78%) students reported that clayey soil had lower filtration power. There were total (100%) students who reported that sandy soil had the highest filtration power.

4.3.4.16 Lesson 4 Let Us Know the Soil - Topic - Effect of Acidic Solution over Plants

Instructional Objective

- Students will relate the adverse effects of acidic solution on the growth of plants in their own words.
- Students will suggest the different ways to make soil fertile.

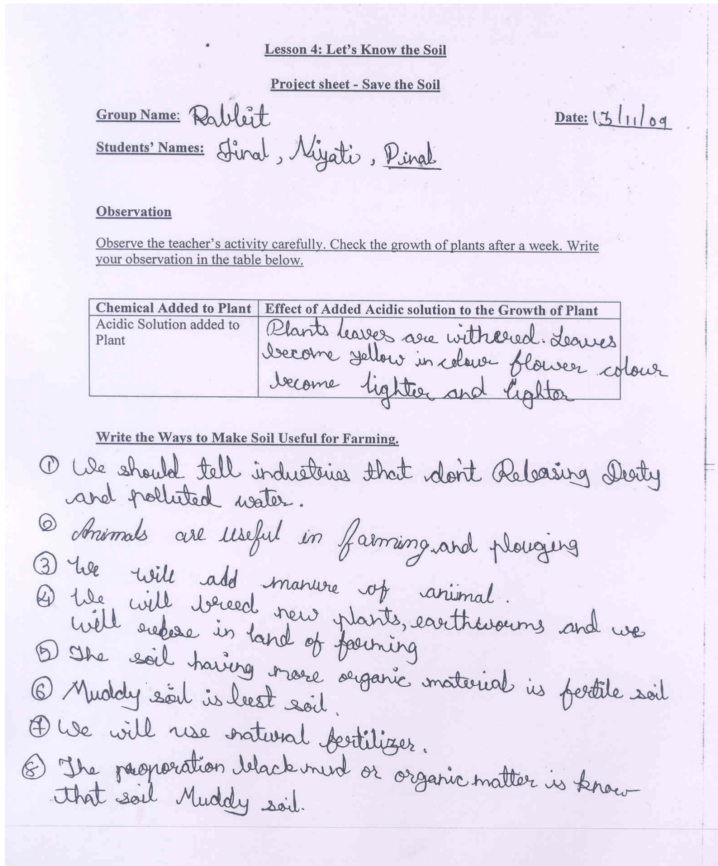
Description of Group Project Activity - Logical-mathematical and Linguistic

The teacher discussed the effects of pollution over soil. It was the project activity in which the teacher himself showed the demonstration due to the hazards involved in using acid. The teacher poured the acidic solution over the potted plant of vinca and kept it aside for one-week period for students' observation. It was a group activity. So, the teacher instructed them to observe the condition of the plant including the leaves, flower and stem over a period of one week. The teacher handed over the activity sheet to each group for writing down the effects of acidic solution over the plant and ways to make soil useful for farming. Each group was governed by a group leader and the other students acted as discussants. The teacher suggested the students to prepare different slogans to save the soil. Photograph 5 mentioned below shows how the students involved in the observation.

Photograph 5 Students Observing the Effect of Acidic Solution over Plant

The student's sample activity sheet is mentioned in figure 37.

Figure 37 Student's Activity Sheet - Save the Soil



Lesson 4: Let's Know the Soil

Project sheet - Save the Soil

Group Name: Rabbit Date: 13/11/09

Students' Names: Sinal, Niyati, Pinal

Observation

Observe the teacher's activity carefully. Check the growth of plants after a week. Write your observation in the table below.

Chemical Added to Plant	Effect of Added Acidic solution to the Growth of Plant
Acidic Solution added to Plant	Plants leaves are withered. Leaves become yellow in colour flower colour become lighter and lighter

Write the Ways to Make Soil Useful for Farming.

① We should tell industries that don't Releasing Dirty and polluted water.
② Animals are useful in farming and plouging
③ We will add manure of animal.
④ We will breed new plants, earthworms and we will refuse in land of farming
⑤ The soil having more organic material is fertile soil
⑥ Muddy soil is best soil.
⑦ We will use natural fertilizer.
⑧ The proporation black mud or organic matter is know that soil Muddy soil.

Common features observed in the group activity were mentioned as under.

- The students mentioned that leaves of the plants were withered and they became yellowish and light green.
- Total (82.60%) students mentioned that plants' leaves were withered and became black. They mentioned that colour of leaves fainted slowly. They indicated that the plants' stem bent, and leaves folded and bent towards the downward direction.
- They mentioned that the colour of stem and leaves changed also.
- It was also mentioned by all the students that the potted plant died due to the effect of acid.
- Only (02.17%) student reported that the potted plant did not absorb the acid which showed the wrong conception of what happened while adding acidic solution over the plant.

The students' responses to make soil fertile for making it useful for framing purpose were found as under.

- The students suggested watering to plants and recommended to use muddy soil.
- They mentioned that industries should not be allowed to pollute soil by releasing dirty water over soil.
- The students also reported that natural manure and cow's dung should be used to make soil fertile.
- The students also suggested the use of earthworms to increase the fertility of soil.

It was said from the students' responses that the students were able to observe the minute changes occurred due to the addition of the acidic solution over the potted plant and were able to mention appropriate ways to make soil useful for farming. It indicated that the students were able to use the knowledge gained through the previous activities for a particular activity.

4.3.4.17 Lesson 12 Light and Its Properties - Topic - Light is must to see an object – Looking into Box

Instructional Objective

- Students will conclude light is necessary to see the object.

Description of Activity 1 Visual-spatial and Logical-mathematical

The two different situations were provided to the students to study. In the first situation, the students were asked to see through the hole made at the top of the box. While, in the second situation, one of the doors of the box was opened and all the students were asked to see through the hole made at the top of the box. The box contained different kinds of things such as keys, white chalk, different coloured chalks, ruler, sharpener, rubber band, pencil, key-chain, chain, coin and rubber in it. All students were not able to see and locate the things kept in the box under situation 1. They were able to see and count the things in the box when asked to see under the situation 2. All the students replied that light was not there in situation 1 which made difficult to see. It meant that the students were able to understand light was necessary to see the objects and it would not be possible to see the objects in darkness. For situation 2, all the students reported that they were able to see the objects because the door was opened and light was present.

4.3.4.18 Lesson 12 Light and Its Properties -Topic - Light travels in a straight path – a Three Cardboard Experiment

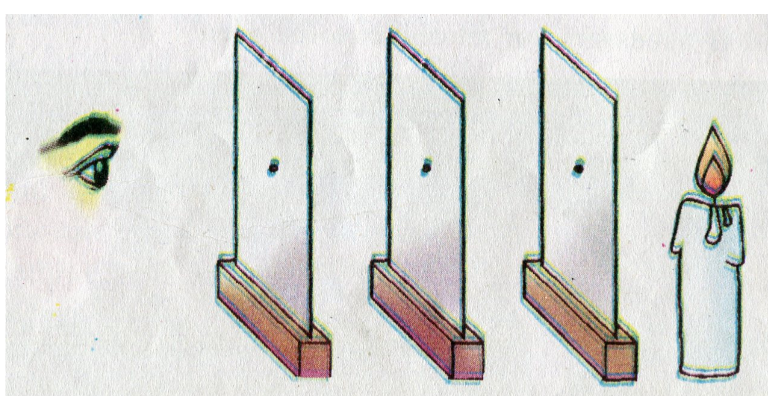
Instructional Objective

- Students will arrange the three cardboards to see the light through the holes of three cardboards.
- Students will conclude that light travels in a straight path.

Description of the Activity 5 Logical-mathematical, Bodily-kinesthetic and Interpersonal

The teacher demonstrated the activity with the help of the students to conclude that light travels in a straight path. The students were given opportunity to work in groups wherein one student was assigned task to arrange the cardboards in a different situation to check whether light could be seen or not while the other students were trying to look thorough the cardboards thus arranged. The arrangement of the experiment is presented in figure 38.

Figure 38 Arrangement of the Experiment To Study the Path of Light



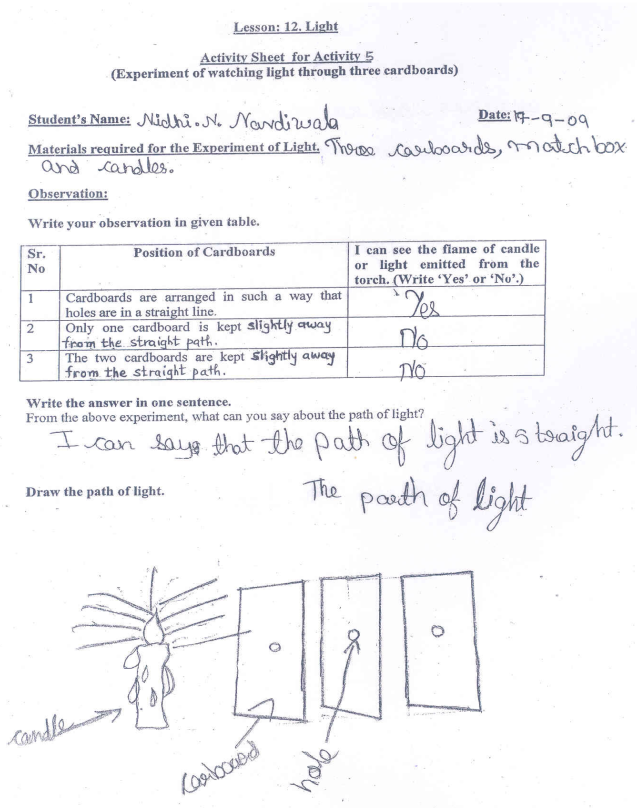
(Source of Figure 38: Science and Technology, Standard V, Gujarat State Board of School Textbooks, Gandhinagar)

The experiment was carried out in different groups. The students' participation in group activity is mentioned in photograph 6.

Photograph 6 Students' Conducting Experiment – Path of Light

The sample of student's activity sheet is mentioned in figure 39.

Figure 39 A Student's Activity Sheet for the Path of Light



Lesson: 12. Light

Activity Sheet for Activity 5
(Experiment of watching light through three cardboards)

Student's Name: Nidhi. N. Nandiwala   Date: 17-9-09

Materials required for the Experiment of Light. Three cardboards, matchbox and candles.

Observation:

Write your observation in given table.

Sr. No	Position of Cardboards	I can see the flame of candle or light emitted from the torch. (Write 'Yes' or 'No'.)
1	Cardboards are arranged in such a way that holes are in a straight line.	Yes
2	Only one cardboard is kept slightly away from the straight path.	No
3	The two cardboards are kept slightly away from the straight path.	No

Write the answer in one sentence.
From the above experiment, what can you say about the path of light?
I can say that the path of light is straight.

Draw the path of light.   The path of light

The students' observations were mentioned in table 19.

Table 19 Students' Observations for the Experiment: Light Travels in the Straight Path

Sr. No.	Position of Cardboards	I can see the flame of candle or light emitted from the torch. (Write 'Yes' or 'No')
1.	Cardboards are arranged in such a way that holes are in a straight line.	Yes - (97.82%) students
2.	Only one cardboard is kept slightly away from the straight path in such a way that the holes were not matched.	No - (100%) students
3.	The two cardboards are kept slightly away from the straight path in such a way holes were not matched.	No - (100%) students

It was clear from the above table 19 that the majority of the students were able to observe correctly. They reported the same in the activity sheet for the first observation. (97.82%) students drew the path of light as a straight line using the ruler.

Majority of the students (97.82%) mentioned that the path of the light was a straight line. It was, therefore, concluded that the students were able to infer the path of light was straight on the basis of the observations. It meant that the students were able to use the observation skill appropriately to infer correctly that light traveled in straight path.

Description of the Activity 6 Logical – mathematical, Interpersonal and Musical

For better clarity of light travelling in the straight line, the teacher provided another experience to all the students to see the flame of the candle / light of the torch through the straight pipe. The teacher also instructed them to see the flame of the candle / light of the torch after bending the plastic pipe. This was a group activity. For this activity, the teacher instructed the students to observe and discuss among them about their observations and what could be said about the property of light. All the students told that they could not see the flame of the candle / light of the torch after bending the plastic pipe but they could see the flame of the candle / light of the torch through the straight pipe. It showed that all the students were able to observe correctly and they stated that the straight pipe made possible to see light. The teacher asked the question: What do they think about the path of light? Is it zig-zag or straight? All the students mentioned that the path of light is straight as they could see the light through the straight pipe. The students sang the below mentioned song on property of light with claps.

Song on Property of Light

"Light travels
Light travels
Light travels in straight path
Because I saw the light
When the cardboards' holes are matched".

4.3.4.19 Lesson 6 Water and Its Importance -Topic - Evaporation of Water and Its Role in Rain Falling

Instructional Objective

- Students will compare the analogy of evaporation in plastic bag with the evaporation of seawater.
- Students will infer evaporation is required for cloud formation.

Description of Activity 5 Linguistic and Logical - mathematical

In this activity, the students were encouraged to explain what happened at very first stage in cloud formation. Here, the teacher instructed students to write their possible reasons for what happened first during cloud formation. Based on interaction with other students, all the students wrote in their notebooks what happened first in the first stage of cloud formation. To promote thinking, the teacher also showed them the closed transparent plastic bag having water. This plastic bag was kept in sunlight for 6-8 hours. The teacher asked students what they saw and why they saw the moisture gathered on the inner surface of the plastic bag. All the students mentioned that they saw droplets of water gathered on the inner surface of the plastic bag. The teacher also asked what they saw when water was boiled in kettle or when tea was heated in vessel. It was found that (89.13%) students stated that water evaporated due to heat caused by the sun and vapours of water formed clouds. It meant that majority of the students had the idea that presence of the sun is required for evaporation of water and water vapors get combined to form clouds.

4.3.5 Study of Process of Learning Science in relation to Prediction - Process Skill

The activities, which exclusively demanded the use of prediction process skill, were clubbed together. The students' responses were analyzed using the activity sheets and the classroom observation. The brief description of the activity along with how students carried out particular activity and demonstrated the prediction skill is discussed in the subsequent sections.

4.3.5.1 Lesson 2 Learn Preparing Groups - Topic - Substances that Float and Sink

Instructional Objective

- Students will write prediction about which objects / substances will sink or float.
- Students will report the correct observation of sinking and floating of the objects / substances based on experimentation.

Description of the Activity 4 Logical - mathematical and Musical

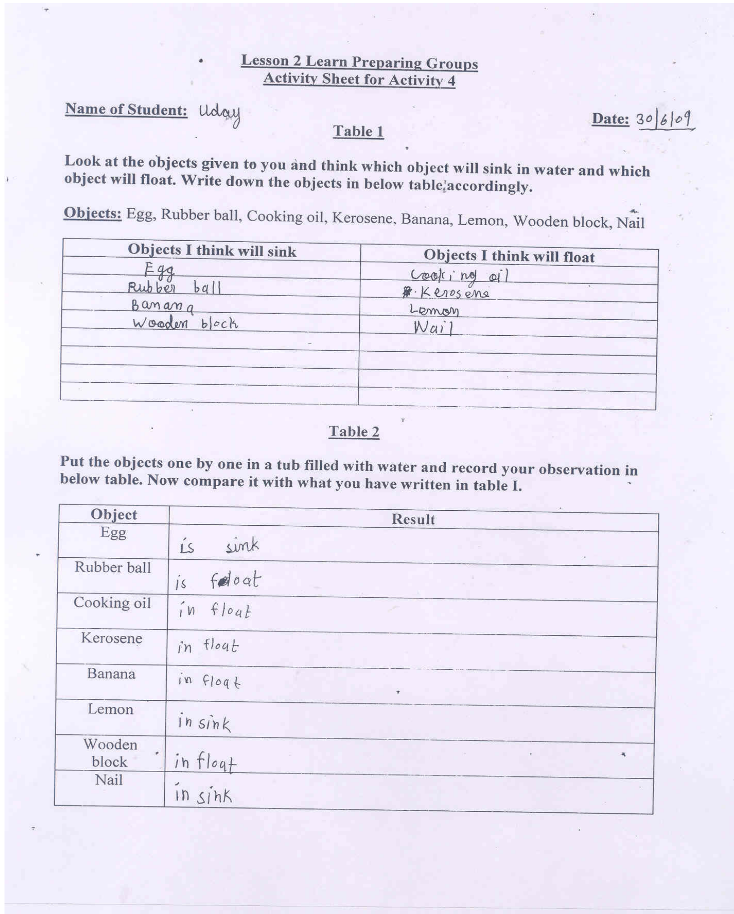
It was the activity given to the students to experiment and to study which objects sink or float over water. Prior to the experimentation, the students were asked to report what they predicted for sinking or floating of the particular objects given to them for study. The song showing the reason for floating and sinking of the particular object was sung by the students with claps after doing the activity. The song is mentioned as under. (http://www.k12.hi.us/~shasincl/poems_prop_cycle_weather.html)

Song - Floating and Sinking

"Why do things float?
Why do things sink?
What do you think?
What do you think?
Things that float
Are lighter than water.
That's why they float.
That's why they float.
Things that sink
Are heavier than water.
That's why they sink.
That's why they sink".

A student's activity sheet is mentioned in figure 40.

Figure 40 A Student's Activity Sheet Showing Prediction and Observation



Lesson 2 Learn Preparing Groups

Activity Sheet for Activity 4

Name of Student: Uday

Date: 30/6/09

Table 1

Look at the objects given to you and think which object will sink in water and which object will float. Write down the objects in below table accordingly.

Objects: Egg, Rubber ball, Cooking oil, Kerosene, Banana, Lemon, Wooden block, Nail

Objects I think will sink	Objects I think will float
Egg	Cooking oil
Rubber ball	Kerosene
Banana	Lemon
Wooden block	Nail

Table 2

Put the objects one by one in a tub filled with water and record your observation in below table. Now compare it with what you have written in table I.

Object	Result
Egg	is sink
Rubber ball	is float
Cooking oil	in float
Kerosene	in float
Banana	in float
Lemon	in sink
Wooden block	in float
Nail	in sink

The students' predictions for floating and sinking of the objects / substances are mentioned in table 20.

Table 20 Students' Prediction: Sinking or Floating

Students' Prediction	Percentage of the Students
Eggs sink	(86.95%) students
Rubber Ball sinks	(08.69%) students
Cooking Oil sinks	(08.69%) students
Kerosene sinks	(08.69%) students
Banana sinks	(06.52%) students
Lemon sinks	(45.65%) students
Wooden Block sinks	(13.04%) students
Nail sinks	(86.95%) students

As mentioned in the above table 20, majority of the students were able to predict rightly about what would happen when particular object / substance was added to the tub filled with water. It meant that the students had some prior experiences that the lightweight objects float over water. Observations made by the students are shown in the table 21.

Table 21 Students' Observation: Sinking or Floating

Students' Observations	Percentage of the Students
Egg sinks	(100%) students
Rubber ball floats	(100%) students
Cooking oil floats	(100%) students
Kerosene floats	(100%) students
Banana floats	(91.30%) students
Lemon sinks	(91.30%) students
Wooden Block floats	(95.65%) students
Nail sinks	(100%) students

The table 21 data clearly indicated that majority of the students observed correctly and reported the correct observation for sinking and floating of the particular object/substance in water. There were only few students who reported banana and wooden block sink in water. The students' observations showed that majority of the students used visual sense correctly for observation.

4.3.5.2 Lesson 11 Air - Topic - Property of Air - Air is everywhere

Instructional Objective

- Students will give reasons why crushed paper kept inside the glass remained dry while immersing glass into a bucket filled with water.

Description of the Activity 2 Logical - mathematical

It was the group activity wherein the students were given an opportunity of learning by doing that air occupied the space. Students in a group were asked to observe the glass before immersing it into the bucket filled with water. The teacher showed the students how to put crushed paper at the bottom of the glass. The teacher explained the meaning of the term 'predict' and the importance of prediction in science. The students were asked to predict whether the crushed paper kept inside the glass become wet or not. Each student was given the activity sheet to write their answers and predictions in it. The teacher, thereafter, demonstrated the activity by immersing the glass into the bucket filled with water and removed the glass slowly from the bucket. The students were asked to observe the glass and the crushed paper carefully. The students in a group were asked to do the same activity turn by turn. The activity sheet contained the three questions mentioned in figure 41.

Figure 41 Format of Activity Sheet - Crushed paper does not get wet

Lesson 11 Air

Activity Sheet for Activity 2

Student's Name: **Date:**

Read the following questions carefully and write answers in the space provided.

1. Was the glass wet before immersing it in bucket filled with water?

2. What do you predict? Will the crushed paper kept inside the glass become wet?

3. Why the crushed paper inside the glass does not become wet?

All the students reported that glass was sry before immersing it in bucket filled with water. Very few (08.69%) students predicted that crushed paper kept inside the glass would become wet while total (91.30%) students predicted that the crushed paper kept inside the glass would not become wet. The results of the prediction were surprising. It was expected that most of the students of this age would predict that the crushed paper inside the glass would become wet. But it was not so, and this might be due to the students' prior exposure to the content of science. There were (86.95%) students who mentioned that air was responsible factor that kept the crushed paper dry so it did not become wet. The rest students did not mention any reason why the crushed paper kept inside the glass remained dry when glass was immersed into the bucket filled with water. This analysis led to conclude that majority of the students in the class inferred air as responsible factor that prevented the crushed paper from making it wet.

4.3.6 Study of the Process of Learning Science in relation to - Communication Process Skill

The activities, which exclusively demanded the use of communication process skill, were clubbed together and the students' responses were analyzed using activity sheets and classroom observation. This includes the brief description of the activity along with how students carried out particular activity and demonstrated the communication process skill.

4.3.6.1 Lesson 3 Living - Non Living - Topic- Characteristics of Living and Non - Living

Instructional Objective

- Students will write the appropriate characteristics of the living and non - living in the Venn diagram.

Description of Activity 2 Logical - mathematical

The teacher explained the concept of Venn diagram and explained how to write the characteristics of the living and non - living in the Venn diagram. It was found that all the students mentioned the characteristics of living and non - living in the Venn diagram appropriately. Thereafter, the teacher asked the questions such as similarities and differences between 'aeroplane' and 'bird'. The teacher instructed them to write the similarities and differences existing between 'aeroplane' and 'bird' in the Venn diagram.

It was found that the students understood the overlapping part of both the circles was meant for writing similarity between 'aeroplane' and 'bird' such as 'flying' after repeated explanation of the teacher. Very few students faced difficulty to comprehend aeroplane as non - living but later on, all students understood why aeroplane was not classified as living. This was confirmed when all the students drew the Venn diagram with correct mentioning of similarities and dissimilarities for 'aeroplane' and 'bird' in Venn diagram.

4.3.6.2 Lesson 3 Living - Non Living - Topic –Music affects Plant

Instructional Objective

- Students will explain that plants are living on the basis of Jagdish Chandra Bose's work.
- Students will explain that plants should not be cut.
- Students will write uses of plants.

Description of the Activity 5 Musical and Intrapersonal

It was the activity wherein the students were instructed to listen different kinds of music (CD, Folder – Lesson 3, Files- x-files, jugal Track 02). After listening, the students were asked about their preferences indicating which music they liked to listen. The teacher asked which music helped to calm down their minds and to relax. Thereafter, the teacher gave information of Jagdish Chandra Bose's work for indication that plants exhibited sensitivity using PPT (CD, Folder- lesson 3, File- Dr Bose) to show the picture of a distinguished scientist. The students were given the below mentioned paragraph to read. Then, they were asked to reply the questions asked in given activity sheet.

Paragraph

I am a neem tree. My leaves are bitter in taste. I am a big tree. I provide home to all birds. I am useful to man. Neem soap and some medicines are made from my leaves. Mosquitoes run away when my leaves are burnt. I give coolness in summer. I do not harm man but I feel unhappy and upset when man cuts me.

Review Questions

1. How is neem tree useful to man?
2. Should we cut the neem tree? If not, why?

The teacher discussed various uses of neem tree and explained living feels sensation after collecting the activity sheets. Majority of the students (93.74%) mentioned that neem tree was useful to them as it provided materials to prepare neem soap, medicines etc. They also mentioned that neem tree provided home to birds to live and coolness in summer. Some students also mentioned that neem tree was useful as a repellent for the mosquitoes along with other uses of neem tree such as making of medicines, providing coolness and habitation to birds.

All (100%) students mentioned that no one should cut the neem tree, as it was useful to us. They reported that neem tree provided coolness in summer, and medicines and soap had been prepared from neem tree. The students' responses indicated that though some (17.39%) students were able to write the answer in their own language but all the students were able to comprehend the meaning of the paragraph and wrote the answers accordingly.

4.3.6.3 Lesson 3 Living - Non Living - Topic - Plant and animals show sensitivity

Instructional Objective

- Students will explain plants are living because plants show sensitivity when it is touched. (Based on the example of 'touch-me-not-plant')
- Students will explain that the living is sensitive towards the changes occurring in their nearer surrounding.

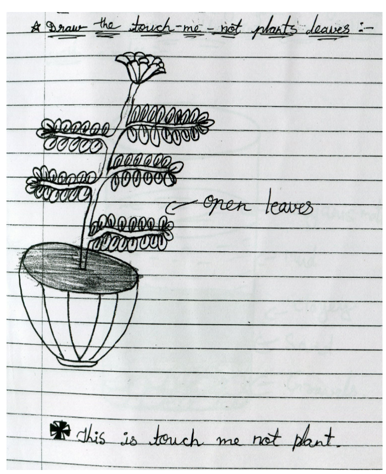
Description of Activity 6 Visual - spatial and Naturalist

The teacher brought the 'touch-me- not' plant' in the class, provided opportunity to the students for its careful observation and allowed students to touch it also. The teacher asked the colour of leaves and its branches, and size of stem. The photograph 7 shows the students' touching and observing the 'touch-me-not-plant.'

Photograph 7 Students Observing the 'Touch-me-not-plant'

The teacher explained the effect of seasonal environmental changes to animals and human in brief. Majority of the students (91.30%) reported correct observation regarding the colour of the leaves. They compared the size of the leaves of 'touch-me-not' plant with other known plants. They found this activity like magic while observing the folding of the leaves of 'touch-me-not' plant and asked the reason of their folding. All students explained that plants and animals are sensitive and animals feel pain when someone beats them. The figure 42 shows the student's drawing of the 'touch-me-not-plant'.

Figure 42 A Student's Drawing of the 'Touch-me-not-plant'



4.3.6.4 Lesson 2 Learn Preparing Group - Topic - Usefulness of Group Formation in One's Life

Instructional Objective

- Students will write reasons (in their own words) for the importance of systematic working and classification of objects / substances into group which make daily tasks easy.

Description of the Activity 6 Linguistic and Intrapersonal

This activity was initiated by questioning regarding the things the students usually keep in the cupboard, kitchen, on study table, on computer table and in school bags. The teacher used probing skill to know their understanding about improper arrangement of things at home / kitchen / room. The students were asked to complete the statements noted below meaningfully.

Complete the below given statements with proper reasons.

(1) When I will be free, I will help mother to keep the edible things at one place… (2) I will keep notebooks, pen, pencil, textbooks, and assignments on the study table… (3) Textbooks and workbooks should be kept separately because…(4) School uniforms should be kept at a place in my cupboard because…(5) I learnt from this chapter to organize………………as that will help to keep my work…

The analysis of the responses to above sentences indicated that the students understood how systematically arranged things facilitated their daily work. The analyses of the students' responses also indicated that their vocabulary was limited and the sentence pattern was also found incorrect with respect to grammar. It was found that the students comprehended the questions properly and the concept of group formation. The students of this stage had shown the development of ideas about the usefulness of group formation in daily life and gave reasons that systematically arranged study related materials, edible things in kitchen and uniform in cupboards would save time and make tasks easy for completion.

4.3.6.5 Lesson 5 Seed and Its Germination – Topic - Germination in Onion

Instructional Objective

- Students will conclude the conditions required for germination of onion or potato in their own words.
- Students will draw the picture of germinated onion or potato.

Description of the Activity 4 Logical-mathematical, Naturalist, Bodily-kinesthetic and Visual-spatial

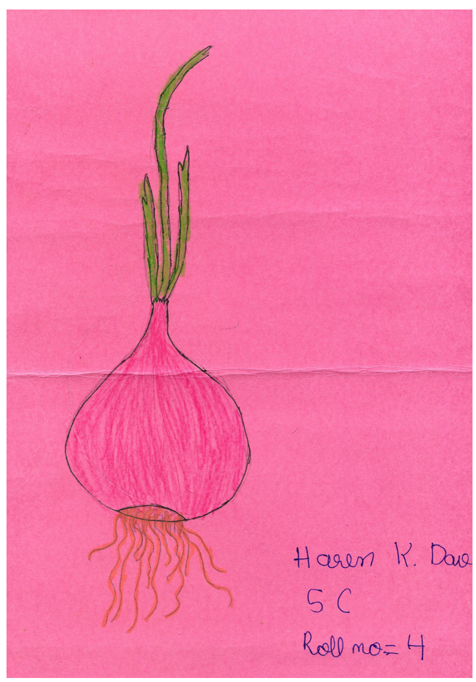
This activity was carried out to broaden the students' horizons of learning that how germination takes place in onion. The teacher demonstrated the germinated onion to them and explained the entire procedure to do the experiment using the easily available means like toothpicks, water and a beaker. They were instructed to observe carefully the germinated onion and told to draw the figure of the same in their science notebooks. They were also assigned a task to conduct the same experiment at home with the permission of their parents to use onion.

Majority of the students selected onion to study germination. A few students (21.73%) attempted to study the germination in potato. A very few (04.43%) students were able to show germination in potato. It was found that except a few, almost all the students were able to observe the tiny roots sprouted in onion and they drew the same with proper labeling. The level of water (in glass) required for its contact with onion was also mentioned appropriately by all students in the drawing of this activity. The students showing the experiment carried out at home to study the germination of onion is shown in photograph 8.

Photograph 8 Students Showing Germination in Onion

The student's chart for germinated onion is shown in figure 43.

Figure 43 A Student's Chart of Germinated Onion



4.3.6.6 Lesson 5 Seed and Its Germination - Topic - Seed Dispersal

Instructional Objective

- Students will name the factors responsible for seed dispersal.
- Students will explain the factors that cause the dispersal of seed.

Description of the Activity 5a Visual - spatial and Naturalist

The students were shown PowerPoint Presentation regarding the seed dispersal (CD, Folder – Lesson 5, File- Presentation for seed dispersal). The slides contained the pictures of meswak tree, bombax, calotropis, lotus, *takmaria*, *raljko*, cocklebur and *gokhru*. The teacher also showed two small movie clips on seed dispersal (CD, Folder- Lesson 5, File-Burdock Seed Dispersal, File- Seed Dispersal2).

It was found that whole class was able to name the factors causing the dispersal of seeds. They also explained reasons that seeds light in weight got spread by the wind to far places. The students communicated verbally that seeds fell from the tree planted nearer to river and these seeds were carried by river-water, and thus, they got dispersed. The students mentioned that the undigested fruits with seeds were excreted by animals. So, animals also played the significant role in the dispersal of seeds.

Description of the Activity 5b Bodily - kinesthetic

The teacher revised the content by a game. The teacher said aloud various names of seeds like lotus, *rajko*, seeds of bombax tree, meswak tree, cocklebur (*gaderu)*, *gokhru*, takmaria, and calotropis. The teacher instructed the students to show the sign of drinking if the seed was dispersed by water. Accordingly, they were instructed to show the action of 'blowing it out' for wind and the action of flying by showing the movement of hands if seed was dispersed by bird. They were instructed to say aloud the names of animals if the seed was dispersed by animals or found in excreta of animals. It was found that the majority of the students were able to identify the factors that cause the dispersal of particular seed and did the proper actions as per the instructions given to them. Very few students had difficulty in recognizing how the seeds of calotropis and bombax trees were dispersed. They faced difficulty in pointing out the factors that disperse the seeds of *'Gaderu'* and *'Gokhru'* in the beginning.

4.3.6.7 Lesson 5 Seed and Its Germination - Topic – Reflecting Seed Dispersal with regard to Human Life

Instructional Objective

- Students will appreciate the factors responsible for seed dispersal by writing reasons in one or two lines.

Description of the Activity 6 Visual–spatial, Intrapersonal, Naturalist and Linguistic

This activity was introduced after the activity 5 to help students reflect on their perceived roles in the environment with regard to 'seed dispersal'. The teacher instructed the students to imagine the conditions required for seed dispersal with closed eyes and asked them to complete the following sentences mentioned in activity 6. The format of activity sheet for activity 6 was as under in figure 44.

Figure 44 Format of Activity Sheet for Seed Dispersal

Lesson 5 Seed and Its Germination
Activity Sheet for Activity 6

Student's Name: **Date:**

Read the following sentences carefully. Complete them meaningfully. Write proper reasons with examples.

1. I should appreciate the role played by water and wind as ………………

2. I must appreciate birds, insects, and animals because they help in **……..**

All the students (100%) mentioned that wind caused the seeds to move from one place to another. Majority of students (93.47%) indicated that the seeds of meswak, calotropis, and bombax tree were light in weight and were dispersed by wind. Majority of the students (76.08%) reported that the seeds of *rajko*, takmaria, lotus were dispersed by water. All the students (100%) gave reasons that the seeds dispersed from one place to another due to stream of water and these dispersed seeds would germinate if proper conditions of seed germination would be met. It meant that all the students were able to communicate why water should be conserved. Majority of the students (89.13%) gave reasons to appreciate birds, insects, and animals for seed dispersal. They also mentioned that sometimes birds dropped half-eaten fruits which were eaten by animals and found undigested in their excreta. Such seeds would germinate if they get air and water. They also wrote the examples of Cocklebur *(Gaderu)* and *'Gokhru'* for seed dispersed by animals such as goat and sheep.

4.3.6.8 Lesson 11 Air - Topic - Wind and Its Uses

Instructional Objective

- Students will find out the uses of wind (by reading the paragraph given) and write accordingly.
- Students will mention the damage caused by wind in their own words.

Description of the Activity 1 Linguistic

The teacher instructed the students to read paragraph mentioned in activity sheet carefully and asked what ideas it contained. Instructions were given to the students to find out the answer from the paragraph and write the answers briefly in the activity sheet. The teacher discussed the uses and damages caused by wind after collecting the activity sheets.

There were (86.95%) students who used the same sentence pattern as mentioned in the paragraph. It was found that the students were facing difficulty in writing answers in their own words. All (100%) students wrote that wind is useful to make wet clothes dry. They mentioned that wind caused '*farakdi'* to rotate and kite to fly. The students also wrote that wind was useful in rotating the wings of windmill and so the energy was produced. A few students mentioned that flag fluttered due to wind. It was found from the students' responses that almost all the students reported at least two or more uses of wind. There were different responses for the damages caused by wind. The general response was: wind damaged the human properties such as buildings, trees and bridge when it blew with great force. It was found that a very few students used the words 'storm' and 'cyclone' instead of using the word 'wind'. It indicated that the students did understand what the question meant and what could be the possible right answers.

4.3.6.9 Lesson 9 Food and Health - Topic - Necessity of Food

Instructional Objective

- Students will relate the necessity of food with health.

Description of Activity 1 Interpersonal and Linguistic

The teacher initiated the discussion by asking the advantages of taking food. The teacher noted down the students' answers on blackboard. The teacher instructed the students to discuss advantages of food within group. It was a group activity wherein the students were guided to discuss among group members regarding importance of food. They were given six incomplete sentences and they had to write proper reasons to make them meaningful. One of the students was a leader in a group to assign tasks to group members, one was a writer, and other students were members to discuss. The students were asked to complete the following incomplete statements with proper reasons.

Statement 1 Food Provides…………

Statement 2 Man will feel good and healthy if ……

Statement 3 Man will not fall ill if ……

Statement 4 We should eat food because ……

Statement 5 Body becomes weak if ……

All groups reported that food provided energy to body and was required to maintain good health because it made body strong, and man would not fall ill. They further added that that food gave us proteins, carbohydrates and helped man to remain healthy. It showed that the students in-group had prior knowledge about the nutrients and were able to generate idea for the necessity of food.

The students in groups mentioned different reasons for why man would feel good and healthy. They reported intake of good food and breathing fresh air were required to feel good and to be healthy. The analyses indicated that the students had the idea that good food habits and walking were must to feel good and to have better health. There were varied responses for why man would not fall ill. The groups' responses were that food and air was required to be free from illness. There were two groups who emphasized on intake of fresh food and plenty of water. This showed that the students were able to show relationship between food and diseases, but they were not able to point out that diseases were caused due to the poor food preservation practices, eating food available from the *'lorry'* and vendors. They did not mention the diseases caused due to the contaminated water and food. It meant that the prior knowledge was not properly reflected in students' responses. There were varied responses for -'Body becomes weak if…' They mentioned that excessive working caused weakness in body if one did not take vegetables, fruits, pulses, fresh and clean water, and air along with medicines if prescribed. It was basically understood from the students' responses that they had basic understanding about the importance of food and its impacts including do's and don'ts.

4.3.6.10 Lesson 9 Food and Health -Topic - Finding the Names of Food from Word Block - A Word Game

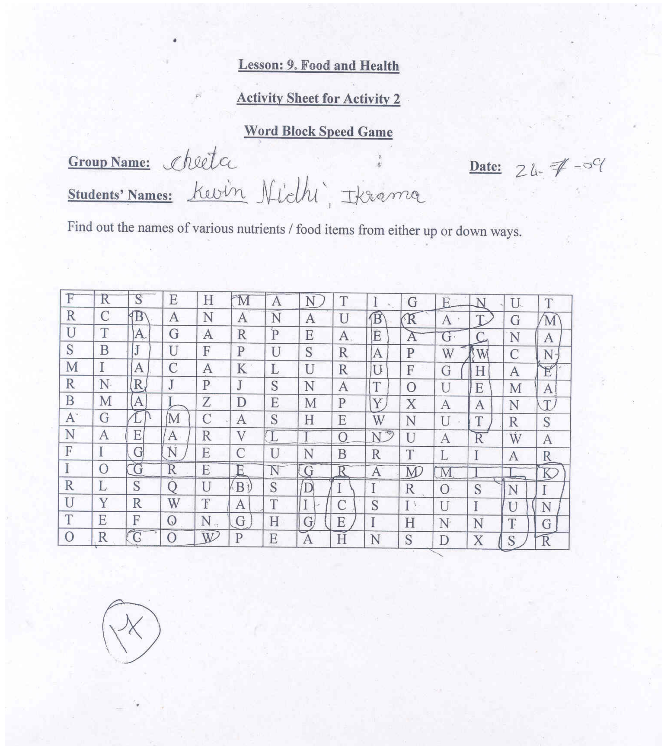
Instructional Objective

- Students will find out the hidden names of food from given word block.

Description of Activity 2 Linguistic and Interpersonal

The students were asked to find out the names of various nutrients, and food items by encircling either upwards or in downwards in word block. It was carried out with a purpose to see how rapidly the students were able to find out the names of food items from the word block. In this activity, one student worked as a leader to give chance to all members of the group one by one. A sample of group activity sheet is mentioned in figure 45.

Figure 45 A Student's Activity Sheet - Finding the Names of Nutrients / Food Items



Lesson: 9. Food and Health

Activity Sheet for Activity 2

Word Block Speed Game

Group Name: cheeta **Date:** 24-7-09

Students' Names: Kevin Nidhi, Ikrama

Find out the names of various nutrients / food items from either up or down ways.

F	R	S	E	H	M	A	N	T	I	G	E	N	U	T
R	C	B	A	N	A	N	A	U	B	R	A	T	G	M
U	T	A	G	A	R	P	E	A	E	A	G	C	N	A
S	B	J	U	F	P	U	S	R	A	P	W	W	C	N
M	I	A	C	A	K	L	U	R	U	F	G	H	A	E
R	N	R	J	P	J	S	N	A	T	O	U	E	M	A
B	M	A	L	Z	D	E	M	P	Y	X	A	A	N	T
A	G	L	M	C	A	S	H	E	W	N	U	T	R	S
N	A	E	A	R	V	L	I	O	N	U	A	R	W	A
F	I	G	N	E	C	U	N	B	R	T	L	I	A	R
I	O	G	R	E	E	N	G	R	A	M	M	I	L	K
R	L	S	Q	U	B	S	D	I	I	R	O	S	N	I
U	Y	R	W	T	A	T	I	C	S	I	U	I	U	N
T	E	F	O	N	G	H	G	E	I	H	N	N	T	G
O	R	C	O	W	P	E	A	H	N	S	D	X	S	R

The students in group found out different food items. Different food items related to food were located such as *bajara*, rice, wheat, nut, *tuar*, milk, pulse, pea, cowpea, green gram, banana, cashew nut, and gram. This indicated that the majority of the students knew the food items and located them easily from the word block.

4.3.6.11 Lesson 9 Food and Health -Topic - Balanced Diet

Instructional Objective

- Students will prescribe balanced diet by forming groups.

Description of the Activity 4 Bodily-kinesthetic

This activity was carried out with connection to the activity 3 (page no.174) in which the students had already learnt that the relationship between good food and health. Thus, it was aimed to reinforce the learning about the need of balanced food. In this activity, the teacher distributed flashcards to each student wherein names of various food items were written. The groups of students were instructed to carry the hanging flash cards with names of cereals (Wheat, rice, *bajara*, maize), pulses(*tuar*, green gram, gram, *udad*, beans, pea, cowpea), green vegetables, dry fruits (cashew nut, raisen, almond, walnut, fig), sweets, *panipuri,* noodles and food items sold at *lorry*. Then, they were asked to group in 'cereals', 'pulses', 'green vegetables' and 'dry fruits' while music played. One student was selected on the basis of chit method, and was called upon to prepare balanced diet by reading the flashcards. It meant that s/he had to select those students which helped him/her to show balanced diet. This way, the opportunity was provided to different students. A game was played in which the teacher instructed all the students to carry the given flash cards and form a group to show a balanced diet in one minute only.

Various selections of the food items based on the flash cards indicated that majority of the students had understanding that sweets, sugar, '*pani-puri'*, food items sold at *'lorry'* should not be taken as food. Some choose noodles as a food item. This showed that there was the need to teach the side effects of noodles in general to the students at this age so that they would decide what to eat and what not to eat.

4.3.6.12 Lesson 9 Food and Health -Topic - Preparation of Chart of Balanced Diet

Instructional Objective

- Students will suggest bad food habit based on hypothetical situation.
- Students will develop the chart of the balanced diet.

Description of Activity 5 Logical - mathematical

The teacher implemented this activity to emphasize what should be included in balanced diet. The teacher initiated the discussion with the students regarding what type of food should be taken. The teacher mentioned the points regarding the food one should take on the blackboard. The hypothetical situation was given to the students to think and write answers in their notebook which is mentioned as under.

Hypothetical situation

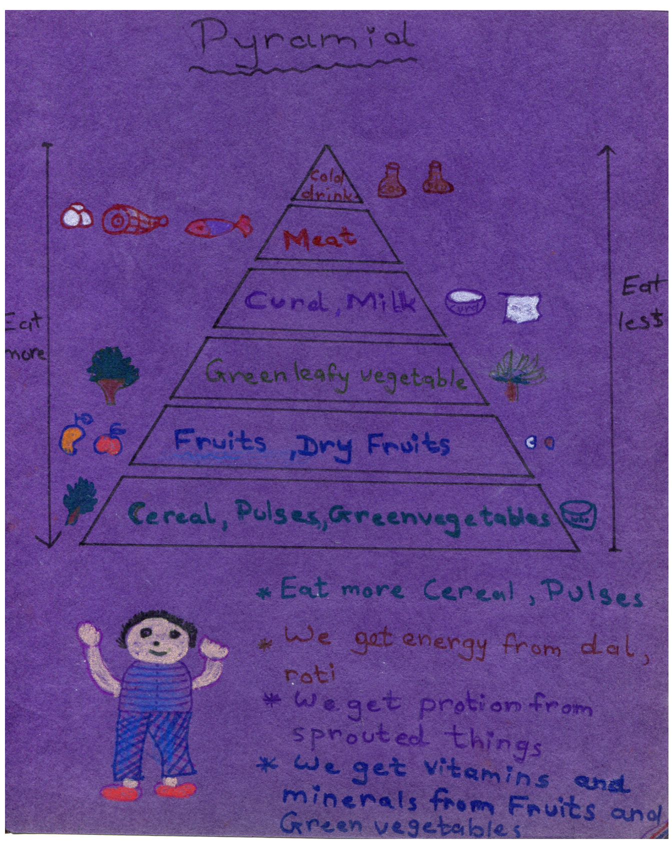
Your younger sister Shraddha likes to eat sugar very much. She takes sweet balls whenever she goes to party. She eats sweets too much. She does not like to take milk. She eats only some of the vegetables.

Questions

- Do you find the food habit of your sister as good? If not, give reasons for it.
- How will you correct your sister's food habit?
- Which diet menu will you prescribe for your younger sister?

All the students mentioned verbally that food habit of Shraddha was not good and provided reasons that sugar was not good for the health. They mentioned that they would prefer to explain harmful effects of sugar over body to their young sister. They suggested the food menu of *dal*, rice, vegetables, *roti* and adequate amount of water for younger sister. The student's pictorial chart for balanced diet is mentioned in figure 46.

Figure 46 A Student's Pictorial Chart for Balanced Diet



The students indicated cold drinks, sugar, and sweets on the top of the pyramid and the food (cereals, pulses, green vegetables) required in more quantity was mentioned in the broader sections of the pyramid. It meant that the students were able to communicate which type of food should be taken in more quantity.

4.3.6.13 Lesson 9 Food and Health -Topic –Introspecting One's own Food Habit

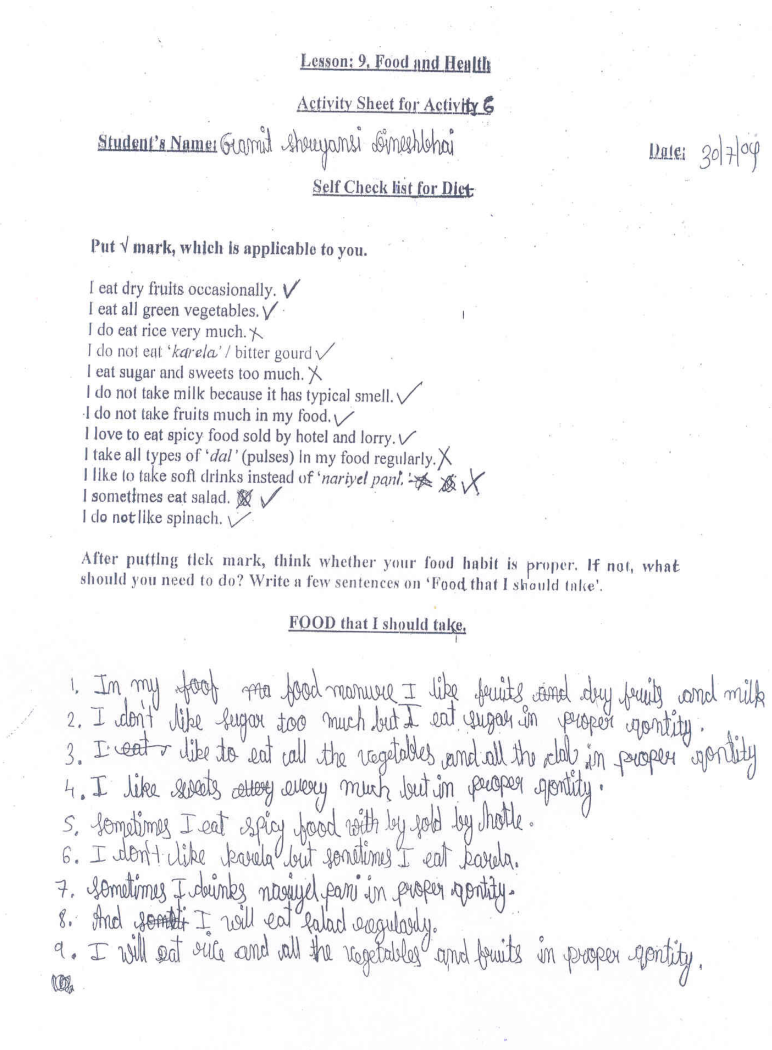
Instructional Objective

- Students will criticize their own food habits.
- Students will write a paragraph mentioning which food should be taken with reasons.

Description of Activity 6 Intrapersonal

Self-check list for diet provided scope to the students to reflect on their own food habits. The teacher distributed activity sheets to the students. The activity sheet had the statements for their food habits and the students were asked to put tick mark '√' if it was applicable to them or put 'X' tick mark if sentence was not applicable to them regarding the food they ate. The students were asked to write the small paragraph on *'Food that I should take'* to correct their food habits. A student's sample activity sheet is mentioned in figure 47.

Figure 47 A Student's Activity Sheet for Self – Check List for Diet



Lesson: 9. Food and Health

Activity Sheet for Activity 6

Student's Name: Gamit Shreyansi Dineshbhai **Date:** 30/7/09

Self Check list for Diet

Put √ mark, which is applicable to you.

I eat dry fruits occasionally. ✓
I eat all green vegetables. ✓
I do eat rice very much. ✗
I do not eat '*karela*' / bitter gourd ✓
I eat sugar and sweets too much. ✗
I do not take milk because it has typical smell. ✓
I do not take fruits much in my food. ✓
I love to eat spicy food sold by hotel and lorry. ✓
I take all types of '*dal*' (pulses) in my food regularly. ✗
I like to take soft drinks instead of '*nariyel pani*.' ✓
I sometimes eat salad. ✓
I do not like spinach. ✓

After putting tick mark, think whether your food habit is proper. If not, what should you need to do? Write a few sentences on 'Food that I should take'.

FOOD that I should take.

1. In my ~~foof~~ ~~ma~~ food manure I like fruits ~~and~~ dry fruits and milk
2. I don't like sugar too much but I eat sugar in proper qontity.
3. I ~~eat~~ like to eat all the vegetables and all the dal in proper qontity
4. I like sweets ~~every~~ every much but in proper qontity.
5. Sometimes I eat spicy food with by sold by hotle.
6. I don't like karela but sometimes I eat karela.
7. Sometimes I drinks nariyel pani in proper qontity.
8. And ~~somti~~ I will eat salad regularly.
9. I will eat rice and all the vegetables and fruits in proper qontity.

The students' responses for the self-check list are mentioned in table 22.

Table 22 Responses of the Students for the Self - Check List for Food

No.	Statements	Responses of the students
1.	I eat dry fruits occasionally.	Yes (10.86%); No (89.13%)
2.	I eat all green vegetables.	Yes (78.26%); No (21.73%)
3.	I do eat rice very much.	Yes (69.56%); No (30.43%)
4.	I do not eat 'karela' / bitter gourd.	Yes (91.30%); No (08.69%)
5.	I eat sugar and sweets too much.	Yes (65.21%); No (34.78%)
6.	I do not take milk because it has typical smell.	Yes (76.08%); No (23.91%)
7.	I do not eat fruits much in my food.	Yes (30.43%); No (69.56%)
8.	I love to eat spicy food sold by hotel and lorry.	Yes (86.95%); No (13.04%)
9.	I take all types of 'dal' (pulses) in my food regularly.	Yes (60.86%); No (39.13%)
10.	I like to take soft drinks instead of *'nariyel pani'*.	Yes (80.43%); No (19.56%)
11.	I sometimes eat salad.	Yes (76.08%); No (23.91%)
12.	I do not like spinach.	Yes (73.91%); No (26.08%)

Majority of the students (91.30%) mentioned that they did not take *'karela'* (= bitter gourd). (86.95%) students mentioned that they preferred to take food sold by *'lorry'* and hotel. On the other hand, there were (78.26%) students who reported that they took all green vegetables in food and (80.43%) students reported that they preferred *'nariyel-pani'* (=coconut water) instead of soft drinks. Reasonably, quite a large number of students (76.08%) mentioned that they were taking salad. There were (60.86%) students who reported that they would take all type of '*dal'* in a proper quantity regularly as it was good for body.

The analysis of the paragraph "Food that I should take' also confirmed the students' proper understanding regarding the food. A few students wrote that *'karela'* (bitter gourd) was good for health. But, they would include it in food menu occasionally.

(45.65%) students reported they would not prefer to eat food from vendors and hotels though it was tasty because it was not good for health. There were (19.56%) students who mentioned that *'nariyel pani'* (coconut water) was better than soft drinks and they would minimize the intake of soft drinks. Total (36.95%) students mentioned that they would reduce excessive use of rice. (34.78%) students reported that they would take care to include proper amount of dry fruits. There were (69.56%) students who reported that pulses, cereals, and vegetables should be taken in proper quantity to keep body health. It indicated that almost all students demonstrated proper understanding of the food they should take.

4.3.6.14 Lesson 9 Food and Health -Topic –Preparing the Food Menu with the Help of Interview of Parents

Instructional Objective

- Students will indicate food for their age.
- Students will explain the reasons why junk food, sugar, sweets, soft drinks and food from *'lorry'* should be avoided.

Description of Activity 7 Interpersonal

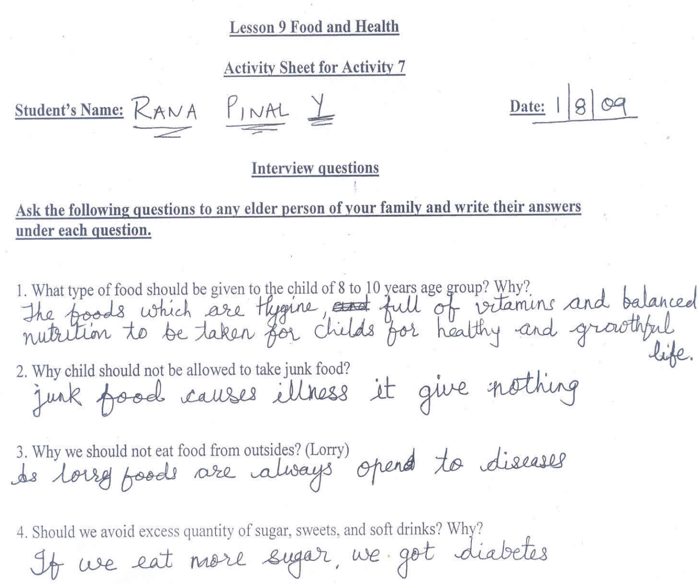
The interview schedule had total four questions. The students were guided how to take interview of an elder person of family and they were instructed to note down the responses of the elder person. The activity 7 comprised four interview questions as under.

Questions

1. What type of food should be given to the child of 8 to 10 years age group? Why?
2. Why child should not be allowed to take junk food?
3. Why we should not eat food from outsides? (Lorry)
4. Should we avoid excess quantity of sugar, sweets and soft drinks? Why?

After collecting the activity sheets, the teacher discussed which food should be taken by the child of 8 to 10 years age group. A student's activity sheet is mentioned in figure 48.

Figure 48 Student's Reported Answers as an Interviewer



Lesson 9 Food and Health

Activity Sheet for Activity 7

Student's Name: RANA PINAL Y Date: 1|8|09

Interview questions

Ask the following questions to any elder person of your family and write their answers under each question.

1. What type of food should be given to the child of 8 to 10 years age group? Why?

The foods which are Hygine, ~~and~~ full of vitamins and balanced nutrition to be taken for childs for healthy and grawthful life.

2. Why child should not be allowed to take junk food?

junk food causes illness it give nothing

3. Why we should not eat food from outsides? (Lorry)

As lorry foods are always opend to diseases

4. Should we avoid excess quantity of sugar, sweets, and soft drinks? Why?

If we eat more sugar, we got diabetes

(95.65%) students reported food items such as *roti*, milk, pulses, grams, fruits, and leafy vegetables should be given to the child of 8 to 10 years age group because it was required to keep body fit and healthy. A few students (04.34%) reported that food full of vitamins and balanced food should be given to the child of 8 to 10 years age group. Some students mentioned to include milk for calcium, *horlicks* and dry fruits as they were the rich source of energy. The students provided reasons that *'junk food gave nothing'* and caused illness so it should not be taken. They also mentioned that junk food contained much soda and fat. Majority of the students (89.13%) mentioned that junk food contained fewer nutrients and vitamins so it should not be taken. (65.21%) students reported that food sold in *'lorry'* might cause disease so such food should not be taken. There were (34.78%) students who described the situation that flies sat on the food available from the outside. So, it is better to avoid such food to avoid diseases. Total (82.60%) students reported that outside food was tasty but it was salty, spicy and it did not have good amount of nutrients. So, consumption of food from the *'lorry'* should be avoided. All students (100%) reported that excessive use of sugar, sweets were not good for health and should be avoided because it contained fewer nutrients, caused diabetes and problems of digestion and blood pressure. The students' responses to the questions asked indicated that the students gave proper reasons for why junk food and excessive use of sugar and sweets should be avoided.

4.3.6.15 Lesson 14 Measurement of Length - Topic - Units of Measurement from History to Standard Measure

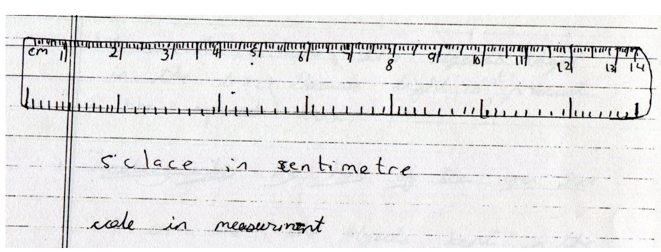
Instructional Objective

- Students will draw the scale of measurement with compass-ruler showing measurements in inches or centimetres.
- Students will give the names of units of measurement of length.

Description of the Activity 2 Logical - mathematical and Visual - spatial

The activity begun by the teacher's story telling about how different kinds of units of measurements were invented by men by the period of time. The teacher used the PowerPoint Presentation (CD, Folder – Lesson 14, file- Measurement of length story) to help students in visualizing the history of the invention of the units of the measurement of length. The teacher explained the different units of measurement of length and instructed them to observe the ruler carefully and draw the ruler in their notebooks. A student's drawing for the scale of measurement for length is shown in figure 49.

Figure 49 A Student's Drawing for the Scale of Measurement of Length



It was found that all the students attempted to draw the scale showing small lines of measurement units between two consecutive numbers mentioned on the ruler. Except a few students, they made mistake to draw the equal measurement of inch or centimeter in the drawing of scale. All the students mentioned centimeters, inches and meters as the units of measurement of length.

4.3.6.16 Lesson 16 Energy - Topic - Sources of Energy for Living and Non-living

Instructional Objective

- Students will list down various sources of energy.

Description of the Activity 1 Logical - mathematical

An activity similar to the activity given in the Science and Technology textbook of Gujarat Textbook Board was given in which the students were asked to mention the sources of energy of the living and the non-living. This activity made use of the students' prior knowledge and linked it with the new knowledge. The responses were categorized in percentage mentioned in table 23.

Table 23 Sources of Energy for Living and Non - Living

Living / Non - Living	Food / fuel used	Responses of the Students in Percentages
Truck	Diesel	(78.26%) - Students
	Petrol	(19.56%) - ”
	Fuel	(02.17%) - ”
Bike	Petrol	(95.65%) - ”
	Battery	(02.17%) - ”
	Diesel	(02.17%) - “
Donkey	Grass, grain	(89.12%) - ”
Lion	Flesh / Meat	(47.82%) - ”
	Herbivore	(43.47%) - ”
	Deer	(02.17%) - ”
Sparrow	Seeds, grain, wheat, rice, juar, gram	(76.05%) - ”
	Small insects	(13.04%) - ”
	Grapes	(02.17%) - ”
Frog	Insects, fly	(73.90%) - ”
	Butterfly	(08.69%) - ”
	Grass, leaf	(04.34%) - ”
	Mosquito	(02.17%) - ”
	Water	(02.17%) - ”
Snake	Rat, Mouse	(43.47%) - “
	Small animals, and insects	(30.43%) - ”
	Insects	(28.26%) - ”
	Egg	(10.86%) - ”
	Frog	(02.17%) - ”
	Drinks blood	(02.17%) - ”

*Table 23 continued on next page.

Table 23 Sources of Energy for Living and Non - Living

Living / Non - Living	Food / fuel used	Responses of the Students in Percentages
Cat	Milk	(36.95%) - Students
	Mouse, rat	(39.13%) - ”
	Cream	(06.52%) - ” (Butter can be written specifically.)
	Chapatis	(02.17%) - ”
	Fish	(02.17%) - ”
Rickshaw	Petrol	(50.00%) - ”
	CNG	(30.43%) - ”
	Gas	(15.21%) - ”
	Kerosene	(02.17%) - ”
	Diesel	(02.17%) - ”
Electric Train	Electricity	(82.60%) - ”
	Diesel, and / or magnate	(10.86 %) - ”
	Petrol	(04.34%) - ”
	Coal	(02.17%) - “

Majority students enquired about food taken by snake. CNG had been made compulsory fuel for rickshaw in Surat and major cities. But only, (30.43%) students wrote CNG as a fuel, and (15.21%) students mentioned gas as a fuel for rickshaw. (19.56%) students mentioned petrol as fuel for truck which was a wrong answer. The analyses of the above data shown in table 23 indicated that students reported various sources of energy for living and non - living. It can be said that the students knew that the living and machinery required energy to work and their sources of energy.

4.3.6.17 Lesson 16 Energy - Topic - Sun as a Fundamental Source of Energy

Instructional Objective

- Students will explain the sun as the fundamental and inexhaustible source of energy.

Description of the Activity 3 Visual - spatial and Logical-mathematical

The teacher showed the movie clip of the sun as a source of energy (CD, Folder-Lesson 16, File-solar energy) and explained with reasons why it is a fundamental source of energy. The teacher provided basic information for solar heater and showed the model and chart of solar cooker to explain how solar energy was used to cook food without using gas or electricity. The students gave reasons that plants use sunlight to prepare food. The animals such as cow, buffalo, donkey, goat, elephant and deer ate plants. Lion, tiger and leopard eat cow, buffalo and deer. They mentioned that energy was available due to the sun and its energy was in abundance to us so it was a fundamental and inexhaustible source of energy. It indicated that the students were able to give reasons why the sun was a fundamental and inexhaustible source of energy.

4.3.6.18 Lesson 16 Energy - Topic_- Wind and Flowing Water –Sources to generate Energy

Instructional Objective

- Students will explain the uses of wind and flow of water to generate energy.
- Students will prepare the model of windmill using waste material.

Description of Activity 5 – Logical – mathematical and Bodily-kinesthetic

The teacher showed students the hand-made model of windmill which was prepared by chart paper and pins and explained its functioning in brief. The teacher linked this activity with the preparation of windmill from paper with a focus on making best out of the west material at low cost. The teacher explained students to prepare the same at their home by providing them required guidance. Thereafter, the teacher discussed how energy is produced by flow of water briefly. It was found that all the students explained dams are constructed to store river-water which can be used for irrigation and they, too protect cities from flood. They mentioned that stored water at dam when falls from the height, it moves the turbine and energy is produced if the turbine is connected with the electric generator. The students mentioned that windmill is set up at coastal area where wind is blowing at great speed. The students further indicated that blowing of wind at great speed is the cause to rotate the blades of the windmill and the generator helps in producing electric energy. The photograph 9 indicates the student showing the model of windmill made from chart paper.

Photograph 9 A Student showing the Windmill made from Chart paper

4.3.6.19 Lesson 16 Energy - Topic - Reasons for Judicious Usage of Energy

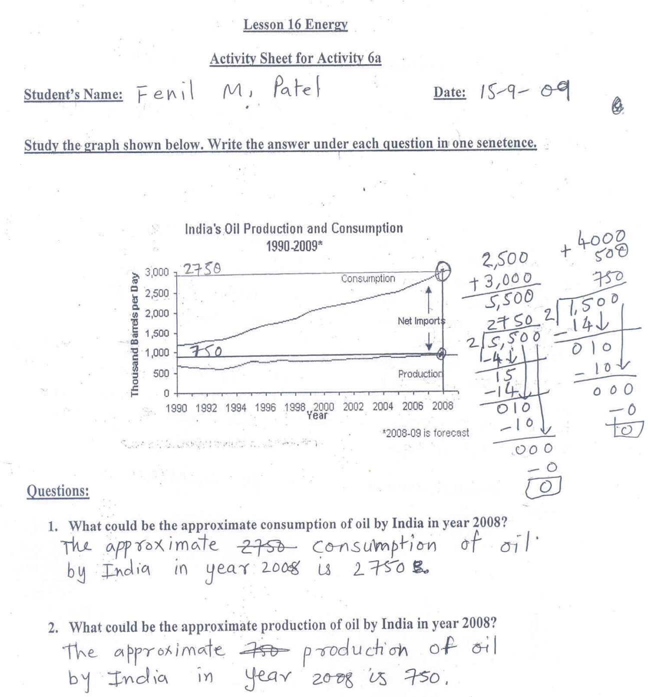
Instructional Objective

- Students will give reasons for judicious use of sources of energy.

Description of the Activity 6a Logical - mathematical and Intrapersonal

The students were taught using blackboard work how to interpret the graph of production and consumption of natural gas of India in the year 2008. The teacher explained in brief showing the pie chart of countries providing crude oil in PowerPoint Presentation (CD, Folder- Lesson 16, File -My country India needs energy) that India faces the scarcity of energy. Thereafter, the teacher gave students the activity sheet in which they were asked to mention the approximate figure of production and consumption of oil by India in the year 2008. The teacher took rounds in the class and explained how to interpret the graph of production and consumption of oil when students found difficulty. A student's sample activity sheet is mentioned in figure 50.

Figure 50 A Student's Interpretation of Graphical Data


Lesson 16 Energy

Activity Sheet for Activity 6a

Student's Name: Fenil M. Patel Date: 15-9-09

Study the graph shown below. Write the answer under each question in one senetence.

Questions:

1. What could be the approximate consumption of oil by India in year 2008?
The approximate ~~2750~~ consumption of oil by India in year 2008 is 2750 B.

2. What could be the approximate production of oil by India in year 2008?
The approximate ~~750~~ production of oil by India in year 2008 is 750.

The analyses of the students' responses for above activity showed that the (60.86%) students mentioned 3,000 barrels and (19.56%) students mentioned 2,500 barrels of oil for consumption. A few (08.69%) students mentioned 2,750; another (08.69%) students mentioned 2,800 barrels of oil for consumption. The responses of the students indicated that majority of the students were able to indicate almost correct consumption of the oil in the year 2008. A very few (02.17%) student indicated 30,000 barrels of oil perhaps due to hurry in replying. The students' responses were almost nearer to the correct figure for the consumption of the oil. It meant that majority of the students were able to comprehend the graphical presentation and they were able to communicate approximate consumption of oil.

The categorization of the students' responses indicated that (78.26%) students indicated 1,000 barrels of production of oil which is slightly higher figure for the approximate production of oil by India in the year 2008. (08.69%) students estimated the 750 barrels and (02.17%) student estimated 700 barrels of oil for production of oil which were very nearer to the answer. (10.86%) students mentioned 900 barrels of oil by India in the year 2008. It meant that majority of the students were able to comprehend the graphical presentation and they were able to interpret the approximate production of oil.

Description of the Activity 6b Logical – mathematical and Intrapersonal

The exhaustible and inexhaustible sources of energy were taught. The teacher also explained the scarcity of the sources of energy by drawing the pie chart of countries providing the crude oil to India on the blackboard in the activity 6a. The students also worked on the activity wherein they had to estimate the production and consumption of oil in India in the year 2008. The teacher distributed the activity sheet 6b to the students and discussed the necessity of thoughtful usage of exhaustible sources of energy. The teacher instructed the students to think and write the reasons to complete the incomplete sentences meaningfully. The statements are mentioned as below.

1. I should make thoughtful use of energy sources like…….
2. I should not waste energy sources because my country India has…
3. I will tell my younger brother / sister not to use energy unnecessarily because…
4 I will not use petrol, kerosene unnecessarily because…

The students mentioned that different exhaustible sources of energy such as petrol, kerosene, diesel, natural gas and CNG should be used thoughtfully. Here, it was expected that all students would mention all the exhaustible sources of energy for thoughtful use of energy. But this did not happen because some students mentioned two, three or four exhaustible sources of energy. It meant that students faced difficulty to recall all exhaustible sources of energy.

There were (91.30%) students who mentioned that India has less sources of energy so India has to pay money to other countries to buy sources of energy. They also added that it was difficult to move from one place to another in the absence of sources of energy as automobiles would not run without fuel. They wrote that villages lacked sources of energy and it would be difficult to go to villages by walking to buy vegetables and fruits.

The students provided reasons for telling to their younger sisters or brothers not to use energy unnecessarily were : India had no energy so energy should be used in urgency. Some students responded that energy could be wasted if younger brother / sister would go from one place to other using vehicles. The students gave different answers for not using exhaustible sources of energy such as petrol and kerosene unnecessarily as mentioned here. (17.39%) students reported that it would be difficult to move from one place to another without the availability of sources of energy like petrol. A few other students (06.52%) reported that India has less sources of energy so India has to pay money to other countries to buy petrol, kerosene and diesel. Therefore, one should inform his/her younger brothers or sisters to use sources of energy judiciously. There were total (82.60%) students who reported that there would be a scarcity of the sources of energy in future. It was found that the students comprehended their responsibilities to use sources of energy judiciously. They were also able to express the reasons for the judicious usage of various exhaustible sources of energy.

4.3.6.20 Lesson 12 Light and Its Properties - Topic - Electric Bulb – An Artificial / Manmade Source of Light

Instructional Objective

- Students will give reasons (in their own words) for electric bulb as manmade and an artificial source of light.

Description of the Activity 3 Linguistic

The teacher described briefly the invention of electric bulb by Thomas Alva Edison to arouse interest among students. The teacher asked the questions related to the electric bulb's discovery such as: Who invented the electric bulb? Mention the story of electric bulb in your own words. Why is electric bulb not a natural source of light? The teacher asked them to write a small paragraph on contribution of Thomas Alva Edison in making electric bulb in their own words. It was found that all the students pointed out the repeated trials of Scientist Thomas Alva Edison in inventing the electric bulb. They also appreciated the contribution of Thomas Alva Edison by mentioning that invention of bulb made the people's tasks easy.

4.3.6.21 Lesson 12 Light and Its Properties - Topic - Usefulness of Light in Daily Life

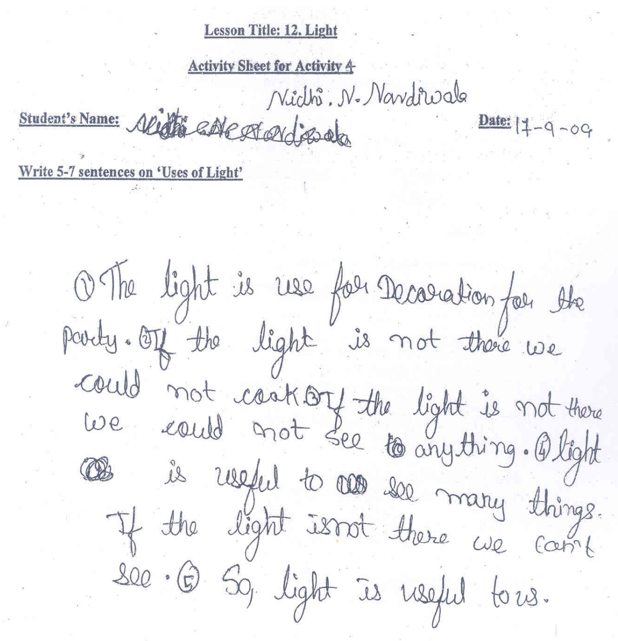
Instructional Objective

- Students will write down 5-7 sentences on the ‘Uses of Light.’

Description of Activity 4 Visual - spatial and Linguistic

It was mind imagery to visualize the scenario of surrounding in the absence of light. The students were asked to write down a paragraph on ‘usefulness of light’. The teacher asked them to describe picture that they imagined about life without light. A student’s sample activity sheet is mentioned in figure 51.

Figure 51 A Student’s Activity Sheet for Uses of Light


Lesson Title: 12. Light

Activity Sheet for Activity 4

Student’s Name: Nidhi. N. Nandiwala Date: 17-9-09

Write 5-7 sentences on ‘Uses of Light’

① The light is use for Decoration for the party. ② If the light is not there we could not cook ③ If the light is not there we could not see anything. ④ light is useful to see many things. If the light isnot there we can't see. ⑤ So, light is useful to us.

The students narrated different uses of light in day-to-day life such as it was necessary to do the homework, to celebrate *‘Diwali’* festival and to find objects. They mentioned that light was used to show traffic signal to avoid accidents, to show the advertisements, to cook, and to study. The students mentioned that light was also used to decorate home, to play, and to see things at night. The responses indicated that the students were able to visualize wide uses of light to mankind and they conveyed usefulness of light by supplying logical reasons.

<u>4.3.6.22 Lesson 12 Light and Its Properties - Topic_- Decoration of *'Diva'*</u>

<u>Instructional Objective</u>

- Students will decorate the '*Diva'* in a group.

<u>Description of Activity 7 Bodily- Kinesthetic, Visual-spatial and Interpersonal</u>

The teacher formed various groups of students. Each group comprised of five students. The teacher announced the aim of the activity and showed them the ideal specimen of a decorated *'diva'* and asked them to observe it. The teacher took round in the class and guided them how to decorate the *'diva'*. The teacher distributed the necessary things such as*'diva'*, glue and other materials for its decoration. The students themselves decided the colour and design for the *'diva'* after taking consent of the group members. They decorated the *'diva'* in groups. The teacher took care that all the students in each group will have equal chance of participation with the help of the group leaders. Then, the teacher collected their decorated *'diva'* and provided feedback to the students. The teacher lighted the decorated *'diva'* and asked them: What does candle give when it is lighted? Where do we use *'diva'* generally? The teacher also discussed the importance of *'diva'* in '*Diwali'* festival, the festival of light and its religious importance. All the students replied that 'diva' and candle give us light. The students indicated that '*diva'* is generally lighted during the days of '*Diwali'* festival which is used for decoration and worshipping the Lord. Photograph 10 shows the decorated 'diva' of the students.

Photograph 10 Decorated '*Diva*' by the students

4.3.6.23 Lesson 4 Let Us Know the Soil - Topic - Usefulness of Soil

Instructional Objective

- Students will give examples of wealth available from the crust of earth.
- Students will give reasons for conservation of the soil.
- Students will colour the pictures of creatures living inside soil.

Description of the Activity 1 Visual-spatial and Logical - mathematical

The teacher showed PowerPoint Presentation (PPT) of various uses of soil such as minerals available from the crust of earth and agricultural uses of the soil. (CD, Folder – Lesson 4, File- Presentation for soil) The teacher asked questions regarding what they saw in PPT and asked them to list various uses of soil in the sequence of slides shown in PowerPoint Presentation. The teacher asked to give reasons for conservation of soil. The students narrated the content of the PPT slides in its sequence. Some students did mistake while recalling. But, they listened what others said and they showed their agreement accordingly. They were surprised to know how a teaspoon accommodated creatures more than world's population. They also explained various uses of soil such as minerals and metals available from the earth's crust to make weapons, machinery and to build houses. They also added that soil was used by farmers to plough and to produce food for mankind. Thereafter, the teacher distributed pictures to the students. (Pictures were taken from (1) http://www.soil-net.com/sm3objects/activities/Colouring_2.pdf and (2) http://www.soil-net.com/sm3objects/activities/Colouring_5.pdf)

The pictures displayed the lines as mentioned below under.

- **Picture 1** Most of our food is grown in soil!
- **Picture 2**. A teaspoon of soil contains more creatures… than there are people on the earth.

The teacher instructed the students to read the sentence mentioned in the picture aloud and colour it. The students were instructed to complete the task at home. The students' work is mentioned in figure 52.

Figure 52 Students' Colouring Work for Soil

4.3.6.24 Lesson 4 Let Us Know the Soil –Topic - Components of the Soil

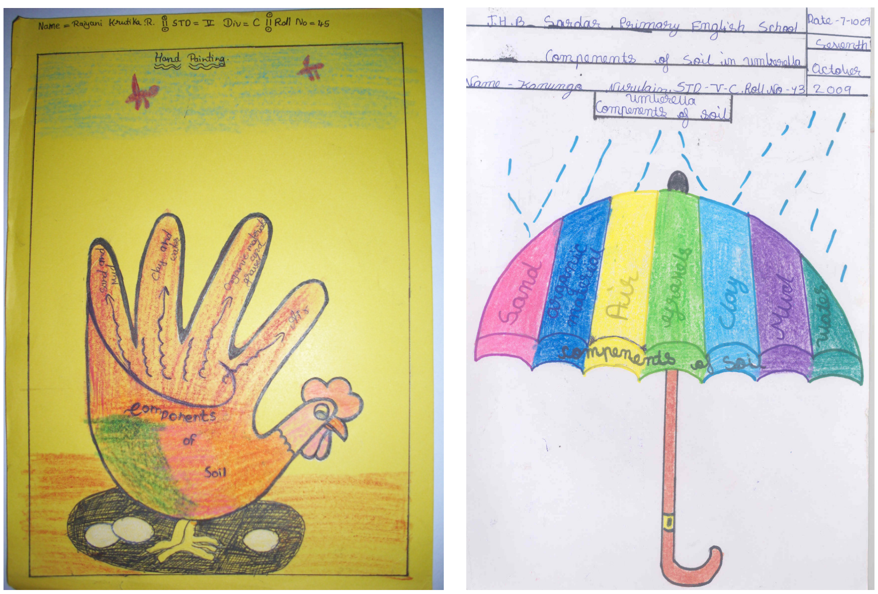
Instructional Objective

- Students will represent the components of soil (gravel, sand, mud and clay) in both - umbrella form of chart and in diagram of hand.

Description of the Activity 5 Visual - spatial

With connection to previous activities, the teacher instructed the students to recall and write the components of soil in two different charts. The first chart included the drawing of umbrella and writing of the components of soil in the strips of it. Another chart was the drawing of the picture of one's own hand and writing each component of the soil in the space of each finger. The activity was initiated by asking the number of components of soil and their names. The chart papers were distributed to the students to draw the schematic representation of the components of soil in both the charts. The specimens of the students' work are mentioned as under in figure 53.

Figure 53 Students' Charts for the Components of Soil



The data of the students' work showed that they mentioned the components of soil such as air, water, and organic material along with gravel, sand, clay and mud. This is because students learnt in earlier activities that air, water/moisture and organic material are present in the soil.

4.3.6.25 Lesson 4 Let Us Know the Soil - Topic - Measurement of Water

Instructional Objective

- Students will explain the process of measurement of water using measuring cylinder.

Description of the Activity 8 Visual - spatial and Musical

Before showing the movie clip (CD, Folder – Lesson 4, File - Measuring volume), the teacher instructed the students to listen to the music carefully and catch the words sung in the song. The teacher showed the movie clip for measurement of liquid using measuring cylinder to the students and asked what they saw in movie clip and what the volume of the liquid was. Small movie clip with the music attracted the students' attention and the students gave correct answer as the figure was quite clear in the movie clip demonstrating the measurement of volume of colourless liquid. The students rightly recalled and identified the apparatus used for measuring liquid. This activity was carried out with connection to the subsequent activity in which the students had to measure the filtration capacity of different soil-samples.

4.3.6.26 Lesson 4 Let Us Know the Soil - Topic - Moisture Holding and Filtration Capacity of Soil

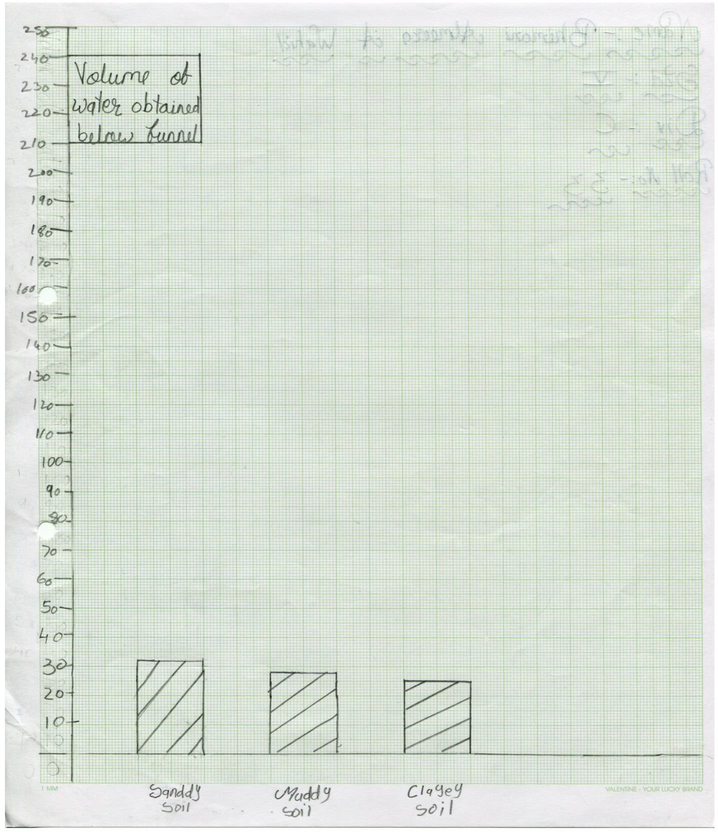
Instructional Objective

- Students will compare the filtration capacity of sandy, muddy and clayey soil.
- Students will infer sandy soil has highest, muddy soil has moderate and clayey soil has the least filtration power.
- Students will draw the bar graph of filtration capacity of soils. (sandy, muddy and clayey)

Description of Activity 9b Logical-mathematical and Visual - spatial

The students drew the graph of filtration capacities of sandy, muddy and clayey soils with difficulty even after the teacher's explanation. The students faced difficulty to count the unit measure of scale on graph to write numbers on both the axes. They drew the bar of the filtrate collected for three samples of soil. But, they made mistake to keep equal distance between two consecutive bars for samples of soil on x-axis. It indicated that they experienced difficulty in understanding that the graph was composed of squares of 1 centimetre. The diagram of the scanned graph is mentioned in figure 54.

Figure 54 A Student's Graph for Filtration Capacity of the Soils



The minute analysis revealed that mostly all the students except a few (08.69%) students, all were able to draw the correct height of the filtrate with regard to Y – axis on repeated explanation provided by the teacher.

4.3.6.27 Lesson 4 Let Us Know the Soil - Topic - Selection of Soil for Agriculture - Purpose

Instructional Objective

- Students will write a letter narrating which soil sample is better for agriculture-purpose on the basis of filtration capacity and organic matter found in soil.

Description of the Activity 9c Musical and Linguistic

It was a letter-writing activity in which the students were supposed to provide scientific reasons for the selection of soil for agricultural-purpose. The teacher motivated the students to sing a song which is mentioned as under. (http://www.songsforteaching.com/earthsciencegeology/soil.htm)

<u>Song on Soil</u>

"All soils have various properties
Like color, texture and fertility
A soil's ability to retain water
Or hold it
Is known as its water capacity
Each of these properties
Play a large role
While determining
A specific type of soil
Topsoil's dark
And rich with organic materials
Like tiny bits of plants and animals
It retains a lot of water... Top soil
So think of it
Like a big kitchen sponge
Sandy soil drains very well
So its water capacity is a bit low
The sandy grains
Don't stick together too well
And contain little organic material
Clay soils are very sticky
And the texture of clay
Is very fine
Mix wet clay and straw
To make adobe
A great building material
If you have the time".

The teacher explained them the letter-writing format including introduction, middle and last section of the letter. The format of letter discussed is mentioned in the figure 55.

Figure 55 A Format of Letter for Soil

Letter Format

What will I tell Farmer Green?

Planning Sheet for My Letter

Introduce myself:

____

____

____

____

Tell him what I think about the field he is interested in buying:

____

____

____

Tell him what I found out about the 3 soil samples:

____

____

Sample 1:__________________

Sample 2:__________________

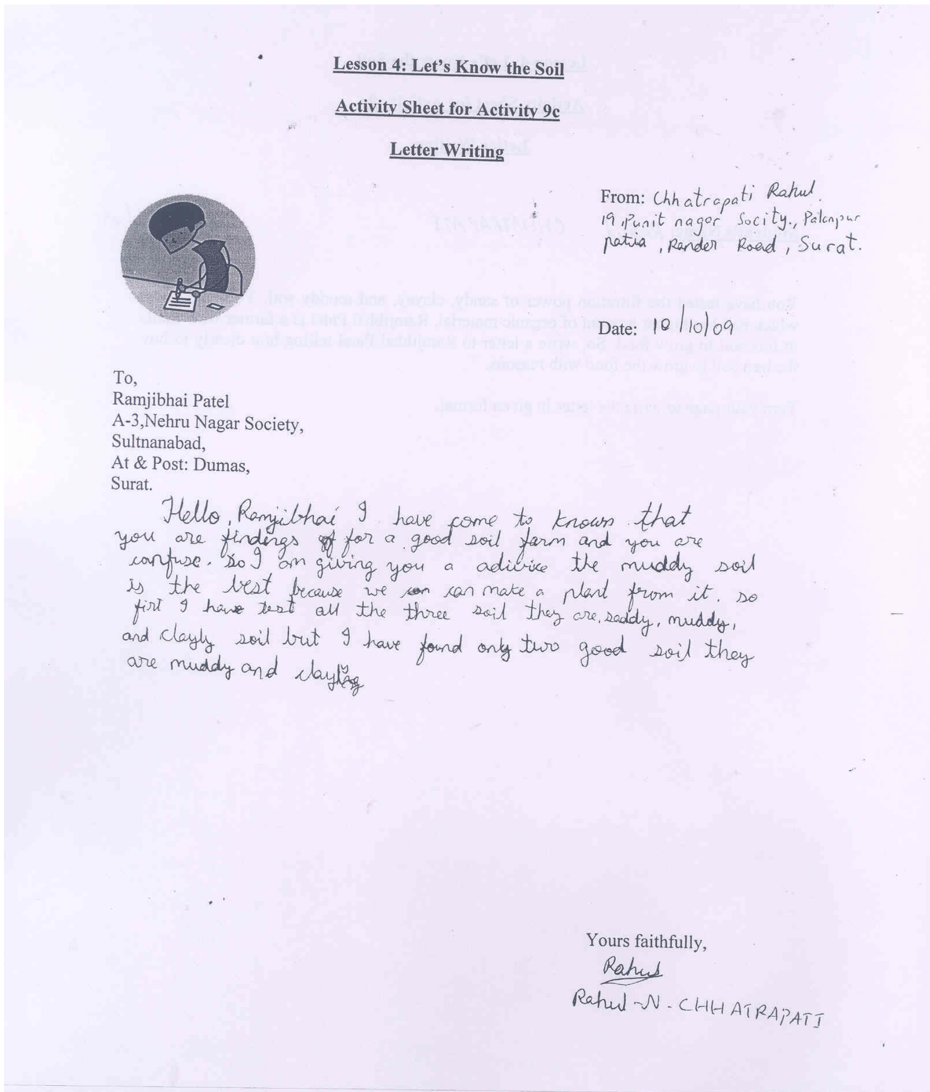
Sample 3:__________________

Following questions were asked to initiate the discussion.

1. Why sandy soil does not hold water on filtration?
2. Which soil contains the highest amount of organic matter?
3. Which soil is the fertile soil?
4. Which soil do you think should be used for growing crop? Why?

A student's sample activity sheet is mentioned in figure 56.

Figure 56 A Student's Letter-Writing for Selection of Soil for Agriculture - Purpose



Lesson 4: Let's Know the Soil

Activity Sheet for Activity 9c

Letter Writing

From: Chhatrapati Rahul.
19, Punit nagar Socity., Palanpur patia, Rander Road, Surat.

Date: 10/10/09

To,
Ramjibhai Patel
A-3,Nehru Nagar Society,
Sultnanabad,
At & Post: Dumas,
Surat.

Hello, Ramjibhai I have come to knows that you are findings ~~of~~ for a good soil farm and you are confuse. So I am giving you a adiwice the muddy soil is the best because we ~~can~~ can make a plant from it. so first I have test all the three soil they are, saddy, muddy, and clayly soil but I have found only two good soil they are muddy and clayly

Yours faithfully,
Rahul
Rahul N. CHHATRAPATI

(45.65%) students wrote that muddy soil had moderate moisture holding power while sandy soil took less time to dry. A few students (13.04%) mentioned that muddy soil had less filtration power. But, they did not mention muddy soil's fertility with reference to a particular soil. (30.43%) students mentioned that the clayey soil should be used for agriculture as it had minimum filtration capacity. The students' writing was not refined as expected and almost half of the total number of students (45.65%) were able to communicate that muddy soil was suitable soil for the farming and agriculture purposes. The coherent knitting of the ideas that the muddy soil was rich in organic matter and had moderate water holding capacity so it should be used for agriculture-purpose was found in very few students' writing.

4.3.6.28 Lesson 6 Water and Its Importance - Topic - Uses of Water

Instructional Objective

- Students will list down the day- to -day usage of water in human life.

Description of the Activity 1 Visual - spatial

The teacher instructed the students to prepare the list of various uses of water. The teacher discussed some of the uses of water in daily life with the pictorial presentation of usage of water on blackboard. Almost all students listed various uses of water at home and they were able to explain uses of water in words appropriately. The students generally indicated various uses of water at home and some students mentioned specific uses of water such as use of water in farming and constructing homes and for existence of life.

4.3.6.29 Lesson 6 Water and Its Importance - Topic - Appreciation of Importance of Water in Daily Life

Instructional Objective

- Students will display the data of usage of water in a table systematically.
- Students will appreciate the uses of water in day to-day life. (By counting quantity of water in tins or buckets)

Description of Activity 2 Logical - mathematical and Interpersonal

This was a group activity. The students in a group of 3-5 were asked to write average usage of water either in tins or buckets for a particular activity by discussion. The students were also instructed to report the total amount of water used by them per day in the activity sheet given. The activity sheet had the following format mentioned in figure 57.

Figure 57 Format of the Activity Sheet for Daily Usage of Water

Lesson 6 Water and Its Importance

Activity Sheet for Activity 2

Group Name: **Date:**
Students' Names:

Discuss with your group members about the daily usage of water. Complete the following table with appropriate data.

Table: Approximate Usage of Water

Activity During Day	How much of water is used? (Write in number of tins or buckets.)
Brushing the teeth	
Toilet	
Bathing	
Cooking	
Drinking	
Washing clothes	
Cleaning vessels	
Cleaning of house	
Plants in garden	
Animals	
Total Amount of water per day	

Only two groups reported usage of water in bucket while the rest of the students reported its use in terms of 'tin'. It was observed from the activity sheets that four groups did not consider the difference between tin and bucket while doing mathematical operation for addition. The rest students displayed the approximate amount of water required in the above daily activities correctly in the activity sheet. The students mentioned that water is very precious as they realized that how much water they are using in various daily activities. They indicated that the use of water should be minimized to avoid scarcity of water.

4.3.6.30 Lesson 6 Water and Its Importance - Topic - Various Sources of Water

Instructional Objective

- Students will write names of various sources of water.

Description of the Activity 3 Visual-spatial

The teacher explained and showed PowerPoint Presentation of various water sources like well, river, lake, hand pump and ocean (CD, Folder – Lesson 6, File- Sources of water). The teacher, thereafter, asked the students to summarize briefly of what they saw. Also, the teacher asked them to give the names of various rivers of Gujarat state. This activity was carried out to help the students to provide names of various sources of water and also to realize them its scarcity. It was observed that almost all the students named various sources of water and except a few students; majority of the students mentioned the names of rivers of Gujarat state namely *Narmda, Tapi, Mahi* and *Sabarmati*.

4.3.6.31 Lesson 6 Water and Its Importance - Topic - Water Cycle

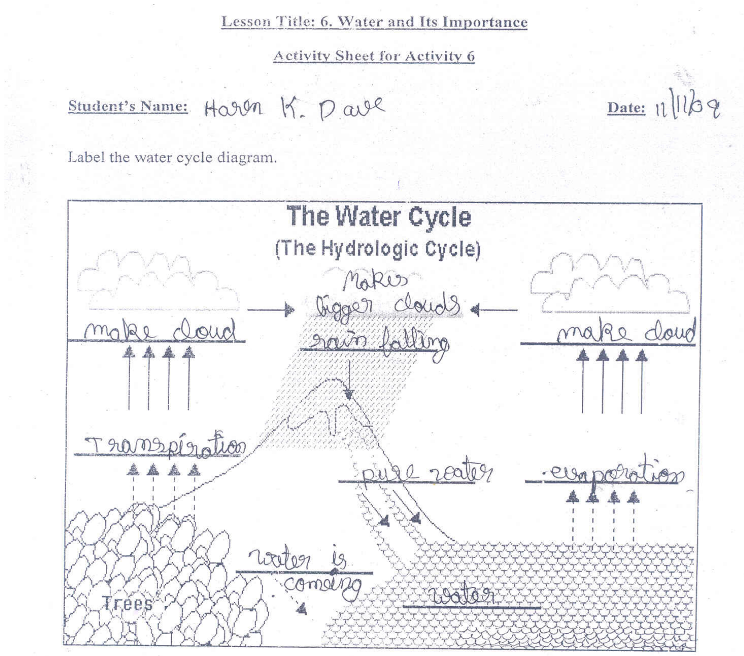
Instructional Objective

- Students will explain water cycle.
- Students will label the diagram of water cycle appropriately.

Description of the Activity 6 Visual - spatial, Logical - mathematical and Musical

The concept of water cycle was explained using two small movie clips (CD, Folder – Lesson 6, File - Cool Water Cycle Song, File - Water Cycle Song). The students were instructed to watch both the movie clips carefully. The teacher encouraged them to hear the song first, and then, sing a song with clapping. The teacher wrote the definitions of evaporation and condensation on the blackboard and explained both the terms by drawing evaporation and condensation of water on blackboard. The students were asked to write the same in their notebooks and were instructed to prepare the chart showing water cycle at home. The teacher gave the activity sheets to the students to label the diagram of water cycle. All students labeled the diagram of water cycle correctly. An example of labeled diagram is mentioned in figure 58.

Figure 58 A Student's Labelling in Water Cycle Diagram



(Source of the above figure:
http://www.enchantedlearning.com/geology/label/watercycle/)

4.3.6.32 Lesson 6 Water and Its Importance -Topic - Formation of Well and Ground Water

Instructional Objective

- Students will explain the creation of well and stream of water.

Description of the Activity 7 Logical-mathematical, Bodily-kinesthetic, Interpersonal and Visual-spatial

The teacher used the brainstorming technique to know what the students thought for the availability of water in well. Questions asked were: In which season does rain fall? Where does the rainwater go?

The teacher drew a picture of mountain showing the flow of rainy water collected at the base of the mountain. The teacher explained that when water gets place to come out, it starts flowing. This is known as stream of water. The teacher showed them the demonstration of ground water formation in a beaker by pouring water in a beaker filled with the gravels and the sand particles. The teacher instructed the students to observe movement of water in gravels and sand particles. The teacher asked them the question: Where did water go in the glass filled with gravels and soil? The teacher explained that rainy water was absorbed by soil in the same way as they observed. The teacher demonstrated the formation of well with the help of students. The teacher formed the groups of students and instructed that a student in a group would add water into a tub filled with the soil. After a few minutes, the teacher asked the students of all the groups to wear plastic gloves and dig soil to make pit in the centre of the tub. After digging by the students, the teacher asked, what did you observe? Why did we get water while digging soil? The teacher gave them the activity sheet wherein they had to find out the path of water in sand particles and gravels by using pencil or sketch pen at home.

Except 3-4 students, none was able to give reasons that water spreads easily in soil and gravels did not withhold water as soil did. They did not tell flow of water went down in soil and formed a stream of water which was found in the form of well while digging. It indicated their low reasoning ability for this activity. The students understood when teacher explained with demonstration again. The students, thereafter, replied sand particles, gravels did not withhold water and small soil particles absorb water. When the teacher asked them to show the path for water, (Water maze game) they asked how many paths could they draw? All the students showed more than one path for water reaching to the bottom in water maze. It indicated that the students succeeded to locate more than single way for the path of water.

4.3.6.33 Lesson 6 Water and Its Importance - Topic - Linking Importance of Water with Personal Life

Instructional Objective

- Students will explain the importance of water in life.
- Students will write a paragraph on 'My life without water.'

Description of the Activity 8 Linguistic, Logical – mathematical, Visual – spatial and Intrapersonal

The teacher discussed the importance of water in physiological processes of body like digestion, excretion, and the circulation of blood. The importance of sea and river to transport heavy goods was also discussed. Other uses of water such as in the paper industry and seed dispersal by water were also discussed. The teacher instructed the students to close their eyes and imagine the scenario of plants, animals and human life in the absence of water. The teacher gave the activity sheets to the students to write a small paragraph on 'My life without water' in 7-8 lines after the discussion. This activity was specifically devised to help the students organize, learn, and present the ideas in a logical manner.

Almost all (95.65%) students reported that the plants and the animals would die without water. All students wrote that they did not get vegetables and fruits to eat so they would not get energy and consequently they would be tired. These responses indicated that almost all the students linked the importance of water for the existence of one's life, the life of plants and animals. It also showed that only (10.86%) students were able to relate the importance of water in other spheres of life such as uses of water in the production of paper and the cleaning of homes, clothes, and utensils. It meant that the majority of the students considered the usefulness of water as a necessity to sustain life. It was because that they learnt water as one of the three basic necessities of life such as air, water and food.

4.3.6.34 Lesson 6 Water and Its Importance - Project Activity - Making of Chart of Water Cycle

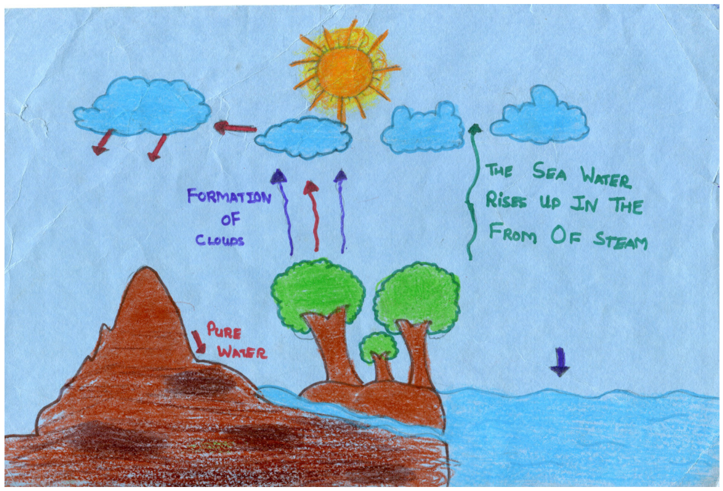
Instructional Objective

- Students will create the chart of water cycle.

Description of Project Activity - Bodily-kinesthetic, Logical - mathematical and Visual-spatial

The teacher also developed the schematic diagram of chart of water bracelet on blackboard. On each bracelet, the teacher wrote the sequence of water cycle. The teacher instructed students to prepare either water cycle bracelet or chart of water cycle. A sample of the student's water cycle chart is mentioned in the figure 59.

Figure 59 Student's Chart of Water Cycle



Photograph 11 shows student holding the water cycle bracelet mentioning the various steps of water cycle.

Photograph 11 A Student Showing the Water Cycle Bracelet

4.3.6.35 Lesson 6 Water and Its Importance - Project Activity - Making Poster Describing the Importance of Water

Instructional Objective

- Students will create the posters describing importance of water.

Description of Project Activity Logical - mathematical and Visual-spatial

The teacher showed one ideal specimen of poster describing the importance of water. The teacher also showed them PowerPoint Presentation of poster showing water conservation (CD, Folder – Lesson 6, File -WATER IS PRECIOUS-posters). The teacher facilitated the group discussion on what types of posters should be made and directed the students to work in group. Following figure 60 shows the student's work that shows how a student demonstrated his understanding to save the water and its importance to the human life.

Figure 60 A Student's Poster for Conservation of Water

4.3.6.36 Lesson 6 Water and Its Importance - Topic_- Water Harvesting Model for Urban Area

Instructional Objective

- Students will create roof top rain water harvesting model through recharge pit for urban area.

Description of Project Activity - Logical - mathematical and Bodily-kinesthetic-Making of Roof Top Rain Water Harvesting Model through Recharge Pit for Urban Area

The teacher discussed scarcity of water and invited students' suggestions for its conservation. Thereafter, the teacher introduced the concept of 'Roof top rain water harvesting through recharge pit for urban area'. The teacher explained that 'Roof top rain water harvesting through recharge pit for urban area' is suitable for buildings having a roof area of 100 sq.m.. The teacher explained the shape and size of recharge pit such as it is constructed 1 to 2 m. wide and 2 to 3 m. deep which are back filled with boulders (5-20 cm), gravels (5-10mm), and coarse sand (1.5- 2mm) in graded form. The teacher further illustrated with the drawing of the recharge pit on the blackboard showing boulders at the bottom, gravels in between and coarse sand at the top. It was also explained that mesh should be provided at the roof to prevent leaves or any other solid waste / debris from entering the pit. Need of a desilting /collection chamber at the ground to arrest the flow of finer particles to the recharge pit was also discussed. The teacher showed them the ideal model for roof top rain water harvesting through recharge pit for urban area and motivated them to create the same model at their homes. Photograph 12 shows a student showing the roof top water harvesting model for the urban area wherein rain water from the terrace is shown to be collected in the recharge pit.

Photograph 12 A Student showing the Roof Top Rain Water Harvesting Model through Recharge Pit for Urban Area

4.3.6.37 Lesson 7 Observation of Living World - Topic - Variation in Leaves

Instructional Objective

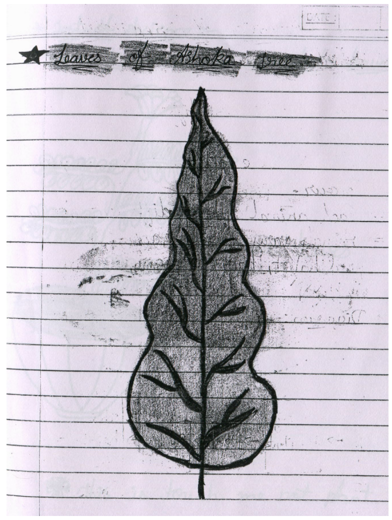
- Students will draw picture of leaves showing minute veins based on their thorough observation.
- Students will differentiate the leaves of a particular plant from the other plants' leaves based on shape, colour and size.

Description of the Activity 3 Naturalist and Visual-spatial

This activity was given to the students to help them to differentiate one plant's leaves from the other. The teacher showed them various leaves of plants which were different in shape, size and colour. The teacher asked the students to select a leaf to draw and colour the picture of leaf in their notebooks. The activity was discussed by the teacher to know what types of differences in various leaves they observed. The students replied various reasons for the differences of leaves. They mentioned that some leaves are long; some are very small in size such as leaves of neem tree. They told some leaves are dark green in colour; some are light green in colour. They also pointed out that the differences in ashoka tree's, mango tree's and neem tree's leaves with regard to their variation in shapes appropriately. Thereafter, the teacher explained them that different plants' leaves vary in colour, shape and size.

It was observed that some students did shading by pencil in drawing of leaf. Almost all the students drew the picture of leaf with tiny and major veins in the leaf. They also drew the shape of leaf in accordance with the original shape of it that was given to them for observation and drawing. A student's drawing of the ashoka tree's leaf is mentioned in figure 61.

Figure 61 A Student's Drawing of Ashoka Tree's Leaf



4.3.6.38 Lesson 7 Observation of Living World – Topic – Colourful Print of Leaves

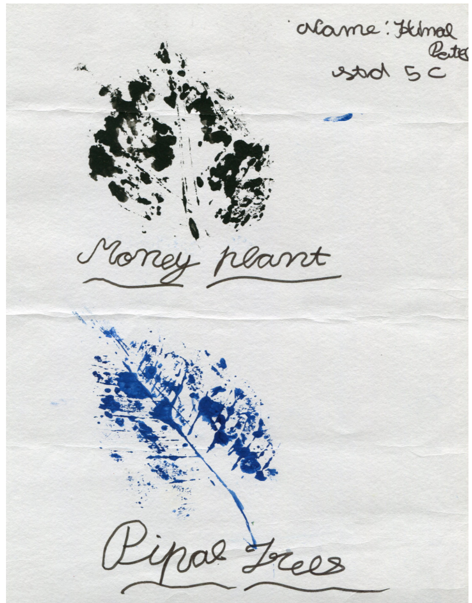
Instructional Objective

- Students will create the colourful print of leaves.

Description of the Activity 4 Bodily - kinesthetic and Visual - spatial

The teacher showed them an ideal specimen of the colourful print of the leaves. The teacher involved the students in showing the entire procedure for creation of colourful print of leaves in class using their water colours. This activity was carried out to help students to make their learning concrete that different plants' leaves vary in shape, colour and size. The teacher, thereafter, distributed chart papers and leaves to the students to do the same activity at home. An example of student's work is mentioned in figure 62.

Figure 62 Colourful Print of the Leaves



It was observed that some students faced difficulty in creating the colourful print for the leaves of '*ashoka'*, mango and '*champa'* trees perfectly.

4.3.6.39 Lesson 7 Observation of Living World - Topic - Creating the Images of Animals

Instructional Objective

- Students will create images of various animals using thumb impression and painting.

Description of the Activity 5 Bodily - kinesthetic and Visual - spatial

The teacher began the activity by asking the students which animal they liked the most and the reasons for the same. The teacher showed them the ideal specimens of prepared pictures of tortoise, cat and dog using the thumb impression and painting method. This activity was given with a view to develop communication skill in the students considering the shapes of the animals and also to arouse their interest to learn in detail about the characteristics of the animals. The students' work is mentioned as under in figures 63.

Figure 63 Colourful Prints of an Elephant

The students were surprised to know that one could colour the picture of animals using thumb and water colours. It was found that the students were good at drawing so, they found the activity easy. Some students (21.73 %) found this activity difficult to prepare the neat and decent pictures of animals.

4.3.6.40 Lesson 7 Observation of Living World - Topic - Usefulness of Plants

Instructional Objective

- Students will make a list of plants with their uses.
- Students will give reasons to conserve plants.

Description of the Activity 6 Visual - spatial and Logical - mathematical

The teacher asked the students to list down the names of the plants that they know. After that, the teacher discussed various uses of plants and drew the schematic diagram showing the same on blackboard simultaneously. The teacher asked the students to draw the same diagram in their notebooks by adding some new uses if they knew. The other learning experience was provided to the students was the provision of information of various plants of medicinal values (such as liquorice, *pushkar mul,* tylophora asthmatica, *ardusi, brambhi)* other than ginger, basil and bitter gourd. The teacher showed some herbs like liquorice, *pushkar mul*, leaves of neem, basil, tylophora asthmatica, *ardusi, brambhi* which are used as ayurvedic medicines. The students in a group observed the specimens of medicinal plants. The teacher developed the schematic diagram of medicinal uses of the plants with the help of the students.

It was observed that all the students listed down various uses of plants to conserve the plants. Some of the students also indicated the use of ginger, basil in the preparation of tea and the use of bitter gourd to treat malaria. Students' schematic diagrams for uses of plants and plants used as medicines are mentioned in figures 64 and 65 respectively.

Figure 64 A Student's Schematic Diagram of Uses of Plants

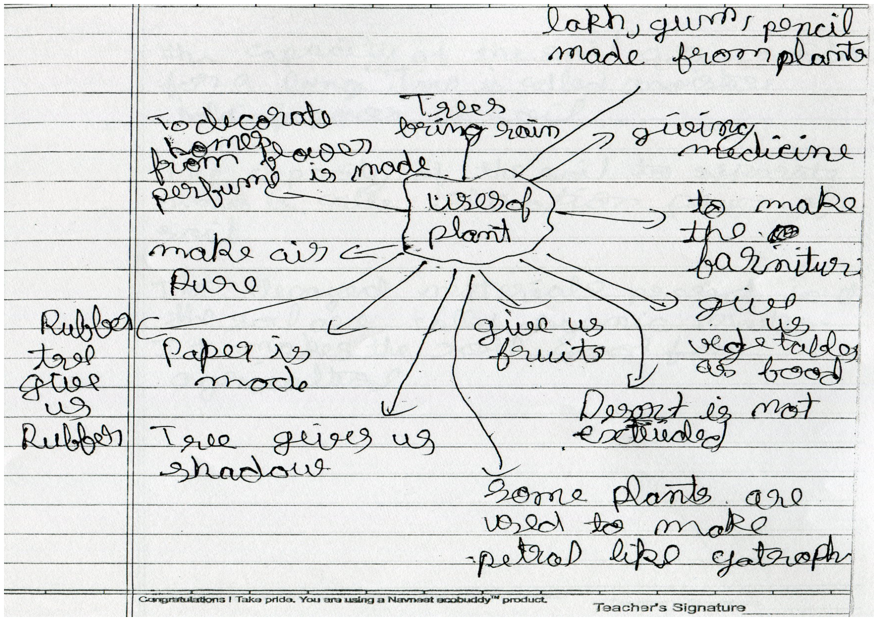
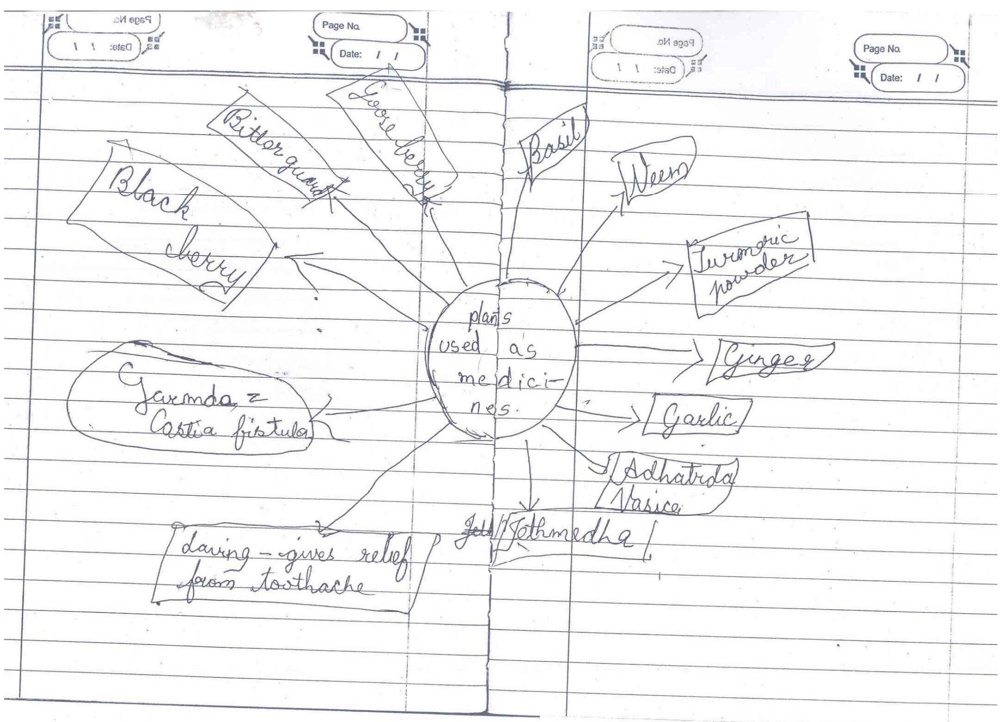


Figure 65 A Student's Schematic Diagram of Plants Used as Medicines



4.3.6.41 Lesson 7 Observation of Living World - Topic - Usefulness of Small Insects

Instructional Objective

- Students will explain the utility of white ant (termite), earthworm and honeybee for human beings.

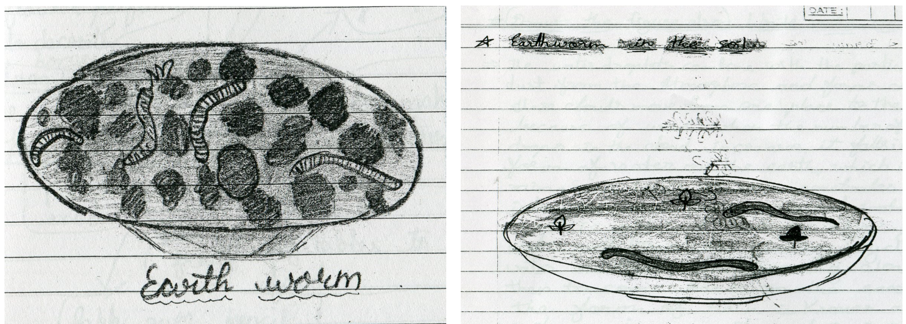
Description of the Activity 7 Naturalist, Visual - spatial and Musical

The teacher showed earthworms moving in the lump of soils kept in a plastic dish. The students were instructed to observe carefully to notice the colour, size, shape of the earthworm and its body. The teacher asked the students to draw the picture of earthworm in their notebooks. The activity was preceded by showing PPT (PowerPoint Presentation) of the small insects such as honey bee, white ant and termite including their uses. (CD, Folder- Lesson 7, File- INSECTS1). The small movie clip of honey bee was also shown to the students. (CD, Folder- Lesson 7, File- dance of honey bee). The uses of honey bee and earthworm were discussed. The students were encouraged to write small song on honey bee which they sang in the class too. Photograph 13 shows the students observing earthworm.

Photograph 13 Students Observing Earthworm

The students drew the picture of earthworm with the minute circular marks over its body. It was found that almost all the students noticed the shape, size and small lines over earthworm's body. Their pictures of earthworm were as relevant as in reality. The two students' drawings of earthworm are mentioned as under in figure 66.

Figure 66 Students' Drawing of Earthworm



Some of the students took initiative for writing a song on honey bee which is mentioned below.

<u>Song Composed by the Students</u>

<u>A Song on Honeybee</u>

Honey Bee, Honey bee. (2)

You are wonderful. (2)

You make sweet tasty honey. (2)

I like your dance. (2)

They sang the song with clapping. The song lines indicated the uses of honeybee. It indicated that the students were able to communicate the characteristics of honeybee. The students also explained that termite (while ant) and earthworm make the soil soft by doing the work of cultivation. The students communicated that honey bee provides honey that is used for medicinal purpose.

4.3.6.42 Lesson 7 Observation of Living World - Topic - Usefulness of Animals

Instructional Objective

- Students will write the uses of animals.
- Students will give reasons to conserve animals.
- Students will give reasons in their own words to ban the exploitation of animals for entertainment purpose.

Description of the Activity 8 Naturalist, Logical - mathematical, Intrapersonal, Visual-spatial and Musical intelligence

The teacher asked the students to prepare the list of animals along with their uses. The movie clip depicting the cruelty against animals by man was shown by the teacher. The discussion focused on how they felt if someone behaved in the same way as they saw cruelty to animals in movie clip (CD, Folder- Lesson 7, File- Circus Animal Cruelty Abused for Entertainment). The teacher showed them the movie clip of animals (CD, Folder- Lesson 7, File- Animals singing) and asked them which sentence they heard often.

All the students mentioned that sweaters are made from animals' wool. They indicated that various leather items such as jacket, belt, and shoes are made from animals' skin. They mentioned that cow, buffalo and goat give milk. The students further added that ox, camel, horse and elephant are useful to pull heavy loads in country like India. The students said that animals are living and they also had the right to live in the forest. They mentioned that animals experience pain when they are beaten. They gave reasons that animals should never be caged to perform activities in circus. They also mentioned that man should not kill the animals for getting fur and tusks (of the elephants). It was found that the students were able to put their ideas logically to communicate various reasons for stopping cruelty. Thus, they expressed love towards animals.

4.4 Analysis of Opinionnaire Data

The objective 4 was *"to study the opinion of experimental group students for implemented instructional strategy for learning science based on the theory of Multiple Intelligences"*.

Opinionnaire was a three point scale - 'Agree', 'Cannot Say', 'Disagree'. Frequencies of the students' responses were counted for all three above mentioned categories for a total of thirty-two statements in the opinionnaire and were represented in percentages. The intelligences' specific statements were randomly arranged in the opinionnaire. For analysis, statements for a particular intelligence were arranged together and percentage analysis is mentioned as under. Numbers in bracket in all noted tables below indicate the percentage of the students. Numbers mentioned without the brackets indicate the number of the students who opined particular response.

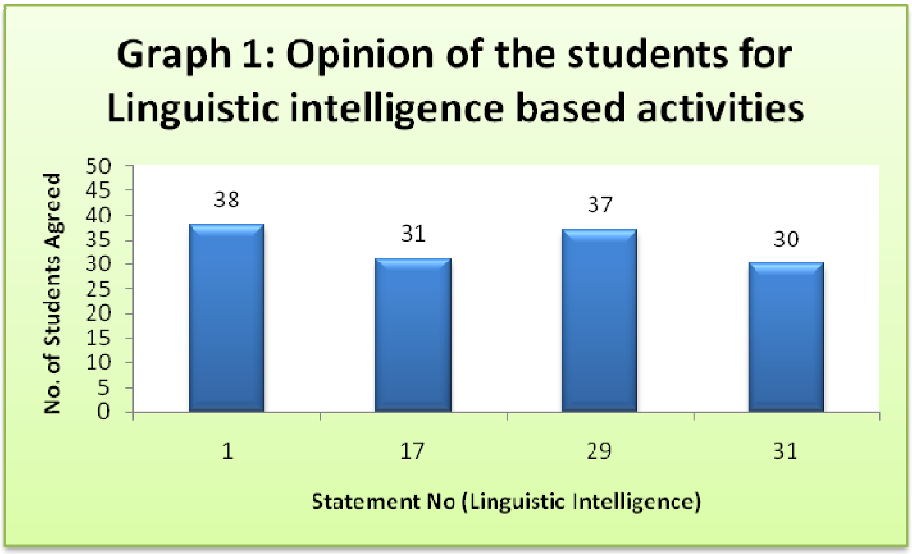
4.4.1 Opinion of Students for Linguistic Intelligence based Activities

The statements related to linguistic intelligence were sequenced in the opinionnaire on numbers- 1, 17, 29 and 31. The table 24 indicates the opinion of students for linguistic intelligence based activities.

Table 24 Opinion of Students for Linguistic Intelligence based Activities

Sr. No.	Linguistic Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 1:** Paragraph writing activity in science improved writing skill.	38 (82.60%)	05 (10.86%)	03 (06.52%)
2.	**Statement 17:** Writing conclusion / inference in the activity sheet was useful in arriving at common understanding.	31 (67.39%)	11 (23.91%)	04 (08.69%)
3.	**Statement 29:** The activity of finding words from word-block increased curiosity to learn new words in science.	37 (80.43%)	07 (15.21%)	02 04.34%)
4.	**Statement 31:** I could express what I learnt in science when I wrote answers in the activity sheet.	30 (65.21%)	11 (23.91%)	05 (10.86%)

Opinion of the students for linguistic intelligence based activities is presented in Graph 1 mentioned as under.



The higher level of agreement among the students for the linguistic intelligence based activities (Table 24 and Graph 1) indicated that the students preferred word games, writing answers and small paragraphs on concepts of science in the activity sheets. The students also opined that they were able to express in words what they wanted to convey. It indicated that writing answers, small paragraphs and learning by means of word games also helped them to understand the concepts of science and enabled them to express their understanding of the concepts of science in their own words. It led to infer that such activities appealed and engaged students in learning science.

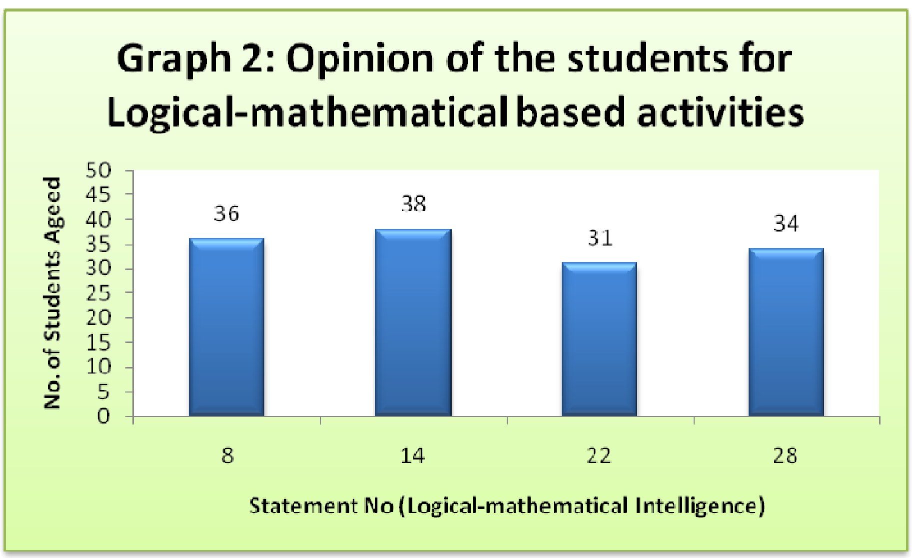
4.4.2 Opinion of Students for Logical-mathematical Intelligence based Activities

The statements related to logical-mathematical intelligence were sequenced in the opinionnaire on numbers - 8, 14, 22 and 28. The table 25 indicates the opinion of students for logical-mathematical intelligence based activities.

Table 25 Opinion of Students for Logical-mathematical Intelligence based Activities

Sr. No.	Logical-mathematical Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 8:** Measuring height of plants made me relate plants as living.	36 (78.26%)	05 (10.86%)	05 (10.86%)
2.	**Statement 14:** Writing characteristics of the living and the non-living in two overlapping circles were helpful to understand differences between living and non-living.	38 (82.60%)	05 (10.86%)	03 (06.52%)
3.	**Statement 22:** Questions asked in science class made me think step by step.	31 (67.39%)	11 (23.91%)	04 (08.69%)
4.	**Statement 28:** Interpreting graphical data was useful in learning science.	34 (73.91%)	06 (13.04%)	06 (13.04%)

Opinion of the students for logical-mathematical intelligence based activities is presented in graph 2 mentioned as under.



The students' opinion as shown in table 25 and graph 2 showed majority of the students preferred logical-mathematical intelligence specific activities. Such activities included the appropriate use of graphic organizer such as Venn-diagram, question to promote inquiry, and interpretation of graphical data. These logical-mathematical intelligence specific activities made students think and helped them to explore the concepts of science. Various activities to measure height of plants and length of the textbook and cloth, width of the desks provided opportunity to the students to apply knowledge in new situation. These activities aroused interest in learning science and encouraged them to learn. Thus, learning science became meaningful. The opportunities offered to students to use logical thinking ability made their comprehension of concepts of science easy eliminating the scope of cramming.

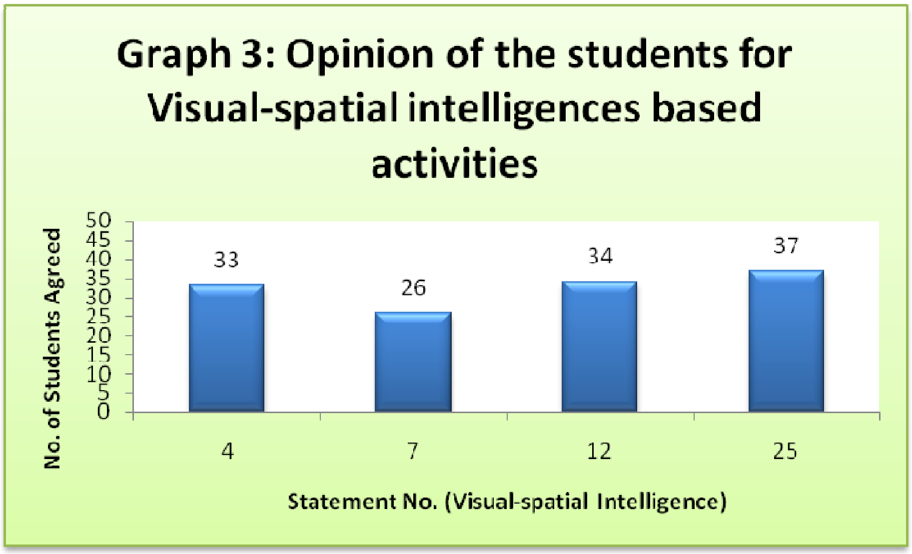
4.4.3 Opinion of Students for Visual-spatial Intelligence based Activities

The statements related to visual-spatial intelligence were sequenced in the opinionnaire on numbers - 4, 7, 12 and 25. The table 26 indicates the opinion of students for visual-spatial intelligence based activities.

Table 26 Opinion of Students for Visual-spatial Intelligence based Activities

Sr. No.	Visual-spatial Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 4:** Drawing germinated seeds, plants, and earthworm helped to observe carefully.	33 (71.73%)	10 (21.73%)	03 (06.52%)
2.	**Statement 7:** Observing things in reality was useful to understand the important concepts in science class.	26 (56.52%)	15 (32.60%)	05 (10.86%)
3.	**Statement 12:** Exercise to think in images gave new ideas.	34 (73.91%)	08 (17.39%)	04 (08.69%)
4.	**Statement 25:** Watching movie clips and PowerPoint Presentation helped to visualize concepts of science.	37 (80.43%)	05 (10.86%)	04 (08.69%)

Opinion of the students for visual-spatial intelligence based activities is presented in graph 3 mentioned as under.



From the table 26 and graph 3, it was noted that observation tasks followed by drawing pictures, exercise to think in images, use of movie clips and PowerPoint Presentations assisted majority of the students to visualize the abstract concepts of science. Such visual-spatial intelligence based activities helped them to link new knowledge effectively with the prior one making the concepts of science clearer and easier. 56.52% students opined that observing things in reality helped them to understand the important topics of science. Lower level of agreement may be attributed to the fact that students in earlier classes had no such exposure. Although students were curious and excited, it was difficult for them to link it with previous learning. The use of PPTs (PowerPoint Presentations) and movie clips helped the students to visualize and led them to generate new ideas in science strengthening their learning in effective way. Majority of the students opined favourably on the above noted visual-spatial intelligence specific statements.

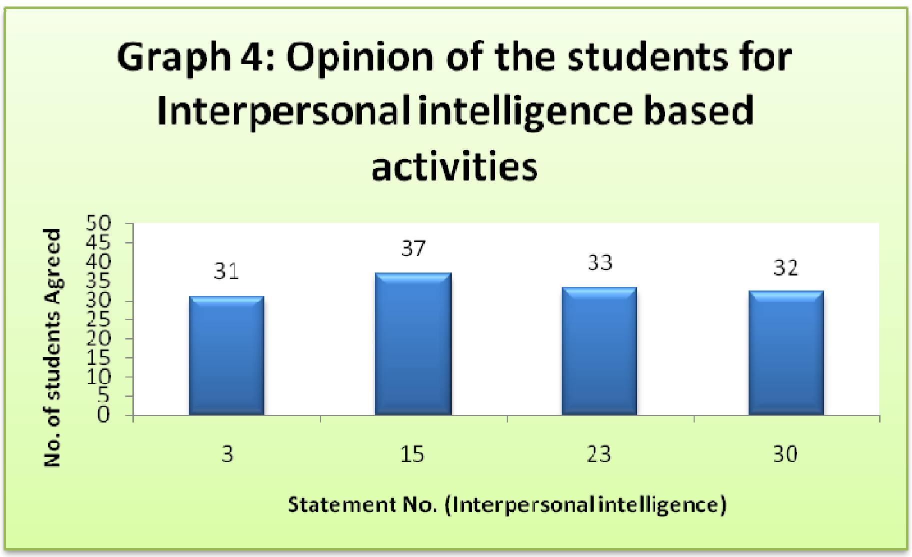
4.4.4 Opinion of Students for Interpersonal Intelligence based Activities

The statements related to Interpersonal intelligence were sequenced in the opinionnaire on numbers 3, 15, 23 and 30. The table 27 indicates the opinions of students for interpersonal intelligence based activities.

Table 27 Opinion of Students for Interpersonal Intelligence based Activities

Sr. No.	Interpersonal Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 3:** Group activity helped in generating new ideas in science.	31 (67.39%)	06 (13.04%)	09 (19.56%)
2.	**Statement 15:** Activities in group were beneficial in learning science.	37 (80.43%)	04 (08.69%)	05 (10.86%)
3.	**Statement 23:** Discussion in peer groups helped in clarifying concepts in science.	33 (71.73%)	06 (13.04%)	07 (15.21%)
4.	**Statement 30:** By working in a group helped me know my classmates closely.	32 (69.56%)	08 (17.39%)	06 (13.04%)

Opinion of the students for interpersonal intelligence based activities is presented in graph 4 mentioned as under.



The table 27 and graph 4 showed that group activities to solve problem, writing a small paragraph or answers based on discussion in groups, and doing activities in groups were proved useful as such activities generated thinking among the students. The students were able to share their experiences, ideas which led them to understand the concepts. The group discussion helped (67.39%) students to arrive at proper understanding of the concepts of science which covered slightly more than 50% of the students. 69.56% students opined that the discussion in peer groups helped them to know their classmates closely which also covered a little more than 50% of the students. It meant that learning from group members helped them to acquire proper understanding of science. Therefore, the students perceived participation in group activities as useful to them.

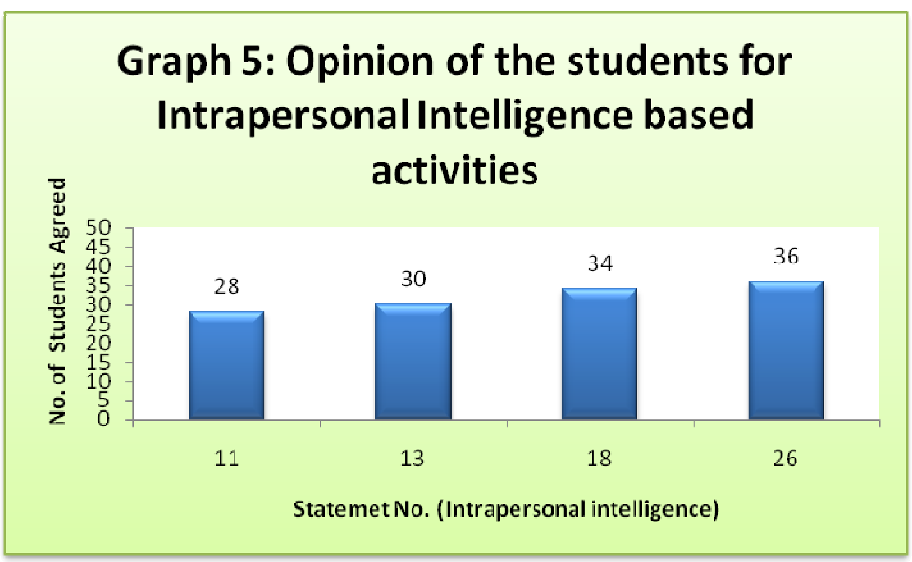
4.4.5 Opinion of Students for Intrapersonal Intelligence based Activities

The statements related to Intrapersonal intelligence were sequenced in the opinionnaire on numbers 11, 13, 18 and 26. The table 28 indicates the opinion of students for intrapersonal intelligence based activities.

Table 28 Opinion of Students for Intrapersonal Intelligence based Activities

Sr. No.	Intrapersonal Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 11:** Knowledge of oneself was useful to develop interest in science.	28 (60.86%)	11 (23.91%)	07 (15.21%)
2.	**Statement 13:** Writing about my own understanding in science class was useful to focus my attention on important concepts taught.	30 (65.21%)	12 (26.08%)	04 (08.69%)
3.	**Statement 18:** I could understand science clearly when I had to relate science topic with myself.	34 (73.91%)	08 (17.39%)	04 (08.69%)
4.	**Statement 26:** Writing a daily log was useful to correct my mistakes in science class.	36 (78.26%)	05 (10.86%)	05 (10.86%)

Opinion of the students for intrapersonal intelligence based activities is presented in graph 5 mentioned as under.



It was apparent from the table 28 that (60.86%) students opined that knowledge of oneself was useful to develop interest in science. The lower level of agreement could be explained to less developed intrapersonal intelligence among the students. It meant that there should be more curricular input apart from teaching of science to develop intrapersonal intelligence of the students. (65.21%) students preferred writing about their own understanding in science which covered a little more than (50%) of the students. These (65.21%) students opined that writing about their own understanding in science was useful to focus their attention on important concepts of science. Majority of the students (78.26%) welcomed the activity of daily log writing. The daily log writing activity also helped students to know their mistakes and to improve their behaviour in science class. The daily log writing made science learning effective and understandable for the students. Activities such as relating science topics with themselves and reflecting on one's own understanding in science class made comprehension of science concepts easy as they could relate these with their lives.

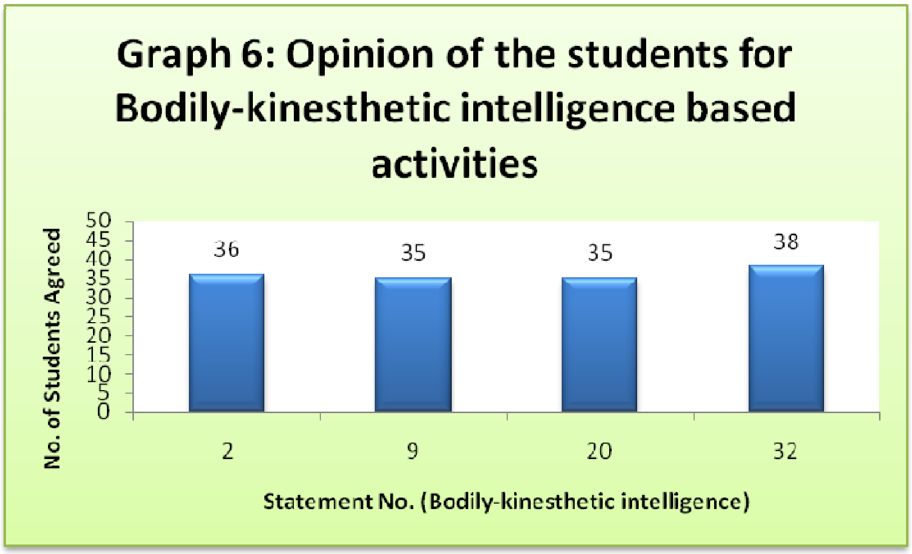
4.4.6 Opinion of Students for Bodily-kinesthetic Intelligence based Activities

The statements related to bodily-kinesthetic intelligence were sequenced in the opinionnaire on numbers 2, 9, 20 and 32. The table 29 indicates the opinion of students for bodily-kinesthetic intelligence based activities.

Table 29 Opinion of Students for Bodily-kinesthetic Intelligence based Activities

Sr. No.	Bodily-kinesthetic Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 2:** Breathing in and out and physical exercises made me ready to learn science.	36 (78.26%)	05 (10.86%)	05 (10.86%)
2.	**Statement 9:** I could draw the path of light when I arranged the cardboards in a specific way.	35 (76.08%)	09 (19.56%)	02 (04.34%)
3.	**Statement 20:** Doing experiment myself was useful in understanding basic science topics.	35 (76.08%)	05 (10.86%)	06 (13.04%)
4.	**Statement 32:** Model making was useful activity in understanding concepts in science.	38 (82.60%)	04 (08.69%)	04 (08.69%)

Opinion of the students for bodily-kinesthetic intelligence based activities is presented in graph 6 mentioned as under.



The table 29 and graph 6 suggested that the majority of the students considered physical exercises to relax and take break in science class including the activities of small scale experiments, making of small models, and arrangement of apparatus to conduct experiments were effective in science learning. The students of this age are physically very active and they do not prefer to sit quietly and act as passive learners. Such characteristics of students of this age when aptly focused for their learning experiences, the students could develop interest in learning science.

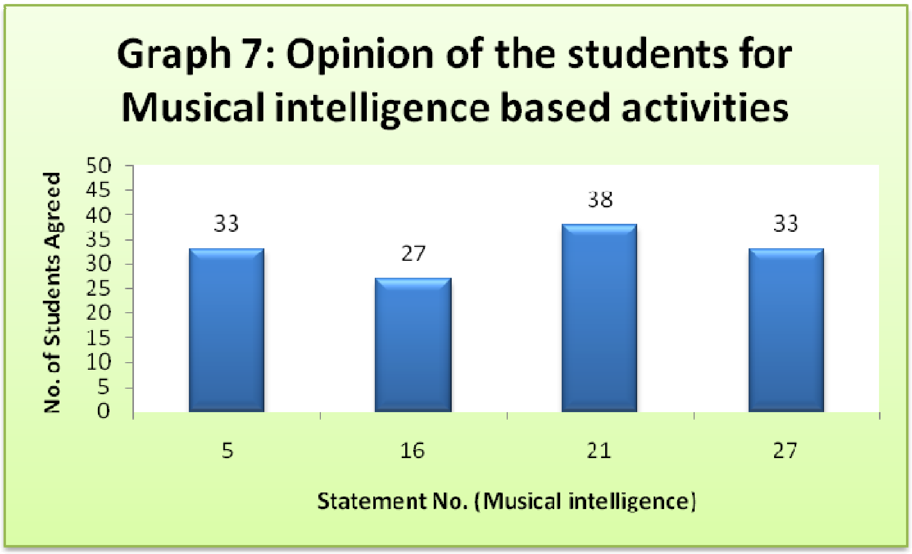
4.4.7 Opinion of Students for Musical Intelligence based Activities

The statements related to musical intelligence were sequenced in the opinionnaire on numbers 5, 16, 21 and 27. The table 30 indicates the opinion of the students for musical intelligence based activities.

Table 30 Opinion of Students for Musical Intelligence based Activities

Sr. No.	Musical Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 5:** Listening music of movie clips related to science increased my interest to learn science.	33 (71.73%)	08 (17.39%)	05 (10.86%)
2.	**Statement 16:** Singing songs with clapping was useful to remember science topics easily.	27 (58.69%)	08 (17.39%)	11 (23.91%)
3.	**Statement 21:** Learning science was enjoyable when I heard the songs of science clips.	38 (82.60%)	06 (13.04%)	02 (04.34%)
4.	**Statement 27:** Encouragement provided by the teacher to sing the songs helped me to remember important science topics.	33 (71.73%)	09 (19.56%)	04 (08.69%)

Opinion of the students for musical intelligence based activities is presented in graph 7 mentioned as under.



The students' responses to musical intelligence specific activities mentioned in table 30 indicated that (58.69%) students enjoyed learning science by singing song. The reason for the lower number of students for the agreement on the statement-16 can be explained that not all the students had musical intelligence as one of the dominant intelligences. On the other hand, majority of the students preferred listening music and songs in movie clips related to science. Majority of the students also found the teacher's encouragement to sing songs as useful to remember the important science topics in the class. The students found science class interesting whenever their musical intelligence was addressed. This meant that use of music also facilitated the understanding of concepts of science. It could be stated that learning experiences covering music evoked the interest among students to learn and thereby, they opined in favour of musical intelligence specific statements in the opinionnaire.

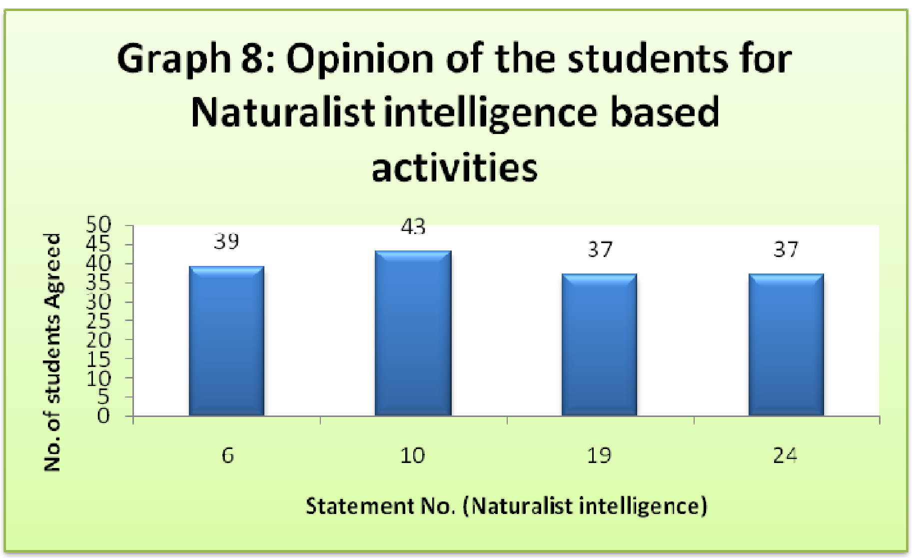
4.4.8 Opinion of Students for Naturalist Intelligence based Activities

The statements related to Naturalist intelligence were sequenced in the opinionnaire on numbers-6, 10, 19 and 24. The table 31 indicates the opinion of students for naturalist intelligence based activities.

Table 31 Opinion of Students for Naturalist Intelligence based Activities

Sr. No.	Naturalist Intelligence Specific Statement	Agree	Cannot Say	Disagree
1.	**Statement 6:** I could realise that plants are living when I touched the 'touch-me-not plant'.	39 (84.78%)	03 (06.52%)	04 (08.69%)
2.	**Statement 10:** I felt to take care of animals after watching the movie clip of circus.	43 (93.47%)	02 (04.34%)	01 (02.17%)
3.	**Statement 19:** Activities to observe germination in onion and *mung* seeds were helpful to understand growth of plants.	37 (80.43%)	05 (10.86%)	04 (08.69%)
4.	**Statement 24:** I could understand differences in plants when I observed different leaves.	37 (80.43%)	08 (17.39%)	01 (02.17%)

Opinion of the students for naturalist intelligence based activities is presented in graph 8 mentioned as under.



The table 31 and graph 8 indicated that majority of the students liked those activities which offered them opportunity to touch the plants, to observe the growth of seeds and plants, and to study the differences in the living world. They also liked the movie clip of circus in which they saw cruelty against animals which sensitized them to express love and compassion for animals. Such learning experiences helped students to learn the characteristics of the plants and animals, kindled interest and curiosity among the students to study plant and animal kingdom. It was, therefore, the students opined positively in favour of naturalist intelligence specific statements.

It can be concluded that the standard V students enjoyed MI based instructional strategy for learning science. It could be further stated that the students preferred various activities addressing their multiple intelligences depending upon the scope of the content and as per their age and interest. The use of science movie clips, PowerPoint Presentations (PPTs), songs, word block game, graphic organizers, hands-on experiences, and opportunities to use science process skills developed interest towards learning science and motivated them to learn science. The same finding was further confirmed based on the findings of focus group interview data.

4.5 Analysis of the Focus Group Interview Data

The focus group interview was conducted in the same school to know standard V students' views about the implemented designed MI based instructional strategy for teaching science. The students' experiences / views for designed MI based instructional strategy were categorized under three major headings such as (1) Opinion of the students for the designed MI based instructional strategy (Includes organization, and sequencing of learning experiences, components), (2) Opinion of the students regarding their experiences related to designed MI based instructional strategy, and (3) Opinion of the students regarding the impact of designed MI based instructional strategy and suggestions to improve science teaching (Effect observed in terms of achievement in science and other effects observed during the implementation of designed MI based instructional strategy).

4.5.1 Opinion of the Students for Instructional Strategy based on the Theory of Multiple Intelligences

The students opined that activities created curiosity to know how they will do activities and learn. They also opined that they wanted to know more about plants, animals, seed germination, soil and energy because they enjoyed learning in science. The students mentioned that they got adequate time to respond to the query, to draw, to represent their ideas into written form and to do different activities. They mentioned that they waited for the science class and they were eager to see what the science teacher will show and what new experiences or activities they will be asked to do. These showed the gradual development of interest among students for learning science. They told that they enjoyed when they did activities by observing, measuring, and experimenting. The students started telling 'good', and 'I enjoyed' during discussion. It meant that the students preferred designed MI based instructional strategy for learning science. The students opined that learning science by various activities made concepts of science easy and helped them to write in examination. These led to infer that whatever activities selected, acted as motivator for the students. The opinion of the students indicated that working in groups, use of PowerPoint Presentations (PPT), movie clips, storytelling, singing songs, projects, and small experiments facilitated the exploration of facts of science by thinking. It was also explored during the group discussion that the students perceived designed MI based instructional strategy as pleasurable learning experience due to daily log-writing, one-minute reflection period, movie clips, songs and hands-on experiences. This clearly indicated that the students identified designed MI based instructional strategy interesting to learn and was relevant as per their age. The students mentioned that they wanted to learn in MI way by the next academic year which supported their wider acceptance to MI based instructional strategy for teaching science at standard V. These led for the inference that learning experiences were properly chosen, relevant, and tailored.

4.5.2 Opinion of the Students regarding their Experiences related to Instructional Strategy based on the Theory of Multiple Intelligences

The students perceived receiving of the activity sheets for the first time in science class differently as they shared feelings such as anxiety, excitement, anger, dislike for writing and a welcoming approach too. Some remarks made by students were as under.

"I felt good when Praful sir gave sheet and Praful sir is teaching well."
"I feel very good when you give sheet for the first time I had some difficulty but you solved. You are giving chance (to write) in activity sheet."

The students' remarks indicated that they liked to write in the activity sheets and they were delighted. The students opined that earlier they felt difficulty as they had to listen, observe, sing, do some activity, think and then write. As per their views, their participation in activities became easy and they were able to learn when they followed the instructions given and listened what the science teacher communicated.

A few students mentioned that it was unthinkable that science teaching could be taught using different types of activities. Pleasant and memorable experiences of the students were: creation of cloud in jar, drawing of earthworm based on observation, PPTs and movie clips on water cycle, honey bees, dispersal of seeds, herbivores, carnivores, historical story of measurement units in length using PPT, the realia of the tailor bird's nest, the activity of sieving soil to study the composition of the soil, and the experiment to prove that air was present in the glass. The students clearly mentioned that they experienced sympathy for animals when they watched the movie clip which depicted the cruelty to animals in circus. The students expressed their views that watching the movie clip describing cruelty to animals in circus stirred their hearts. The making of water-harvesting model for urban area, project activity on packaged food, and the making of windmill model were perceived as difficult. But, they mentioned that they enjoyed as they were able to do these difficult activities. The students' remarks mentioned as under indicated that they liked the making of wind-mill model.

"When house was made (Water harvesting model to conserve the water), it was time consuming and was difficult also."

"We liked activity of making of windmill."

Different activities taught using group discussion were considered very good experiences of learning from peers. The students felt the experiment of seed germination to check the occurrence of germination of seeds at different points of scale in water and the experiment to find out the filtration capacity of different types of soil, and drawing the graph for the same were a bit difficult. They also told that they faced difficulty while preparing pictures of animals using thumb impression and obtaining coloured prints of leaves. Initially, it was found that that they felt writing daily log a difficult activity. It also emerged from the group interaction that writing of their goals for the science class was a bit difficult for the students. It was found that they understood the utility of writing daily log in learning science with the passage of time as they were interacting with such new experience for the first time. The students expressed that working in group was difficult for them in the beginning due to within group conflicts such as all wanted to write in the activity sheet for they considered writing in the activity sheet in group work was the most rewarding task. Below noted students' remarks suggested that they faced difficulty in some of the activities but they managed to do the activity with the help of their peers, and parents.

"When we were asked to perform the experiments, I faced difficulty, my friends were also not there as thumb impression (activity for animals) was time consuming and my mother was also not allowing me to use water color. So I promised mother that nothing will be spoiled."

"All these activities were helpful in the science examination. I recalled the experiment in examination and I got the answer so I felt very happy."

Thus, it can be said that though the students felt a few activities a little difficult but they preferred performing them and found learning science pleasurable. The students further added that they learnt to plot the graph for filtration capacities of different types of soil and to interpret it. Such activity made science learning easy for them. The students opined that listening to others' views in group activity proved to be useful for them. As per the students' view, the thinking in images, recalling the topics that they learnt, one minute reflection, the story of *'Akbar and Birbal depicting who is the brightest?',* and creating animals' picture using thumb impression method made science learning easy and interesting. The activities of measuring such as to measure the length and width of the cloth and desk, the height of plants, different movie clips with music and songs, the food-pyramid showing what to eat and what not were considered as very good activities by the students. They were enthusiastic in doing activities such as the project to study the effects of acidic solution over plants, the experiment to study the respiration in plants and the activity to study the effects of sunlight over plant's leaves. Some students were of the view that their handwritings were improved by writing in the science class. It can be said that the students felt joy by doing and observing the teacher's demonstration.

4.5.3 Opinion of the Students regarding the Impact of Instructional Strategy based on the Theory of Multiple Intelligences and Suggestions to Improve Science Learning

The students mentioned that active involvement in various activities led them to explore by doing experiments and projects, singing, observing, listening, drawing and working in groups. They further added that such an active engagement was very useful to them for recalling what they had learnt. The students mentioned that the teacher's encouragement to sing the songs also facilitated their comprehension of subject matter in science and they could remember concepts of science easily. It meant that the students gained confidence to write in examination. The students mentioned that they were tuned to the activities of one-minute reflection, thinking in images and thinking with closed eyes with focus on a particular colour. They used the same techniques while taking examination to make their minds calm to recall answers. They also mentioned that they learnt to understand the instruction first before responding. They wrote the answers after thorough understanding of the instructions and the questions asked in the test.

Students mentioned that they did the experiments at their homes and they shared the result with their friends which indicated their increased motivation and curiosity. Different activities such as which object/substance floated over water, studying formation of ground water and well and classification of plants made them curious to learn more about new things and to know the reasons for occurrence of some phenomena. Writing their goals in science class also helped them to visualize their roles and responsibilities in the science class. They opined that daily log writing activity helped them to introspect where they were, and what they were doing in and outside the science classroom. Such exercise also helped them to know and understand their own actions. They came to know about the expected behaviour in science class and started implementing the same in the science classroom. Thus, the daily log systematized their behaviour in science class and making them disciplined. It meant that the sense of responsible behaviour and accountability in learning science slowly emerged among the students.

The exercise of asking meaning of newly introduced and difficult words / terms in the context of science subject made them aware to comprehend the concepts of science systematically with thorough understanding. The practice of understanding the concepts of science well and then using the word in proper sentence-structure in science class assisted them to construct sentences meaningfully. The students were of the opinion that the science teacher's insistence on the correct use of words and sentence construction in science class also helped them to score good marks in DLL (Digital Language Laboratory) subject.

Following suggestions emerged during group discussion with the students.

- Science teaching should incorporate various activities such as drawing charts, pictures, singing, and experiments.
- They suggested that science teaching should also involve the use of movie clips of animals, plants and story-telling.
- The students also indicated the necessity of PowerPoint Presentations with different slide transition effects and animation to learn science.
- They suggested to include daily log-writing so that they could view and monitor their own progress and behaviour.
- The students were of the view that learning should be enjoyable; therefore, teaching should involve games also.
- They mentioned the necessity of providing learning experiences in pairs and in groups and mentioned that learning experiences should include activities allowing scope for observation, classification and measurement.
- The students suggested avoidance of undue importance to writing. They also opined that homework should be given as per their capacities. They suggested that the science teacher should show new experiments and s/he should provide opportunity to do the same.
- As per the students' opinion, the visit to zoo, aviary, and aquarium should be arranged to study the characteristics of birds, animals and fish. They suggested out-door field experiences such as visit to nearby garden to study different kinds of plants.

The focus group interview data also confirmed the opinionnaire data. It was found from the above analysis that the students enjoyed learning science through MI based instructional strategy. They felt learning science pleasurable and preferred various activities that addressed various intelligences.

4.6 Profile of Multiple Intelligences of Experimental Group and Academic Achievement

The objective 5 was, *"to study the Multiple Intelligences profile of standard V students of experimental group with respect to academic achievement of students in science subject"*. Table 32 denoted descriptive statistics of multiple intelligences of the control and experimental groups such as mean, and standard deviation for particular intelligence.

Table 32 Multiple Intelligences

Intelligence	Control (n=41)		Experimental (n=46)	
	Mean	Standard Deviation	Mean	Standard Deviation
Linguistic	4.71	1.346	4.89	1.690
Logical-mathematical	4.17	1.626	4.35	2.057
Visual-spatial	4.66	1.371	4.61	1.468
Interpersonal	3.49	1.630	3.74	1.527
Intrapersonal	3.05	1.596	2.76	1.493
Musical	3.71	1.537	3.61	1.513
Bodily-kinesthetic	4.22	1.492	4.04	1.520

From table 32, it was found that experimental group contained higher mean values in linguistic, logical-mathematical, and interpersonal intelligence and the lowest mean value in intrapersonal intelligence. The standard deviation indicated that the scores in intelligences varied from the mean values almost the same in all the intelligences.

Table 33 shows data of academic achievement for experimental group with relation to score in particular intelligence along with mean values and standard deviation based on post test data.

Table 33 Academic Achievement and Multiple Intelligences of Experimental Group

Sr. No.	Intelligence	Group based on Score range in each intelligence	No. of Students 'N'	Mean (Posttest)	Std. Deviation
1.	Linguistic	Low	9	22.11	8.313
		Moderate	20	29.65	11.264
		High	17	27.71	10.433
2.	Logical-mathematical	Low	16	24.81	8.788
		Moderate	15	23.87	9.635
		High	15	33.87	10.954
3.	Visual-spatial	Low	11	26.55	11.264
		Moderate	22	28.50	11.632
		High	13	26.46	8.676
4.	Interpersonal	Low	23	28.48	10.757
		Moderate	17	29.35	10.758
		High	6	18.17	3.430
5.	Intrapersonal	Low	33	28.18	9.989
		Moderate	11	25.82	12.999
		High	2	24.50	10.607
6.	Musical	Low	23	27.91	11.160
		Moderate	19	27.37	11.061
		High	4	25.25	5.560
7.	Bodily-kinesthetic	Low	17	32.06	11.366
		Moderate	21	25.86	10.061
		High	8	21.88	6.600

Score 8 is the highest score in Teele Inventory for Multiple Intelligence (TIMI). Score 4 and above in particular intelligence was considered as dominant intelligence as mentioned by Teele. It was therefore, scores 8, 7 and 6 were considered as high scores, scores 4 and 5 as moderate scores, and scores 1, 2 and 3 were considered as low scores in particular intelligence. This way, the three groups of students were made on the basis of their scores in each intelligence and the mean values of the post test marks based on these three groups in each intelligence was counted to study the MI profile of the experimental group students with respect to academic achievement of students in science subject.

From the table 33, it was found that the students having moderate score in linguistic intelligence performed well and they got (29.65) mean value which is greater than the

(27.46), mean value of the entire experimental group on post-testing. The students having high score in linguistic intelligence gained (27.71) mean value, little higher than the (27.46), mean value of the entire experimental group on post-testing.

The experimental group students having high score in logical-mathematical intelligence gained (33.87), mean value on post-testing which is greater than the (27.46), mean value of the entire experimental group.

The experimental group students having moderate score in visual-spatial intelligence achieved (28.50), mean value on post-testing which is greater than the mean value of entire experimental group (27.46). The students having low and high score in visual-spatial intelligence got the mean values little lower than the mean value of the entire experimental group on post testing.

Experimental group students having moderate score in interpersonal intelligence achieved (29.35), mean value on post-testing which is greater than the (27.46), mean value of the entire experimental group on post-testing. The experimental group students having low scores in intrapersonal and bodily-kinesthetic intelligence gained higher mean values (28.18) and (32.06) consecutively, which are greater than the (27.46), mean value of the entire experimental group on post testing. The experimental group students having 'low' and 'moderate' scores in musical intelligence succeeded to gain the mean values nearer to the mean value of the entire experimental group on post-testing.

It should be noted here that the highest score in 'Teele Inventory for Multiple Intelligences" (TIMI) is 8 and the maximum score limit is only 28. It is therefore, if a student got 6 score (high score) each in linguistic, logical, visual-spatial, and interpersonal intelligences, his scores in other intelligences would fall under lower range in the rest of the intelligences. In other case, if a student got 5 score (moderate score) each in linguistic, logical, visual-spatial, and interpersonal intelligences, his scores in the rest three intelligences would be also lower. Based on the above analysis, it was therefore, concluded that the experimental group students having moderate scores in linguistic, visual-spatial and interpersonal intelligence succeeded to score above the mean value of the entire experimental group students on post-testing. It was also noted that the experimental group students having high score in logical-mathematical intelligence succeeded to raise their academic achievement above the mean value of the entire experimental group on post-testing. This is supported as the nature of science subject demands logical reasoning abilities to comprehend the concept of science.

4.7 Guidelines for Teaching Science at Standard V based on the Theory of Multiple Intelligences

The objective 6 was, *'to develop the guidelines for teaching science at standard V based on the present study'*. The guidelines for teaching science at standard V were developed based on the researcher's experiences while implementing the MI based instructional strategy and interaction with the students. The guidelines for the teaching science at standard V based on the present study are presented below. These guidelines include subject specific tips centring to teaching of science based on the theory of multiple intelligences.

4.7.1 Sensitivity to Uniqueness of the Learner

Teachers of science should be sensitive enough to know that different learners possess varying degree of strengths and abilities. They should design instructional strategy to teach science that will provide opportunity to students to make use of their multiple intelligences considering the scope of the content and interest of learners.

4.7.2 Knowing Learner

Xie and Lin (2009) denoted, *"If schools could fully comprehend the viewpoints and principles of the multiple intelligences theory, they would be able to see the countless benefits for students' learning and growth"*. The theory of MI has pluralized the concept of intelligence. The science teacher knows learner and understands that who explains well or who argues logically should not only be always praised. But, similarly who draws, who does group tasks effectively, who learns better while singing songs, and using bodily movements can also be considered as a learner of potentialities to learn science. No doubt that logical-mathematical intelligence is the end state for scientists and mathematicians and technicians. It does not mean that science or mathematics teacher should target only this intelligence while teaching. Instead, teaching should be such that it should demand the use of varied intelligences simultaneously or individually.

The achievement in particular subject, performance in co-curricular activities, sports, and cultural events help teacher to know the strength in particular intelligence.

Classroom observation and interaction with students, other teachers and parents will be also useful to know the strength of the students in particular intelligence dominant area. Armstrong (2000) suggested that teacher should keep note of what are the misbehaviour of the students in class to identify the highly developed intelligences. For instance, Armstrong (2000) mentioned that strongly linguistic student will be talking out of turn, the highly visual-spatial student will be busy with doodling and daydreaming, the interpersonally inclined student will be socializing, the bodily-kinesthetic student will be fidgeting and the students having strengths is naturalist intelligence might well bring an animal to class without permission! According to Armstrong (2000), these misbehaviour of the students convey message to the teacher that how they want to learn because such misbehaviours are the diagnostic indicator of how students need to be taught. Another way to identify the students' strengths in multiple intelligences is to develop and study the anecdotal records of the students' activity. The anecdotal records will help teachers to know who can perform well in singing, drawing, group activity, and in conducting experiments. The studies of cumulative records of the students are also one of the ways to know the students' strength in particular intelligence. Students having logical-mathematical as one of the dominant intelligences perform better in science and mathematics over a years and bring consistently higher grades when compared to performance in other subjects. On the same token, the students having linguistic intelligence perform better in tests over years and bring consistently good grades in literature and social subjects. Armstrong (2000) has also provided checklist for assessing students' multiple intelligences which can be used by teacher.

The systematic way of knowing the multiple intelligences profile of students is to administer the Teele's MI inventory (TIMI) (2002)**.** Below mentioned MI inventory/checklist by following websites can be used by teacher.

- What are my learning strengths?Retrieved May 25, 2012, from
  http://www.ldrc.ca/projects/miinventory/mitest.html
- Douglas, N. (2012, July 18). Multiple intelligence test by Niall Douglas
  Retrieved from
  http://www.nedprod.com/Niall_stuff/intelligence_test.html

- Appendix B Multiple intelligences worksheets. Retrieved on May 25, 2012, from http://www.spannj.org/BasicRights/appendix_b.htm#test
- Multiple intelligences inventory. Retrieved May 25, 2012, from http://www.angelfire.com/va/gkerns/revisedteele.html

McKenzie (1999) and Schwed and Melichar-Utter (2008) have also mentioned MI inventory which can be used to identify the multiple intelligences of the learners. A Multiple Intelligences Inventory given by Gregory and Chapman (2007) can also be used by teachers as a reference for observing student behaviours for planning instruction.

4.7.3 Knowing the Nature of Science

The teaching of science aims to develop logical understanding on the basis of sound evidences and reasoning. It demands collecting evidences and linking the links to arrive at common understanding. The laws and theories expounded in science are based on interrelated facts and logical arguments which are open to test for acceptance at any time. The teaching of science aims to develop scientific attitude among learners. The product as well as process aspects need to be taken care while teaching science. The process skills and first hand experiences should be focused for the development of scientific bent of mind.

4.7.4 Concept of Science Process Skills

Science process skills are the specific behaviours that are needed for objective enquiry in learning science. Students require demonstrating understanding and explaining the occurrence of particular phenomena under study based on evidences and logically acceptable arguments. The understanding based on evidences is always open to subject to challenge. Testing one's ideas and accepting the ideas require systematic enquiry processed through basic operations such as observing, measuring, classifying, inferring, predicting, and communicating at the Elementary level whenever applicable. Use of science process skills helps students in generating tentative solutions which can be further confirmed or disapproved by the students while learning science. The science process skills when aptly used by the students make learning concrete and understandable. Table 34 shows the list of basic science process skills with regard to learning science specifically at Elementary level.

Table 34 Science Process Skills

Science Process Skills	Definition
Observation	It is the ability to use the senses appropriately to identify the similarities and differences among objects/substances/events under study. It also covers ability to observe the order in which particular phenomena occurs.
Measurement	It is the ability to use standard as well as non – standard measures to make comparisons or taking readings with accuracy and precision. It involves ability to measure the length, weight, area and volume and it is a quantitative observation.
Classification	It is the ability to group/classify the objects/substances/events on the basis of similarities and differences in characteristics of the same under study.
Inference	It is the ability of interpreting data gained through observation, past experiences and other secondary sources. It makes use of regularities and trends observed in gathered data, observation and measurement to identify the relationship of one variable with others.
Prediction	It is the ability to think systematically and logically what will happen next based on evidences, observations, patterns and relationship observed between data.
Communication	It is the ability to communicate information in oral and written forms, graph, table, charts and pictures which is understandable to others. It covers the ability to listen and respond accordingly so that understanding of the ideas will be developed.

4.7.5 Theory of Multiple Intelligences

Gardner's theory of multiple intelligences widened our horizon to understand the multiple capacities of learners. As per Gardner (1983), there were seven multiple intelligences. Later on, he added eighth intelligence, namely, naturalist intelligence. Following is the brief description of the eight multiple intelligence according to Gardner.

- **<u>Linguistic Intelligence</u>**

  This gives rise to competencies related to linguistic intelligence. Lawyers, writers, storytellers, novelists, journalists, public speakers, comedians and poets widely use this intelligence. This intelligence involves the knowledge that comes through language, through reading, writing, and speaking involving understanding of the order and meaning of words in both speech and writing and a sense of proper use of language. It covers understanding of the socio-cultural nuances of a language, including idioms, plays on words, and linguistically based humour**.**

- **<u>Logical - mathematical Intelligence</u>**

  It is composed of components like deductive and inductive reasoning, including solving of logical puzzles, doing calculations and the like. This intelligence uses numbers, mathematics, and logic to find and understand various patterns. It begins with concrete patterns in the real world but gets increasingly abstract as we try to understand relationships among patterns. It makes one capable to perceive relationships and connections, and to use abstracts, symbolic thought.

- **<u>Visual - spatial Intelligence</u>**

  Many of us knowingly or unknowingly make use of visual - spatial intelligence in day-to-day life which requires the abilities and skill involving the representation and manipulation of spatial configuration and relationship. This intelligence covers sensitivity to colour, line, shape, form, space and relationship among these elements. Painters, land surveyors, architects, engineers, mechanics, navigators, sculptors and chess players generally use this type of intelligence.

- **<u>Musical Intelligence</u>**

  The works of professionals like singers, musicians, composers and instrumentalists demonstrate the use of musical intelligence who are smart enough in pitch discrimination, sensitive enough to rhythm, texture and timbre**.** This intelligence covers the sounds of world, environmental and musical, and one's awareness, enjoyment and ability to use these sounds.

- **<u>Bodily - kinesthetic Intelligence</u>**

  This is basically related with abilities, talents and skills to perform skillful and purposeful movements. It encompasses the capacity to manipulate objects and use a variety of physical skills. This intelligence requires sense of timing and the perfection of skills through the union of mind and body. Generally, dancers, gymnasts and athletes widely use this intelligence.

- **<u>Intrapersonal Intelligence</u>**

  Intrapersonal intelligence includes the capacity to understand oneself. This intelligence helps one to know one's strength and weaknesses. It enables to have an effective working model of oneself covering one's own desires, fears, and capacities. It enables person to use self knowledge effectively in regulating his/her life. Intrapersonal intelligence is evident in psychologists, spiritual leaders, philosophers.

- **<u>Interpersonal Intelligence</u>**

  Interpersonal intelligence encompasses the ability to understand the intentions, motivations, and desires of other people. Thus, it helps one to work effectively with others. The interpersonal intelligence includes sensitivity to facial expressions, voice, gestures. It encompasses the capacity to discriminate different kinds of interpersonal cues and the ability to respond effectively to them. Generally, Interpersonal intelligence is highly developed in teachers, therapists, politicians, and religious leaders.

- **<u>Naturalist Intelligence</u>**

  Naturalist intelligence includes the ability to understand, discern and appreciate different kinds of flora and fauna of nature. It covers the capacities such as recognizing and classifying species, raising/taming animals, and growing plants. It also involves curiosity to know about the natural worlds, its creatures, and weather patterns. Generally, farmers, hunters, gardeners, zookeepers, nature guides, forest rangers widely make use of naturalist intelligence.

The theory of multiple intelligences by Howard Gardner helps teachers to understand that each student has varying degree of strengths in multiple abilities which will help him/her to perform better in particular domain. It also helps teachers to understand that students' multiple abilities should be nurtured. Knowledge of one's self and its usage in devising one's own strategy to work, modifying one's own behaviour, and ability to work in group activities which ensure the group cohesiveness and goals are required. The theory of multiple intelligences helps teacher to understand that the students should be provided opportunity to learn the concepts by using imagination, thinking, observation, measurement, classification, and inference. The teacher should include the use of pictures, drawing, small movie clips, music, songs, hands-on experiences, and bodily movements to help students in learning the concepts and expressing the same.

4.7.5.1 Selection of Intelligence Specific Ways for Teaching

Llewellyn (2007) denoted students working in cooperative groups, doing hands-on activities, writing in science journals, classifying objects, completing remedial or enrichment excursions at their own pace, listening to songs and creating a concrete model of the phenomena observed, make use of interpersonal, bodily-kinesthetic, linguistic, logical-mathematical, intrapersonal, musical, and visual-spatial intelligences respectively. Such strategy is motivating and encourages students' engagement with the lesson content. According to Hammerman (2006), intelligences are the potentials ready to be activated and the ability of a potential to be realized is dependent from the culture, nature of experiences, and motivation of learners. Hammerman (2006) further opined that teacher should bear in mind that most students associate with more than one intelligence, and exposure to a variety of instructional strategies is more likely to increase learning potential among a group of students.

Teacher can devise specific ways to teach science in more individualised way or they can consider all the class students as a whole and can target one or more intelligences together. In individualised way, teachers can group the students of similar MI profile and can teach them accordingly. This type of teaching requires less number of students, readiness to teach in diverse ways and creativity and imagination on the part of teachers. The traditional classroom set up do not allow to offer individualised configured education, specific seating arrangement, and lack of resources and infrastructure facility also restrict to offer individualised education. It is therefore, the science teacher should devise instructional strategy which will offer the best intelligence specific ways to teach the content. While tailoring the activities, the foremost pre-requisite is to ensure teaching in due time with minimal cost and without stretching the content unnecessarily. Teachers should also keep in mind that there can be more ways to teach the same content but overzealous attitude to teach everything by all eight ways is not advisable and suitable. The identification of all possible intelligences specific ways should be enlisted and should be selected appropriately on the basis of learner's needs, interest and scope of the content. Teaching of science is not just restricted to group work, individual work or problem solving and laboratory work for the first time learners of science as a subject. Therefore, teacher of science should find suitable scope to involve novel methods of teaching in which varied intelligences could be addressed.

The table 35 shows the integration of multiple intelligences into teaching of science at Elementary Education. Here, in table 35 particular intelligence related activities have been described in brief wherein focus is on the intelligence which played greater role. It should be noted that other intelligences also play role in learning concepts of science. For instance, when students write a paragraph on contribution of scientists after discussing in group, interpersonal intelligence is also involved along with linguistic intelligence.

<u>Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education</u>

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Linguistic	1. Contribution of Scientists to day-to-day life	<u>I. Writing a paragraph on contribution of scientists</u> Referring science encyclopedia, reference books on contribution of scientists and internet materials such as 1. Techtainment, A blog about science and technology. (2006, October 20). 10 Great Scientists of the World. Message posted to http://techblogbiz.blogspot.com/2006/10/10-great-scientists-of-world.html 2. Isaac Newton (1643-1727) Retrieved January 11, 2011. http://burro.astr.cwru.edu/stu/pre20th_europe_newton.html 3. Scientist, From Wikipedia, the free encyclopedia Retrieved 11 January 2011, from http://en.wikipedia.org/wiki/Scientist 4. Mary Bellis, About.com Guide. James Watt - Inventor of the Modern Steam Engine. Retrieved 11 January 2011, from http://inventors.about.com/od/wstartinventors/a/james_watt.htm Points to be covered- brief introduction of scientists, their contribution to the humans, how life became easy and comfortable, how innovation and scientific principles are used in industry, technology and medical science.	Communication	Scoring should be based on comprehensive coverage to scientists' contribution, logical arguments, fluency, and proper use of language, use of proper semantics, idioms, and proverbs. Score:10 marks (for activity I) Comprehensive coverage – 4 marks Logical arguments – 4 marks Proper use of language – 2 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Linguistic	1. Contribution of Scientists to day-to-day life	II. Debate – if electric bulb was not invented. Points to be covered- brief introduction of Thomas Alva Edison and how his invention of electric bulb has changed life, scenario of life without electric bulb, chaos in human life without light, problems and difficulties posed due to the absence of electric bulb.	Communication Inference	Scoring should be based on coverage given to Thomas Alva Edison's invention of electric bulb and how it changed the entire human life in language that shows student's originality in writing. Logical arguments, fluency, and proper use of language, use of proper semantics, idioms, and proverbs should be kept in mind while evaluating.
		III. Elocution Competition- Is science blessing or curse? Points to be covered- How science has made life comfortable and easy, how man uses science for war and to attain peace over the globe, use of science by wise scientists and terrorists.	Communication Inference	Scoring should be based on logical and convincing arguments. The arguments should clearly mention that proper utilization of science and technology is blessing otherwise it results into curse. Score:10 marks (for activities II and III) Comprehensive coverage – 3 marks Logical arguments – 3 marks Proper use of language – 2 marks Fluency and confidence – 2 marks

*Table 35 is continued on next page.

<u>Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education</u>

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Linguistic	2. Awareness of Diseases, vaccines	<u>IV Teacher can ask students to write a story using the points noted below.</u> Rahul named a boy- only one son of Ramjibhai- Ramjibhai said 'no' to give Polio vaccine to Rahul – after 1 year – Rahul was caught in polio.- Rahul was unable to run, walk fast- Rahul was unable to go for mountain tracking – Rahul learnt walking with callipers – dependent on his friends- motto- importance of vaccines in our life. The story should cover the problems faced by Rahul in adjusting at home and school due to polio. The inability to play, to do physical exercises, the joy of playing was lost with the peers should be highlighted by students. The story should also depict the unawareness, superstition and the carelessness of Rahul's parents for their son. The story should describe the importance of vaccines in human life.	Communication Inference	Scoring should be based on how story appeals to human mind to conclude that unawareness and superstition were the major barriers for Rahul which prevented him to join mountain tracking program. It should highlight the importance of vaccines in time. Score: 10 marks (for activity IV) Clear thoughts - 5 marks Originality - 3 marks Use of language - 2 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Logical-mathematical	1. Calculation of energy K. Cal for man / woman	I. Designing food menu for man / woman for calories required per day. Teacher should explain that use of green vegetables, fruits, dry fruits, juices, sugar, biscuits, curd, milk, and other milk related products is required to get energy to man. Teacher should explain the requirement of energy for man and woman in terms of K. Cal per a day. Students can be asked to design food menu by appropriate selection of food items based on the energy value of food items. The students should be able to suggest the food menu by calculating the required intake of energy in K. Cal. They should also give proper reasons for the selection of various food items.	Inference	Score: 5 marks (for activity I) Scoring based on correct answer of mathematical operation-addition - 2 marks. Arguments for the suggested food items - 3 marks.
	2. Studying plant's growth	II. Measuring height of Plant Students should be asked to measure the height of the plant using string and scale or using meter tape at the end of first, second, third and forth week. They should be asked to give reasons that why plant is living. They should be able to yield accurate and precise measurement for the height of plant.	Measurement Inference	Score: 5 marks(for activity II) Scoring based on accurate and precise measurement of height of plant in all four consecutive weeks – 4 marks Students should infer that plant is living as it shows growth in height – 1 mark.

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Logical-mathematical	3. Studying floating and sinking of the objects or substances into the water. 4. Classification of the things/substances based on similarities	III. Studying floating and sinking of the objects or substances Ask students to report their prediction what will happen if following mentioned objects/substances when simply dropped into the tub filled with water. Objects/substances: Cooking oil, cork, Needle, Small piece of wooden, Thermocol balls Thereafter, instruct students to do the activity by doing. IV. Classification of the things/substances Give students below noted things to classify in four different ways. Instruct them there should be at least two examples in each class. Things/substances: Blue and white coloured chalks, sugar, salt, eggs, cane sugar, honey, kerosene, cooking oil, magnets, keys, rubber, pencil, candle, torch, butter	Prediction Observation Classification	Score:10 marks (for activity III) For each correct prediction/observation/ for each object /substance, assign one mark. For correct prediction whether objects/substances floats or sinks – 5 marks For correct observation whether objects/substances floats or sinks – 5 marks Score: 8 marks (for activity IV) For correct classification of things/substances into four different ways – 8 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Logical-mathematical	5. Why stars seem to twinkle?	V. Experiment to study twinkling of the stars Form an image of a bright source of light on a screen. Place the convex lens on stand. Ensure that lens remains upright in a fixed position. Adjust the height of the lens so that centre of the lens is the same height as the electric bulb used. Place the convex lens in front of the bulb, between the bulb and the screen. Adjust the position of the lens and screen to get a clear image of the bulb on the screen. Ensure that image does not move or twinkle and darken the room. Put hot plate close to the lens and below it and turn on the hot plate, the image will tremble or twinkle just as a star does. Ask students why this happens.	Observation Inference Communication	Score: 5 Marks (for activity V) Students should mention that image of light source trembles/twinkles – 1 mark Scientific reasons that heat energy causing the light rays shift back and forth, or twinkle as well - 2 marks. Appropriate drawing of the experimental condition with neat and clean diagram – 2 marks.

*Table 35 is continued on next page.

<u>Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education</u>

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Visual-spatial	1. Respiratory System of Man	<u>I. Studying the Respiratory System of Man</u> The teacher should use PowerPoint Presentation, movie clips, and model pertaining to respiratory system of man. The teacher should draw the diagram of man's respiratory system with colour chalks showing the in – and out-ways of oxygen and CO_2 gas through alveoli. Ask students to draw the respiratory system based on their observation and memory with proper labeling.	Observation Communication	Asking students to draw the respiratory system based on their observation. Score: 5 marks based on how correctly they showed the relative position of trachea, lung, tetracheole and diaphragm with proper labeling. (for activity I)

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Visual-spatial	2. Diversity in Animals	II. Mind mapping to represent diversity in the animals After teaching diversity in animals including vertebrate and invertebrates, ask students to visualize which specimens of animals they have observed. Ask them to develop mind map of entire concept of diversity in animals. Mind mapping is the effective visual note taking strategy which is spatial, non-linear approach that makes use of mind's ability to work in integrated, interlinked, complex manner. Here, ask students to draw symbols or images to illustrate their concept of diversity in animals such as shape of scorpion, snail, earthworm, amoeba, frog, honey bee. Here, students were supposed to mention topic- diversity in animals in the middle, while classification of animals into two groups on two different sides. They are also instructed to classify the animals based on whether they lay eggs or give birth to younger ones in addition to the classification of animals with legs. Some characteristic features of animals should be displayed by students.	Classification Communication	Score: 14 Marks (for activity II) Scoring should be based on correct classification of animals based on similarities and decent display of mind map of diversity of animals with attractive but appropriate images of animals. Correct classification of animals into vertebrate and invertebrates with at least two examples in each – 2 marks Correct classification of animals into animals that lay eggs and animals that give birth to younger ones with two examples in each – 2 marks Correct classification that mention two examples in each category such as animals without legs, two, four, six, eight, and legs more than eight – 6 marks. Attractive display of at least two correct images of animals with regard to shape - 4 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Interpersonal	Various organs of the body	This can be used as recapitulation. The students can be motivated and prompted to play the skit in which they assume different roles of various organs of the body and discussing the importance and interdependence of various organs.	Inference Communication	Score: 5 marks Putting logical arguments about the importance of various organs of the body - 2 marks Accepting others' ideas and indicating interdependence among the various organs of the body while discussing - 2 marks Time management with concluding message - 1 mark

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Intrapersonal	Terrestrial food chain	Visualizing one's role in maintaining terrestrial food chain considering one's own actions and consequences on environment. This can be done by discussing the human's actions and imbalance generated in food chain. The teacher can ask students to visualize the situation of various animals, birds in such condition and can ask students to set guidelines / code of conduct to prevent such imbalance in food chain. The students can be asked to write a note on their reflection on their imaginary situation as animal or bird and guidelines / code of conduct. The students should be instructed to write guidelines/code of the conduct to prevent imbalance in terrestrial food chain.	Inference Prediction Communication	Score: 5 marks Ability to reflect correctly and putting into proper words - 2 marks. This should highlight one's own actions which are responsible for the damage to the terrestrial food chain. Guidelines / code of conduct for oneself to prevent imbalance in terrestrial food chain - 2 marks. This should include Do's and Don'ts which are scientifically applicable and appropriate to one's life for the management of the terrestrial food chain. Originality - 1 mark

*Table 35 is continued on next page.

<u>Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education</u>

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Musical	1. Pollination	<u>I. Using song to study Pollination</u> -Students should be asked to sing song mentioned on below noted website.– Pollination Rock. Retrieved March 1, 2011 from http://www.youtube.com/watch?v=V5yya4elRLw- (CD, Folder –guidelines, file- Pollination Rock) -Students should be asked to appreciate the music of Pollination movie clip available on - The Beauty of Pollination - Moving Art™ Retrieved January 1, 2012 from http://www.youtube.com/watch?v=MQiszdkOwuU &feature=related (CD, Folder –guidelines, file- Beauty of Pollination) - Writing a song on Pollination and singing of it. Ask them to appreciate the singing of other students. Teacher should observe the students that how actively and interestingly they take part in singing activity. It should be taken care while evaluating students' genuine interest in appreciation of singing of other students or song.	Communication	Score: 5 marks (for activity I) Student's interest in singing song -2 marks This includes the initiation of students in doing activity and how they maintain the same level of interest throughout the activity. Singing song in proper rhythm - 2 marks Appreciating timber and texture of music - 1 mark. (This includes, when the students were asked, they should be able to appreciate the musical sound played by various instruments.)

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process Skills	Evaluation/Assessment
Musical	2. High pitch and low pitch Sound	II. Ask students to fill the two same sized bottles with water. Instruct them to fill the bottle A with water up to 1 inch and bottle B with water up to 4 inch using funnel. Ask students to which bottle contain more air in it and ask them to predict which bottle will produce lower pitch while tapping bottles with metal spoon. Then, instruct students to pour some water in same sized another bottle C and ask them to measure how much air is in the bottle C. Ask students whether bottle A or B contain more air than bottle C? Thereafter, ask students to record their predictions whether bottle C will produce lower or higher pitch than bottle A or B. Instruct students to tap each bottle with metal spoon and ask them to record their observations. Ask students what they can infer about the relationship of higher the amount of air in bottle with the pitch.	Prediction Measurement Observation Inference	Score: 8 marks (for activity II) Correct predictions that particular bottle will produce high pitch sound – 2 marks Correct observation of sound based on hearing - 2 marks Correct measurement of air in bottles A, B and C – 3 marks Correct stating of the relationship between amount of air and pitch – 1 mark

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Bodily-kinesthetic	1.Multiple Reflection	I. Asking students in a group to get maximum number of images by using plane mirrors, candle and protractor Time: 30 minutes Students should be able to show maximum number of images in this activity with showing group harmony in less time.	Communication (by manipulating objects)	Score: 5 marks (for activity I) Demonstrating maximum number of clear images in time - 2 marks Group's cooperation - 2 marks (This includes how effectively in less time, students show the group harmony.) Time management - 1 mark

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Bodily - Kinesthetic	2. *Saptarshi* (Ursa major) Constellation	II. *'Saptarshi'* Constellation Narrate the brief mythological background along with the PowerPoint Presentation of Ursa Major constellation. (Refer:1. Constellations: a guide to the night sky. Retrieved January 1, 2013 from http://www.constellation-guide.com/constellation-list/ursa-major-constellation/ 2. Saptarshi: A wisdom archive on saptarshi. Retrieved January 1, 2013 from http://www.experiencefestival.com/saptarshi 3. Indian mythology. SaptaRishis - The Seven Great Sages. Retrieved September 1, 2012 from http://www.apamnapat.com/entities/SaptaRishi.html). Explain why Ursa Major is known as *'Saptarshi'* constellation according to Indian mythology.Thereafter; ask students to role play the each star of Ursa Major constellation. Ask students to draw the shape of Ursa Major constellations with appropriate labeling of the stars in it. Instruct students to make the shape of *'Sapatrshi'* Constellation by bodily movements.	Observation Communication	Score: 6 marks (for activity II) Scoring should be based on correct identification and display of particular constellation. Randomly draw 5-7 different constellations/arrangements of 5-7 stars and ask students to locate the *'Saptarshi'* constellation from them - 1 mark for correct identification of *Saptarshi* constellation Correct display of *'Sapatrshi'* Constellation in image – 2 marks Correct display of *'Sapatrshi'* Constellation by position of students (teamwork) – 3 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Bodily - kinesthetic	3. *Mruga* (Orion) Constellation	III. *Mruga* Constellation Discuss with the students why Orion constellation is named as '*Mruga*' constellation. Draw the shape of Orion constellation and ask them to develop its chart. Instruct students to draw the shape of Orion constellations with appropriate labeling of the stars in it. Instruct students to make the shape of '*Mruga*' Constellation by bodily movements. Make three teams of students each having seven students. Identify the teams by A, B and C names. Ask only one team to make the shape of '*Saptarshi*' (Ursa Major) constellation and the team 'B' to form '*Mruga*' (Orion) constellation. Ask team 'C' to form random shape of group of stars. Invite the rest students of the class to identify the constellations formed by a particular team.	Observation Communication	Score: 6 marks (for activity III) Scoring should be based on correct identification and display of particular constellation. Randomly draw 5-7 different constellations/arrangements of 5-7 stars and ask students to locate the '*Mruga*' constellation from them - 1 mark for correct identification of particular constellation. Correct display of '*Mruga*' Constellation in image - 2 marks. Correct display of '*Mruga*' Constellation by position of students (teamwork) – 3 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Naturalist	1. Adaptation in plants (Xero-phytes, Hydro-phytes, and Mesophytes)	I. Asking students to make scrapbook with the original specimens of leaves of plants, and photographs of leaves from internet sources (if not available in some cases). Ask students to write a note of 3-4 sentences on each plant's adaptations in their scrapbooks.	Classification	Score: 10 marks (for activity I) 2 marks for all 3 types of plants so, total 6 marks - for comprehensive coverage with properly labeled photographs of plants' leaves. Clear identification of adaptation of plants-4 marks
	2. Types of flowers with united or free petals and united or free sepals	II. Students can be asked to classify the flowers into flowers with united petals, free petals flowers with united sepals and free sepals. They can be asked to develop the scrapbook on flowers mentioning united or free petals / sepals.		Score: 08 marks (for activity II) Correct classification - 4 marks (Students should mention two examples for each category. There are four categories and total eight examples so total 4 marks.) Neatness and comprehensive coverage on types of flowers - 2 marks

*Table 35 is continued on next page.

Table 35 Integration of Multiple Intelligences into Teaching of Science at Elementary Education

Multiple Intelligences	Concepts of Science	Related Activities	Science Process skills	Evaluation/Assessment
Naturalist	3. Setting Aquarium and studying the fish's adaptation	III. Setting Aquarium Before setting the aquarium, ask students the requirements of setting the aquarium and its utility in studying the fish. Ask students to bring snail, and water plants. This can be done with the help of the local science committee at school. Discuss with the students how they will make the aquarium by asking questions such as how sand, stone will be utilized along with the water plants, fish and snail to make aquarium. Discuss how overfeeding the fish and chlorine water creates problem to the existence of fish. Discuss why aeration is required in aquarium. Ask students to observe the fish. Discuss how colour, gills, fin, shape of fish and cover of the scales over body of fish help it to survive in water.	Observation Inference Communication	Score: 5 Marks (for Activity III) Scoring should be based on correct prediction, inference and adequate drawing of the fish Scientifically correct reason for the need of aeration in aquarium – 1 mark Two reasons for various adaptations of fish – 2 marks. Appropriate figure of fish with proper labeling – 2 marks

*Table 35 is continued on next page.

The format of various activity sheets are described in figures 67, 68 and 69.

Figure 67 Examples of Activity Sheets

Concept: Respiratory System of Human

Name of the student: **Date:**

Instructions:

Draw the figure in the space given under question with proper labeling.

1. Draw the chart of respiratory system of human body.

Concept: Heat Energy

Group Name: **Date:**

Instructions:

Write the answers in the space given under each question.

1. Write the name of apparatuses required to measure the boiling point of liquid.

2. Write the observation of boiling point of water measured by your group members.

Table: Observation of Boiling Point

Sr. No.	Students' Names	Boiling Point of Water	Average Boiling Point of Water
1.			
2.			
3.			
4.			
5.			

Figure 68 Examples of Activity Sheets

Concept: Reflection of Light

Group Name: **Date:**

Name of the students:

Instructions:

Draw the figure in the space given under question.

1. Draw the figure to obtain multiple reflection.

2. Write the maximum number of multiple reflections obtained by you.

3. What should be the angel to get maximum number of reflections?

Concept: Food Chain

Name of the student: **Date:**

Instructions:

Write your answers in the space given under each question.

1. Write your reflection in 3-4 sentences, if you are 'Eagle' in food chain, and the food chain is disturbed by man's activity.

2. Write guidelines/ code of conduct for human to maintain the food chain in 3-4 sentences.

a. …………………………………………………………..

b. …………………………………………………………..

c. …………………………………………………………..

d. …………………………………………………………..

Figure 69 Example of Activity Sheet

Concept: Living – Non Living

Name of the student: **Date:**

Find out the names of living and non-living in below noted wordbook across the horizontal and vertical lines.

R	**S**	**P**	**A**	**R**	**R**	**O**	**W**	R	I	Q	B
S	O	D	R	R	D	I	N	O	U	S	A
R	F	G	S	W	I	O	**A**	R	S	M	I
O	D	H	H	**M**	C	G	**S**	O	**B**	N	K
C	L	**B**	**O**	**A**	**T**	O	**H**	A	**O**	A	S
K	I	T	L	**N**	R	A	**O**	T	**O**	B	A
E	O	G	Q	O	Z	S	**K**	L	**K**	S	K
T	K	J	P	R	C	T	**A**	S	O	W	**T**
X	R	A	U	N	B	U	**T**	B	W	R	**A**
E	A	P	B	I	A	O	**R**	D	M	J	**B**
R	I	T	J	O	N	L	**E**	A	X	G	**L**
S	**F**	**R**	**O**	**G**	A	E	**E**	I	Z	E	**E**
I	N	B	S	R	N	O	P	K	Y	R	M
R	I	C	U	E	N	W	R	**S**	U	S	A
I	O	L	T	F	W	S	T	**W**	N	V	C
S	**N**	**A**	**K**	**E**	A	L	A	**A**	K	I	S
E	G	A	U	N	G	O	H	**N**	O	O	O
A	W	H	E	M	O	N	K	E	B	A	T

4.7.5.2 Examples to Integrate Multiple Intelligences

Some examples to incorporate MI of students in teaching of science have been explained as under.

Ex 1 Teaching Arrangement of Molecules present in the Solid, Liquid and Gas

Students should be asked to represent the arrangement of molecules in solid, liquid and gas by their bodily movements. In this activity, students should be asked to stand close to each other to show the arrangement of molecules in solid in particular a shape. Students can be asked to show the difference in the molecular arrangement in liquid and gas wherein they can stand far off from each other in random shape to show the molecular arrangement in gas state. This shows how the bodily-kinesthetic intelligence can be addressed. They can be suggested to draw the diagrams of molecular arrangement of solid, liquid and gases, or can be asked to stick thermocol balls on cardboard to show one-dimensional arrangement of the molecules in solid, liquid or gas. This activity will target the visual-spatial intelligence. The students can be guided to compose song on arrangement of the molecules and should be encouraged to sing it. (Musical intelligence). A discussion in pair or in group can be organized to write the differences between the molecular arrangement in solid, liquid and gases. (Interpersonal intelligence)

Ex 2. Teaching Solar and Lunar Eclipse

The students will be asked to represent the arrangement of sun, moon and earth for the formation of the solar and the lunar eclipses. They should be instructed to hold paper showing the title of sun, earth and moon so that other students can have the idea of the solar and the lunar eclipses. Students can be asked to play the role of the sun, the earth and the moon while showing the solar eclipse or lunar eclipse. The improper arrangement in standing indicates that a particular student finds difficulty in demonstrating the arrangement of planets in the solar or the lunar eclipse (Bodily-kinesthetic intelligence). The students can be asked to give reasons why the lunar or the solar eclipse occurs which will help teacher to know their understanding (Logical-mathematical intelligence). The teacher can discuss the solar and lunar eclipse with the help of PowerPoint Presentation. The students can be asked to prepare charts, diagrams on the solar and the lunar eclipses (Visual-spatial intelligence). Inclusion of movie clips, songs on the solar and the lunar eclipse can be made to ensure the involvement of students' visual-spatial and musical intelligences respectively. The differences among the solar and the lunar eclipse and writing reasons based on group discussion will allow students to use their interpersonal intelligence. A letter writing activity to younger brother for explaining why solar eclipse occurs and exposing myths will involve the linguistic intelligence.

Ex 3. Variation in Plants' Leaves

Think that in how many numerous ways, the difference in leaves can be taught. The examples are provided as here.

- You can ask the students to collect various leaves and draw them (Visual-spatial intelligence).
- You can ask students to have the colourful print of the leaves (Visual-spatial intelligence).
- You can raise questions that promote scientific thinking e.g., how neem tree's leaves differ from mango tree's leaves? Compare the size of leaves of both the mango and the neem trees by measurement (Naturalist, Logical-mathematical and Bodily-kinesthetic intelligence).
- You can ask students to discuss the differences in neem tree's leaves and mango tree's leaves in group. Ask them to write a small paragraph with the drawings of both the leaves (Interpersonal, naturalist, linguistic and visual-spatial intelligence).
- You can motivate students to write a small poem / song on the differences between both the neem and mango trees' leaves and encourage them to sing (Linguistic and musical intelligence).
- You can assign project to students to research on neem and mango trees' leaves and write the report on what they learnt about the differences in both the trees' leaves including uses of both the trees (Linguistic, Logical-mathematical and Naturalist intelligence).
- You can assign tasks to students to differentiate both the trees' leaves from the leaves of trees other than mango and neem tree (Logical-mathematical and Naturalist intelligence).
- Instruct students to write a log on the difficulties faced while learning the differences in plants' leaves. Tell them to write ways to modify their behaviour that hindered their learning (Intrapersonal intelligence).
- The students can be asked to collect different types of leaves. The students should be instructed to touch the surface of a leaf to feel its smoothness. Based on their tactile experiences, students can be instructed to list out the names of the plants' leaves into two classes: Leaf having smooth surface and leaf having rough surface (Bodily-kinesthetic intelligence).

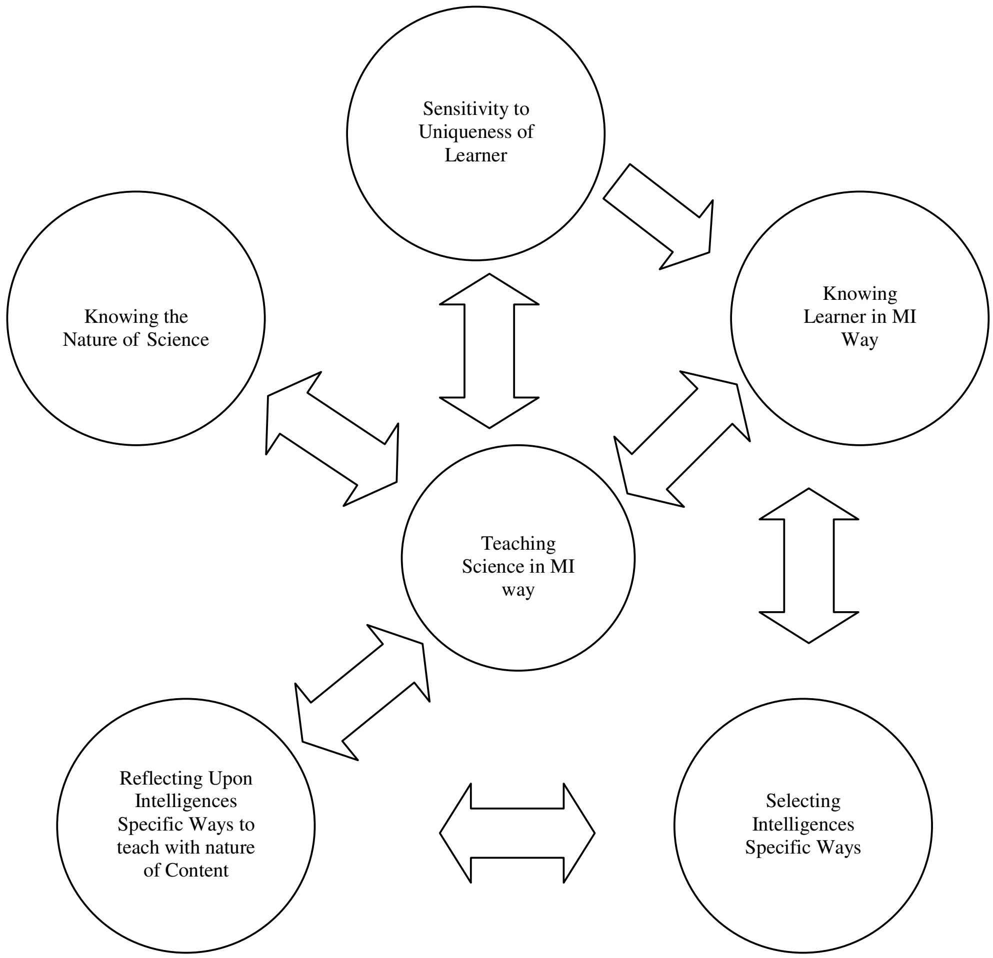
4.7.6 Reflecting upon the Selected Intelligence Specific Ways

It is required that the teacher should ask questions him/her-self regarding the development of MI based instructional strategy before implementing to gather feedback and to improve it further. The teacher should ask: Does the MI based instructional strategy offer scope to various intelligences? Is it developed keeping in mind the interest and curiosity of the students? Is MI based instructional strategy going to appeal the students' interest, curiosity and ensure meaningful learning? Does MI based instructional strategy include the activities which are unnecessary? Does MI based instructional strategy offer opportunity to students to make use of their various intelligences? The questions such as cost-effectiveness and time factor should also be thought of. The teacher should also think that whether his/her dominant intelligences prevented him/her to include/design activities related to particular intelligences.

4.7.7 Actual Implementation

Actual implementation involves appropriate time management. It is therefore, the teacher should check beforehand the apparatus, charts, models, PPTs, movie clips, computer faculties to avoid any confusing situation at the time of implementation. The teacher should take care of progressing step by step while offering multiple intelligences based learning experiences. It should also be taken care that entire class will participate in learning so careful observation along with systematic teaching required. The teacher should keep diary wherein the teacher can note down difficulties faced by students in performing activities and accordingly correct the assigned tasks. Teacher can observe students while performing different types of activities. Figure 70 denotes how development of multiple intelligences based instructional strategy is related with various dimensions of the development of MI based instructional strategy for teaching science.

Figure 70 Planning Instructional Strategy for Teaching Science based on the Theory of Multiple Intelligences



4.7.8 Important Points for Developing Instructional Strategy based on the Theory of Multiple Intelligences

Important points for developing MI based instructional strategy can be summarised as under.

- Have backward and forward looking view with respect to what students learnt in the previous year and will learn in the next year. Thus, find the curricular strand going across the standards.
- Try to enrich the textbook content by providing examples, analogies outside the science textbook whenever applicable. This should be as per the students' age, interest and scope of the content.

a. Locate the supplementary readings from the books, reference books, encyclopedia, and internet resources.

b. Discuss with senior science teachers teaching science at secondary level and science teacher educators to gain insight how to teach particular concept of science.

- State the general objectives in accordance with the competencies stated in the textbook. Split the general objectives into instructional objectives to ensure the content and ways to observe a particular behaviour.
- Classify the particular activity under a separate intelligence or to the group of intelligence such as writing a paragraph of an impact of wind on my life based on group discussion involves linguistic intelligence as well as the intrapersonal and interpersonal intelligence too. See that science classroom should not transform into drawing class, dance class or music class without fruitful achievement of objectives of science teaching.
- Arrange the activities or learning experiences in a sequential order to teach a particular concept of science.
- Review the activities to see whether particular intelligence needs to be addressed are covered or not and try to incorporate such missing intelligence in activity.
- Scientists use logical-mathematical intelligence widely. So, check that how the intelligences other than logical-mathematical can be used in teaching of science with an added focus on science process skills such as observation, inference, prediction, classification and measurement.
- Do not assume that all science concepts can be taught by all the intelligences together. Do not assume that each and every science lesson should target all the eight intelligences either simultaneously or one by one.
- Think that how as a science teacher; you can devise teaching to address less targeted intelligences such as musical, bodily-kinesthetic, intrapersonal and interpersonal intelligences.
- Review MI based science teaching to ensure that it should not incorporate multiple intelligences in such a way that students would feel the content is taught in unnecessarily long and boring ways.

- Take care that students will get opportunity to make use of different intelligences in learning science.
- Plan beforehand for different materials required for activities in science teaching.
- Use the principle of parsimony, principle of learning with fun and principle of integration of different intelligences.
    a) Principle of parsimony refers to minimal usage of material resources and low cost.
    b) Principle of learning with fun refers to maximize students' learning with pleasurable experiences rather than verbal teaching.
    c) Principle of integration of different intelligences refers to involvement of different intelligences of students rather than integrating only one intelligence. (i.e. mono intelligence focused teaching.)
    d) Principle of integrating different process skills into science teaching seeks to provide scope to students to make use of process skills in intelligences focused activities.
    e) Principle of active learning refers to trigger thought process in students rather than simply providing knowledge by one-way process.
- Plan in advance that how group activities and individual reflection period can be carried out. The teacher should encourage students to maintain the daily log activity to keep record of their behaviour. This will help teacher to develop sense of accountability and responsibility among students for their behaviour and learning. The teacher can ask students to complete following mentioned statements meaningfully in their daily logs based on reflection.
    ✓ Today I learnt….
    ✓ Today, I should not do….
    ✓ My mistakes are…
    ✓ Today I should do more efforts to learn…
    ✓ I will work…
    ✓ In this class, I want to learn….
    ✓ In this class, I intend to improve….
    ✓ In this class, I hope to…
    ✓ My goal for this class is…

- ✓ Today (this week) in this class, I learned…
- ✓ Today (this week), in this class, I improved by……
- ✓ In this class, I am pleased that I….
- ✓ A difficulty I am having this class is…
- ✓ I wish that this class….

- Apart from daily-log writing activity, the students can be asked to think on the area where they need to work hard in science class. This can be used as a strategy to modify their behaviour in science class. This uses students' intrapersonal intelligence.
- To address students' linguistic intelligence, provide opportunity to students to write a note on particular concept of science such as scarcity of water and its impact on life. When students are asked to write impact of scarcity of water on one's life, it involves intrapersonal intelligence also. Word games, crossword puzzles, related to science can also be included to address students' linguistic intelligence.
- Use coloured chalks to highlight important points on blackboard or use colour chalks effectively in drawing diagram such concept of water cycle or food chain. Instruct students to develop charts, diagrams, flowchart, fishbone structure for impact of food over health. Students can also be asked to visualize the concept that they have learnt in earlier class for revision of the content, as for example cloud formation. They can be asked to visualize the colour that they like as a peaceful colour and to meditate on what they learnt. This can work as stress reliever also. The students can be asked to draw earthworm, flowers, leaves based on their observation. The science teacher can also use PowerPoint Presentation or movie clips to teach particular topic such as historical story of development of measurement of length. All these various ways help students learn using their visual-spatial intelligence.
- Provide opportunities to students to work in groups or in pairs that involve interpersonal intelligence. The students can be assigned small-scale experiments/activities to do in groups involving the use of interpersonal and bodily-kinesthetic intelligence as well. The students can be asked to think and share what they learnt about particular concept of science before introducing the new topic which also covers their interpersonal intelligence.

- The students can be asked to select a particular animal or a bird's name as their group name. Based on group discussion, the students can be asked to give reasons for the selection of particular name of animal/bird as their group name. This makes use of interpersonal intelligence.
- It should be discussed what jumper has to do when the bar is raised or lowered. The teacher should explain that bar stands for a standard and when standard is raised, it is harder for more people to meet it. Thereafter, the teacher should invite students to suggest their fair standards for homework/projects in group. This involves the interpersonal intelligence.
- Involve students in constructing various models such as windmill, rain water harvesting model for urban area. Such activities offer an opportunity to them to learn using their bodily-kinesthetic and logical-mathematical intelligence.
- Various exercises such as neck rolls, shoulder rolls, knee rotations, and breathing exercises should be carried out before introducing the lesson or to offer break during teaching.
- The students can be instructed to sing a song on particular topic such as water cycle or animal kingdom or types of soil. The students can also be asked to write song on particular topic of science and sing the song with claps and bodily movements. This includes musical intelligence.
- For a teacher who practices multiple intelligences based science instruction, s/he must bear in mind that students differ in terms of their dominant intelligences which make them interested for a particular activity. Such example could be that student with a visual-spatial as dominant intelligence would sometimes rush to the teacher's table to observe the experiment or the specimen. It is also possible that students with visual-spatial as dominant intelligence would also take part actively to draw charts or flow charts. They also prefer the graphic organizers. In such a case, the teacher should work patiently as rebuke or rejection to students would make them feel humiliated or they might feel deprived of their teacher's appreciation or attention. It is therefore, a science teacher should appreciate the performance and works presented by such students and guide them to help their peers.

CHAPTER - V

DISCUSSION, FINDINGS AND SUMMARY

CHAPTER : V - DISCUSSION, FINDINGS AND SUMMARY

5.1 Introduction

The Chapter 5 Discussion, Findings and Summary includes the statement of the problem, objectives, explanation and operationalization of the terms, methodology, discussion on the findings and major findings which are mentioned as under.

5.2 Statement of the Problem

Development of Instructional Strategy for Teaching Science at Standard V Based on the Theory of Multiple Intelligences

5.3 Objectives of the Present Study

(1) To design and implement instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V.

(2) To study the effectiveness of instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V in terms of academic achievement.

(3) To study the process of learning science among the standard V experimental group students in relation to process skills.

(4) To study the opinion of experimental group students for implemented instructional strategy for learning science based on the theory of Multiple Intelligences.

(5) To study the Multiple Intelligences profile of standard V students of experimental group with respect to academic achievement of students in science subject.

(6) To develop the guidelines for teaching science at standard V based on the present study.

5.4 Explanation of the Terms

5.4.1 Instructional Strategy

The instructional strategy would comprise of integration of various activities, methods and media for learning concepts of Science at standard-V based on the theory of Multiple Intelligences.

5.4.2 Multiple Intelligences

The Multiple Intelligences theory propounded by Howard Gardner in 1983 and 1999 is considered as a base for the present study. It includes eight different intelligences namely linguistic, logical-mathematical, visual-spatial, musical, bodily-kinesthetic, intrapersonal, interpersonal, and naturalist intelligence. Multiple Intelligences is abbreviated as ‘MI’ in the present study.

5.4.3 Process Skills

Science process skills are the systematic pathways to explore and gain evidence to study particular phenomena under study objectively. This systematic enquiry helps in developing ideas. The science process skills help to test and verify the results. Science process skills such as observation, communication, inference, measurement, classification and prediction were included in the study.

5.5 Operationalization of the Terms

5.5.1 Academic Achievement

The marks scored in pre- and post-tests are considered here as an academic achievement.

5.5.2 Studying the Process of Learning Science in relation to Process Skills

The indicators of science process skills given by Fraser-Abder (2011) were considered to analyze the process of learning science in relation to process skills. It was studied in observation process skill whether the students were able to identify the similarities, dissimilarities, noticeable changes and properties of the objects such as colour, size and shape. In measurement process skill, it was studied whether the students were able to measure the length, and width of the given objects using a standard tool such as ruler or meter tape accurately and precisely. The students’ ability to measure volume of liquid using measuring cylinder was also studied. The students’ abilities to classify given objects/substances based on their similarities were considered here. In inference science process skill, it was studied that whether the students were able to infer based on the acquired understanding through observation, measurement and classification. It was studied that how students use their prior knowledge systematically and logically to think and predict what will happen for particular phenomena under study. The communication science process skill was studied with reference to how effectively the students were able to communicate their understanding about the scientific phenomena using charts, diagrams, and models, written and verbal modes of expression.

5.6 Hypothesis of the Study

There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.

5.7 Delimitation of the Study

The present study is delimited to

- English medium schools following Science and Technology textbook prescribed by Gujarat State Board of School Textbooks, Gandhinagar.
- The Instructional strategy was developed for chapters - 2 to 7, 9, 11, 12, 14 and 16 of Science and Technology textbook of standard V, Gujarat State Board of School Textbooks, Gandhinagar. The lessons included are: Learn Preparing Groups, Living - Non Living, Let us Know the Soil, Seed and Its Germination, Water and Its Importance, Observation of Living World, Food and Health, Air, Light and Its Properties, Measurement of Length and Energy.

5.8 Design of the Study

The quasi-experimental- pretest-posttest design was adopted for the present study mentioned as below in the notation form.

O_1 X O_2 O_1 O_3 = Pretests, X = exposure of a group to MI based instructional strategy

O_3 C O_4 O_2 O_4 = Posttests, C = exposure of a group to the traditional teaching

5.9 Data Analysis

Mann-Whitney test was used to study the effectiveness of MI based instructional strategy for teaching science. The students' responses in activity sheets were content analyzed and represented into percentage. Opinionnaire data was analyzed using frequency and percentage. The focus group interview data and researcher's diary were qualitatively content analyzed. The MI profile of experimental group students with respect to academic achievement was studied using the posttest mean values in relation to three groups – 'low', 'moderate' and 'high' based on their score in particular intelligence.

5.10 Discussion on Effectiveness of Instructional Strategy in terms of Academic Achievement

The objective 2 was *"to study the effectiveness of instructional strategy based on the theory of Multiple Intelligences for teaching science at standard-V in terms of academic achievement"*. The null-hypothesis H_0 was: *There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.* In order to study the status of null hypothesis H_0, the Mann-Whitney test was used to study the status of hypothesis H_0.

It was found that there was no significant difference between the control and experimental groups on pretesting (U = 791.000, z = -1.305, p = 0.192). It meant that both the groups were statistically comparable in terms of academic achievement also. The experimental group showed the statistically significant difference than the control group on post test (U = 581.000, z = -3.082, p = 0.002). Therefore, the null hypothesis H_0 (H_0: *There will be no significant difference between control and experimental group students of standard V in terms of academic achievements in science.*) was rejected and it was concluded that the experimental group was benefitted by MI based instructional strategy (p = 0.002). This mentions that the experimental group benefitted better than the control group at both the levels of significance namely 0.05 and 0.01. It indicated that designed and implemented instructional strategy for teaching science at standard V based on the theory of multiple intelligences increased the academic achievement of experimental group in comparison to control group on post testing. The increase in academic achievement of the experimental group students can be explained due to MI based instructional strategy. The other factors of experimental validity such as maturity, history, testing and artificiality of the experimental setting were controlled in quasi-experimental design. The researcher also maintained neutral attitude while scoring the answer sheets that led to infer that instructional strategy based on multiple intelligences emerged as a causing factor for the increase in academic achievement. The experimental group students encountered science content in variety of ways in which opportunities were offered to them were: drawing, writing, doing activities and conducting small scale experiments. The experimental group students remained active as activities demanded the use of science process skills such as observation, classification, inference, measurement, prediction and communication. Their active involvement in activities, use of songs, movie clips, PPTs, writing daily log, one-minute reflection, and thinking in images proved as a booster to science learning process. The writing practice provided by means of activity sheets might have also helped students to comprehend the concepts of science thoroughly and to respond properly. It could be said that when the experimental group students were actively involved in the process of learning using different intelligences together in combination or independently as per the scope of content to acquire knowledge, it turned into better learning and the students performed better on written academic achievement test in science. The discussion with the control - group teacher indicated that the control group was taught by lecture method (telling), using ready-made educational software, and audio-visual presentation whenever the teacher got time. It was also found during discussion with the control group science - teacher that no input was given to the students to interact with the groups, peers, and it was not activity based learning. The control group students were not exposed to the hands-on experiences as mentioned by the textbook, experiments or making of models. Not only this but also the control group students were not given opportunity to write their answers in the activity sheets. The control group students were also not taught using the songs, reflection, and by involving them in writing daily log to note down their goals, objectives and modification required in their behaviour in science class. It was found that the control group teacher did not focus attention to use of process skills. The control group students were not provided opportunity to use observation, classification, prediction, inference, communication, and measurement process skills which made learning of science a passive process wherein the teacher taught and the students interacted with the science content actively or perhaps not. The lack of active participation of the control group students was found out as science teaching in control group was greatly accompanied by the dominance of the teacher's talk in science instruction. The statistical superiority of the experimental group in terms of academic achievement compared to the control group was also confirmed by the interest shown by the experimental group students for learning science in focus group interview and their positive agreement on the items of the opinionnaire.

This finding has been supported by Goodnough (2000), Davis (2004), and Daniel (2007). **Goodnough (2000)** also mentioned that the teachers were able to make teaching of science more relevant, meaningful and personalized and observed that many of the student-centred goals were met by using MI theory and students were engaged by using intelligences other than logical-mathematical intelligence. **Davis (2004)** found that the students completed and turned in science class assignment work daily, and they exhibited appropriate behavior for learning during science. Significant improvement in students' achievement, behavior, and self-esteem, development of positive attitude about learning in science was found. These research evidences showed that MI based instruction in learning science was useful to help students to raise their academic achievement and science was made meaningful experience for them. The researches documented by the researchers of the Schools Using Multiple Intelligences Theory (SUMIT) as mentioned in **Kornhaber, Fierros, and Veenema (2004)** supported that the application of multiple intelligences theory was found useful in solving academic problems such as score on standardized achievement test.

Hodge (2005) suggested substantial evidence that multiple intelligences theory contributed positively to students' learning and development. **Daniel (2007)** found that the motivation level of students was increased and they became better motivated towards their studies. **Daniel (2007)** also reported improvement in academic achievement of student. **Cooper (2008)** examined the impact of multiple intelligences and meta-cognition on the achievement in mathematics and found that multiple intelligences treatment group outperformed the comparison on the posttest on a greater number of dimensions. **Mussen (2008)** compared the effect of multiple intelligence pedagogy and traditional pedagogy on grade five students and found significant difference in students' attitude towards learning science for MI group (experimental group). **Akkuzua and Akcay (2010)** found that multiple intelligences theory has a positive influence on tenth class students' achievements in learning chemistry and students were more positively motivated in the science classroom through multiple intelligence teaching method. **Akkuzua and Akcay (2010)** indicated that instructional methods needed to be varied so students could use their intellectual strengths to better understand topics, increase their intrinsic motivation, and encourage active student engagement to improve learning at the secondary school level. **Stanciu, Orban and Bocos (2011)** pointed out that an intervention programme based on teaching techniques derived from multiple intelligences theory led to a significant improvement of academic results in Romanian Primary Education students with learning difficulties.

These research evidences called for the inference that MI based instruction is helpful to increase students' achievement and leaves positive impact on self-esteem, motivation and attitude towards learning. There were total forty six students in the experimental group which made little difficult to provide equal opportunities to all the students to maintain the pace of learning with the traditional set up of classroom. The decreased class size might give the higher increase in academic achievement rather than observed difference in academic achievement in the present study. The researcher suggested replicating the study with the small group of students in learning science using true or quasi-experimental design. It was known while discussing with the other teachers and the principal during informal talk that the students belonged to low socio-economic strata, and the lack of proper parental guidance and motivation from their families were reasons for small difference for both the control and experimental group students on the posttests. These were considered as reasons that whenever new ways of teaching are introduced, the students also require motivation, and acceptance in family otherwise the students might feel exhausted or disinterested to put their sincere efforts in learning. It was also experienced by the researcher during the experimentation as they delayed doing activities; perhaps they faced difficulty in getting support of family to obtain additional simple materials like chart papers, cardboards, coloured pencils and other related materials.

5.11 Process of Learning Science with relation to Process Skills

The objective 3 was *"to study the process of learning science among the standard V experimental group students in relation to process skills"*. The major findings with relation to science process skills are as under.

5.11.1 Process skill - Observation

Initially, the students faced little difficulty in understanding the basic difference between 'to observe' and 'to see.' The explanation and instructions for the same were given to them from time to time which helped them to understand the meaning of 'observation' in the context of subject of Science and Technology. The students were able to:

- point out the effect of sunlight over leaves and mentioned the change in colour of the leaves also.
- notice minute details of the phenomena under study gradually. For instance, the students were able to notice the similarities and dissimilarities among various seeds such as their sizes compare to peanut, their colours, and the texture of the outer surface of the seeds.
- demonstrate effective use of visual sense and some of them used the tactile sense to find the texture of soil particles. Some students measured the size of gravels collected in sieve for wheat even though they were not asked. This showed the attempt to make quantitative observation by a few students.
- notice the happening when the cloud was formed in jar. Majority of the students indicated smoke, clouds, water drops along with match sticks used in the activity.
- report specific characteristic features of animals / birds. They reported food habits, colour with minute observation such as brown, light brown, brownish, red, and yellow. They also reported the specific characteristic features of animals / birds based on their prior understanding and observation. It indicated that students were able to point out the similarities and dissimilarities among animals and birds.

It was said from the analysis that the students were able to observe, identify the similarities and dissimilarities, and characteristic features of the animals / birds, leaves. They also developed their understanding to use visual and tactile senses appropriately. It was also found that the students refined their observation skill gradually and most of the students were able to point out the characteristic features immediately and easily in the later phase of MI based instructional strategy.

5.11.2 Process skill - Measurement

Majority of the students reported correctly the amount of filtrate collected while filtering. This indicated that they were able to read correct figures of measurement. The measurement of width of desk and length of Science and Technology textbook showed that they understood how to measure using non-standard measure. For this, they inferred that such measure will never yield the same result when measured by different students. The precision in measuring the height of plants was also found to be consistent with the actual measurement carried out by the teacher. The students were able to:

- use standard and non-standard measures appropriately after a few mistakes.
- generate the same result on repeated measurement either alone or in groups.
- measure the volume of filtrate with accuracy.

5.11.3 Process skill - Classification

It was found that the students understood the classification of objects, plants, sources of light and energy based on similar characteristics/patterns found among them. They also learnt to focus on the properties of objects/substances which were similar in nature. Initially, majority of the students were found to commit mistakes while classifying soil based on the components present in it but later on, they were able to classify the soils based on components. All the students classified different objects / substances easily. It was found that the students were able to:

- pick up similar characteristics that could work as a basis for classification. It meant that they learnt which information was relevant and could be used for classifying.

- classify the living from the non living based on the differences in their characteristics.
- group the objects / substances in number of ways that indicated increased awareness of the students to locate similarities in objects / substances.
- classify the seeds into monocot and dicot appropriately.
- demonstrate understanding that how plants could be classified based on differences in stem and height.
- classify the sources of energy into exhaustible and inexhaustible sources of energy.
- classify the sources of light into natural and artificial sources of light.

5.11.4 Process skill - Inference

It was found that the students exhibited gradual improvement in drawing inference. The analyses of the activity sheets indicated that the students made mistakes in inferring when they missed to observe minute details. Majority of the students were able to infer the property of light. Majority of the students were also able to infer the conditions required for germination of seed. They generated various reasons for conservation of exhaustible sources of energy. They linked the importance of food with health. It was found that the students showed improvement in drawing inference by providing logical reasons. They learnt to stop jumping over conclusions without support. The students were able to:

- provide reason for avoiding sleeping under trees during night with scientific reason.
- use observation and knowledge to point out the conditions required for the germination of seed.
- provide scientific reasons for variation in measurement when span and finger was used. They were also able to explain why ruler produced the same measurement when measured with accuracy and care.
- use observation to conclude correctly for various activities except indicating the differences why soil of field is different from the soil of river bed.
- notice the appearance of bubble when they repeatedly performed the activity of putting lump of soil into a glass filled with water. It meant that the students

initially found difficulty to notice minute bubble formation which delayed their process of inferring that soil contains air. It was also found that majority of the students faced difficulty to notice the differences of filtration speed between clayey and muddy soil.

- infer the property of light.

5.11.5 Process skill - Prediction

The predictions of majority of the students were found appropriate and were based on their prior experiences and knowledge. The students were able to:

- predict what will happen when objects or substances kept in water.
- predict empty glass contained air.
- predict crushed paper kept inside the glass would not become wet.

It was found that the majority of the students were able to predict about the occurrence of the phenomena while putting objects / substances in water. Majority of the students were also able to predict that crushed paper kept inside the glass will not become wet. They rightly predicted that the empty glass contained air. This showed that the students had the idea that air occupies space and shallow space in a glass though seemingly looks empty but contains the air.

5.11.6 Process skill - Communication

This skill was developed quite differently among students. As majority of the students lacked proper knowledge of grammar. Many a times, it was found that it was not easy for them to communicate easily in verbal as well as in written forms for what they really meant to express. The students, though difficult, interpreted the graph of consumption and production of oil. They also plotted the graph of filtration capacity of sandy, muddy and clayey soils keeping all three bars apart by one centimeter. It was observed that the students developed writing skill gradually and learnt how to express ideas correctly by means of proper use of language. The students were able to:

- show gradual but very slow improvement in writing which facilitated communication easily.
- locate the hidden names of the living and the non-living, and food items from the given word block. They were also able to make the names of various sources of light from given alphabets. It meant that the students were able to do the activities based on their linguistic skill.
- represent their understanding about subject-matter using charts, drawings, models and Venn diagram effectively. They were able to point out the similarities and dissimilarities among the living and the non living in Venn diagram. They were able to draw the picture of germinated seed and onion with its proper labeling. They also drew the picture of correct method of measuring the length of the object using the standard scale. They also drew the schematic presentation of the types of soil which was based on the colour. It was also found that almost half of the students were able to mention that muddy soil is suitable for agricultural-purpose. The lower percentage of the students to indicate suitability of muddy soil for agriculture-purpose suggested their poor ability of drawing inference based on observation and logical reasoning. It was found that all the students were able to label the water cycle diagram appropriately and they drew scientifically correct figure of the 'water cycle'.
- communicate in written words by providing reasons why the grouping of things / objects made their daily functioning easy and the benefits of the food for health. The students drew the pyramid chart of balanced diet demonstrating proper understanding about the food that they should take. They were also able to write a paragraph on 'Food that I should take', 'Uses of light' and 'My life without water' with proper understanding.
- interpret what the graph meant for the consumption of energy and communicated the same accordingly.
- prepare the model of windmill and roof top water harvesting model for urban area. They decorated '*diva*' beautifully.
- draw the figure of leaves with veins and earthworm with the round shapes over its body. This showed that the students were able to observe minute details and they communicated the same appropriately using drawing skill.

- create colourful print of leaves and animals to explain the differences among various plants and animals.

While summing up, it could be said that the students were good at observing towards the end of implementation of MI based instructional strategy. Some students also felt difficulty in using observation and inference skill while learning types of soil. Majority of the students were poor at writing in English. But, later on, they rectified mistakes in language and they learnt to use new words appropriately. It was also observed that majority of the students were good at measuring. The students also classified the objects / substances based on similarities and classified the seeds into monocot and dicot correctly except a very few student. They also predicted correctly whether objects / substances sink or float. It meant the students became aware of using process skills while learning. Their performance improved gradually in using different science process skills.

Bredderman (1983) based on meta-analysis indicated that activity-process-based approaches (Elementary Science Study (ESS), Science-A Process Approach (SAPA), and the Science Curriculum Improvement Study (SCIS)) to teaching science consistently found gains over traditional methods in a wide range of student outcome areas at all grade levels. **Preece and Brotherton (1996)** investigated the long-term effects of teaching science with a special emphasis on process skills with and found out the positive effect of the intervention on Year 8 boy students on GCSE science results. **Ramkumar (2003)** found out that the students were able to propose hypothesis based on certain concepts to explain the occurrence of events and they showed willingness to change ideas in the light of evidence. **Settlage and Southerland (2007)** indicated the effective use of science process skills helps students to make sense of the natural world as they become independent learners and fosters the natural curiosity engaging them in the task of exploration while making learning science understandable to them. Such benefits of science process skills mentioned by **Settlage and Sutherland (2007)** provided a clue to increase in academic achievement because active engagement in various tasks/activities is helpful to students to perform well in the tests. **Fraser-Abder (2011)** clearly mentioned that research on learning including other subjects in curriculum shows that students learn more, remember more and are more likely to use what they learn if they are asked to take more responsibility for their own learning. The daily log writing activity and the interaction of teacher with students regarding their own behaviour and required behavioural modification helped them to rectify their mistakes and behaviour in class. Such exercise also instilled the sense of responsibility and accountability for their learning in science. The increase in academic achievement could be attributed to use of daily log writing activity also.

5.12 Discussion on Analysis of Opinionnaire and Focus Group Interview Data

The objective 4 was *"to study the opinion of experimental group students for implemented instructional strategy for learning science based on the theory of Multiple Intelligences"*.

Opinionnaire contained a three point scale – 'agree', 'cannot say' and 'disagree' which was used along with the focus group interview to know the views of the students for implemented MI based instructional strategy for teaching science at standard V. The analyses of the opinionnaire and focus group interview data indicated that the students preferred taking part in various activities which provided them opportunities to observe, classify, infer, predict and communicate using charts, diagrams, models, verbal and written modes of expression. It meant that careful planning and implementation of MI based instructional strategy for teaching science succeeded in arousing and maintaining the interest of the students towards learning science. It was also found that the students liked doing activities as the activities demanded their active participation in learning science. The students of this age liked to do things on their own. They preferred to talk, share with their friends, to sing songs, and to watch audio-visual presentation in learning. These made students participate in science classroom actively. Gardner's theory of multiple intelligences suggested that there is more than one intelligence and individual demonstrates different strengths in multiple intelligences. The opportunity of using science process skills in learning science, and the scope to interact with the content of science using multiple intelligences engaged the students in learning science. **Teele (1994)** suggested that a model defining relationship between multiple intelligences and the instructional process was found interactive with the students. **Fischer (1997)** found that the use of Gardner's theory enabled educators to create learning environments that enabled all types of students to learn better. **Walker (2001)** conducted research with an aim to study three representative eighth grade students and found that these three young adolescent participants liked learning about multiple intelligence and they had clear ideas about how they would prefer to show their learning. These research evidences also suggested that multiple intelligences based instruction was useful to create atmosphere which made students learn utilizing their multiple intelligences.

5.13 Discussion on Academic Achievement and Multiple Intelligences of Experimental Group

The objective 5 was, *"to study the Multiple Intelligences profile of standard V students of experimental group with respect to academic achievement of students in science subject"*.

Table 36 shows data of academic achievement of experimental group with relation to score in particular intelligence along with mean values and standard deviation based on post test data.

Table 36 Academic Achievement and Multiple Intelligences of Experimental Group

Sr. No.	Intelligence	Group based on score range in each intelligence	No. of Students 'N'	Mean (Posttest)	Std. Deviation
1.	Linguistic	Low	9	22.11	8.313
		Moderate	20	29.65	11.264
		High	17	27.71	10.433
2.	Logical-mathematical	Low	16	24.81	8.788
		Moderate	15	23.87	9.635
		High	15	33.87	10.954
3.	Visual-spatial	Low	11	26.55	11.264
		Moderate	22	28.50	11.632
		High	13	26.46	8.676
4.	Interpersonal	Low	23	28.48	10.757
		Moderate	17	29.35	10.758
		High	6	18.17	3.430
5.	Intrapersonal	Low	33	28.18	9.989
		Moderate	11	25.82	12.999
		High	2	24.50	10.607
6.	Musical	Low	23	27.91	11.160
		Moderate	19	27.37	11.061
		High	4	25.25	5.560
7.	Bodily-kinesthetic	Low	17	32.06	11.366
		Moderate	21	25.86	10.061
		High	8	21.88	6.600

Score 8 is the highest score in Teele Inventory for Multiple Intelligences (TIMI). Score 4 and above in particular intelligence was considered as dominant intelligence as mentioned by Teele. It was therefore, scores 8, 7 and 6 were considered as high scores, scores 4 and 5 as moderate scores, and scores 1, 2 and 3 were considered as low scores in particular intelligences. This way, the three groups of students were made on the basis of their scores in each intelligence and the mean values of the post test marks based on these three groups in each intelligence was counted to study the MI profile of the experimental group students with respect to academic achievement in science subject.

From the table 33, it was found that the students having moderate score in linguistic intelligence performed well and they got (29.65) mean value which is greater than the (27.46), mean value of the entire experimental group on post-testing. The students having high score in linguistic intelligence gained (27.71) mean value, little higher than the (27.46), mean value of the entire experimental group on post-testing.

The experimental group students having high score in logical-mathematical intelligence gained (33.87), mean value on post-testing which is greater than the (27.46), mean value of the entire experimental group.

The experimental group students having moderate score in visual-spatial intelligence achieved (28.50), mean value on post-testing which is greater than the mean value of entire experimental group (27.46). The students having low and high score in visual-spatial intelligence got the mean values little lower than the mean value of the entire experimental group on post testing.

The experimental group students having moderate score in interpersonal intelligence achieved (29.35), mean value on post-testing which is greater than the (27.46), mean value of the entire experimental group on post-testing. The experimental group students having low scores in intrapersonal and bodily-kinesthetic intelligence gained higher mean values (28.18) and (32.06) consecutively, which are greater than the (27.46), mean value of entire experimental group on post testing. The experimental group students having 'low' and 'moderate' scores in musical intelligence succeeded to gain the mean values nearer to the mean value of the entire experimental group on post-testing.

It should be noted here that the highest score in 'Teele Inventory for Multiple Intelligences" (TIMI) is 8 and the maximum score limit is 28 only. It is therefore, if a student got 6 score (high score) each in linguistic, logical, visual-spatial, and interpersonal intelligences, his scores in other intelligences would fall under lower range in the rest of the intelligences. In other case, if a student got 5 score (moderate score) each in linguistic, logical, visual-spatial, and interpersonal intelligences, his scores in the rest three intelligences would be also lower. Based on the above analysis, it was therefore, concluded that the experimental group students having moderate scores in linguistic, visual-spatial and interpersonal intelligence succeeded to score above the mean value of the entire experimental group students on post-testing. It was also noted that the experimental group students having high score in logical-mathematical intelligence succeeded to raise their academic achievement above the mean value of the entire experimental group on post-testing. This is supported because the nature of science subject demands logical reasoning abilities to comprehend the concept of science. It was therefore, concluded that strengths in linguistic, logical-mathematical, visual-spatial and interpersonal intelligence helped the experimental group students to achieve higher mean values than the mean value of the entire experimental group on post-testing.

On the basis of opinionnaire and focus group data, it was found that the experimental group students enjoyed various activities based on the theory of multiple intelligences. During focus group interview, the experimental group students indicated that various activities helped them to learn concepts of science and to perform better in written test. It meant that instructional strategy based on the theory of multiple intelligences engaged them in learning concepts of science using their multiple intelligences. It was also found that the experimental group performed better than the control group students ($p=0.002$). The experimental group students' process skills findings suggested that there was improvement seen in process skills (observation, classification, inference, measurement and communication) over a period of time. It confirmed that the designed and implemented instructional strategy based on the theory of multiple intelligences helped students in understanding the concepts of science. It suggested that development of multiple intelligences was required by providing curricular and co-curricular activities from the beginning to study an expected increase in academic achievement. The teacher of science should also tailor the activities to provide opportunities to the students to make use of varied intelligences together or alone depending upon the scope of the content, age, and interest of the students. This finding is also confirmed by **Hansen (1998)** who reported that teacher educators generally agreed that distributed strength in all intelligence was required for having success in elementary school. **Daniel (2007)** found that knowledge of the multiple intelligences profiles of learners helped teachers to know their learners in a better manner and the teachers learnt to challenge gifted students more while they learnt to treat the slow learners compassionately. The findings of **Burke (1998)** substantiated the hypothesis that strengths in multiple intelligences were predictive of success in concept mapping and ascertaining students' MI profiles could increase teachers' understanding of their cognitive abilities. **Ozdilek (2010)** found out that bodily-kinesthetic learners' achievement level were lower than logical-mathematical, visual-spatial and musical learners based on his study on standard VI students**.**

5.14 Major Findings of the Study

The major findings of the study are as under.

1. There was a significant difference between control and experimental group students of standard V in 'Science and Technology' subject in terms of academic achievement. The experimental group showed the statistically significant difference than the control group on post testing (U = 581.000, z= -3.082, p = 0.002). It suggested that the experimental group was benefitted by MI based instructional strategy (p = 0.002). It indicated that designed and implemented instructional strategy for teaching science at standard V based on the theory of multiple intelligences increased the academic achievement of the experimental group in comparison to the control group on post testing.
2. The experimental group students showed gradual improvement in the science process skills such as observation, classification, prediction, inference, measurement, and communication. The experimental group students were able to notice the similarities and dissimilarities among the objects under study and were able to classify the objects / substances based on their common characteristics. They were also able to provide reasons based on their observation and understanding about the particular phenomena under study in science subject. They were able to report the results using measurement skill appropriately and were able to communicate adequately using verbal and written modes of expression and by drawing. They were able to think logically and scientifically too.
3. With relation to observation process skill, it was found that the students were able to observe, identify the similarities and dissimilarities, and characteristic features of the animals / birds, leaves. They also developed their

understanding to use visual and tactile senses appropriately. The students refined their observation skill gradually.

4. The students were able to use standard and non-standard measures appropriately after a few mistakes and produced the same result on repeated measurement.
5. The students were able to classify the objects under study based on similarities. The students grouped the objects / substances in number of ways that indicated increased awareness of the students to locate similarities in objects / substances. They also classified the seeds into monocot and dicot appropriately and demonstrated understanding that how plants could be classified based on differences in stem and height. They also classified living from non-living.
6. The students were able to use observation skill to infer the conditions required for the germination of seed. They provided scientific reasons for variation in measurement when span and finger was used and explained why ruler produced the same measurement when measured with accuracy and care. They also inferred the property of light and indicated that soil contains air and moisture. They were able to infer the relationship between food and health. The students used observation to conclude correctly for various activities under study.
7. The predictions of majority of the students were found appropriate and were based on their prior experiences and knowledge. It was found that the majority of the students were able to predict about the occurrence of the phenomena while putting objects / substances in water. Majority of the students were also able to predict that crushed paper kept inside the glass would not become wet. They rightly predicted that the empty glass contained air. This showed that the students had the idea that air occupies space and shallow space in a glass though seemingly looks empty but contains the air.
8. The communication skill was developed quite differently among students as majority of the students lacked proper knowledge of grammar. The students, though difficult, interpreted the graph of consumption and production of oil. They also plotted the graph of filtration capacity of sandy, muddy and clayey soils keeping all three bars apart by one centimeter. It was observed that the students developed writing skill gradually and learnt how to express ideas

correctly by means of proper use of language. They represented their understanding about subject-matter using charts, drawings, models and Venn diagram effectively. They were able to draw the picture of germinated onion with its proper labeling. They also drew the picture of correct method of measuring the length of the object using the standard scale. It was found that all the students were able to label the water cycle diagram appropriately and they drew scientifically correct figure of the ‘water cycle’. They drew the figure of leaves with veins and earthworm with the round shapes over its body. This showed that the students were able to observe minute details and they communicated the same appropriately using drawing skill.

9. It could be said that the students were good at observing towards the end of implementation of MI based instructional strategy. Some students also felt difficulty in using observation and inference skill while learning types of soil. Majority of the students were poor at writing in English. But, later on, they rectified mistakes in language and they learnt to use new words appropriately. It was also observed that majority of the students were good at measuring. The students also classified the objects / substances based on similarities and classified the seeds into monocot and dicot correctly except a very few student. They also predicted correctly whether objects / substances sink or float. It meant the students became aware of using process skills while learning. Their performance improved gradually in using different process skills.
10. The experimental group students liked MI based instructional strategy, and considered science learning as a pleasurable experience. They indicated that different activities in science class aroused their interest to learn science, curiosity to know new things, and helped them to write answer in examination.
11. It was found that strength in linguistic, logical-mathematical, visual-spatial, and interpersonal intelligences helped students in learning science.

5.15 Implications

The implications based on present research are as under.

1. MI based instructional strategy should be designed and implemented at School Education to teach different subjects of curriculum.
2. Teaching of science should encompass various activities which should provide opportunities to the students to make use of their various intelligences depending upon the scope and nature of the content as well as keeping in mind the age specific characteristics and interest of the students.
3. The teacher should provide various opportunities to the students to learn the concepts of science using basic science process skills such as observation, measurement, classification, inference, prediction and communication at Elementary level. The teacher should encourage students to demonstrate their understanding based on their acquired understanding through the use of science process skills.
4. Various activities that the science teacher should design and develop are: PowerPoint Presentations (PPTs) and movies on concepts of science, group and peer discussion, hands-on experiences and projects to provide opportunity to students to make use of their psycho-motor abilities.
5. Daily log, graphic organizers, cross word puzzles, word games, storytelling, drawing based on observation, paragraph writing, letter writing, games and songs should also be used in teaching of science.

5.16 Suggestions for Further Studies

Following are the suggestions based on present study.

1. Developed MI based instructional strategy for teaching science at standard V should also be implemented at other parts of Gujarat in English Medium Schools following GSEB (Gujarat Secondary and Higher Secondary Education Board, Gandhinagar). It means that the same study should be replicated.

2. MI based instructional strategy for teaching science at different grade levels should be developed and implemented to see its effectiveness in terms of product and process aspects of science (Academic achievement in science and development of science process skills among students).
3. Case study of students experiencing MI based instructional strategy in terms of academic achievement and development of science process skills should be carried out.
4. MI based instructional strategy for teaching science and other subjects at Secondary and Higher Secondary Education should be developed and implemented to study its effectiveness.

5.17 Conclusion

Based on the findings of the present study, it was concluded that instructional strategy for teaching science at standard V based on the theory of multiple intelligences helped students to perform better than the control group students on post-testing ($p=0.002$). Gradual improvement was also seen in the students' usage of process skills viz. observation, classification, inference, communication and measurement. It was found that strength in linguistic, logical-mathematical, visual-spatial and interpersonal intelligence helped the experimental group students to develop understanding in science. The opinionnaire and focus group interview data indicated that the experimental group students enjoyed learning science based on the theory of multiple intelligences.

The present study offers guidelines for teaching science at standard V based on the theory of multiple intelligences which provide teachers ways to link science process skills addressing students' multiple intelligences in learning science. These guidelines also help teachers teaching science at standard VI to standard VII to design instructional strategy for teaching science on the basis of the theory of multiple intelligences. The examples mentioned in guidelines for teaching concepts of science will assist teachers to make opportunities available to elementary education students learn using their multiple intelligences.

APPENDIX - I

BIBLIOGRAPHY

APPENDIX I BIBLIOGRAPHY

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APPENDIX - II

SCHOOL PRINICPAL'S PERMISSION LETTER

Shri Satya Sai Education Trust's

J.H.B. SARDAR PRIMARY ENGLISH SCHOOL

Sugam Society, Adajan Patia, Rander Road, SURAT - 395 009.
Ph.: (0261) 3268810 E-mail : jhbsardareng@gmail.com

Ref. No.

Date :

To.
Praful P Mogera
C/o. P. J. Mogera
Mission House,
Muglisara,
Surat - 395003

Date: 16-03-2009

Dear Praful

Sub : Permission for conducting teaching assignment

The school management has agreed to give you permission to conduct teaching assignment of Vth Science for a period of six months from June '09, as part of your doctoral study. The school expects most sincere efforts from you. You must ensure that students don't suffer in their academic persuit. We expect you to be punctual .and sincere to your work.

With Best Wishes

Principal .

PRINCIPAL
J.H.B. SARDAR PRI. ENG. SCHOOL
Sugam Society, Adajan Patia,
SURAT-395 009.

APPENDIX - III

LIST OF PRIVATE ENGLISH MEDIUM SCHOOLS

APPENDIX III LIST OF PRIVATE ENGLISH MEDIUM SCHOOLS

As per the record of District Education Office, Surat the list of the private English Medium School is mentioned as under latest by the 31/10/2007.

I. Rander – Adajan Zone identified as *Yagnavalkya Sankul*

Sr. No.	School
1.	Ankur Vidya Bhavan Primary School
2.	Shrimati R. S. Jatvani Primary School
3.	Shri. Blue Bellers Convent School
4.	Prabhattara Public School
5.	Presidency School
6.	Mujdid Alphesani Primary School
7.	Riverdale Academy School
8.	Citizen School
9.	The Pipardiwala English Medium Primary School
10.	Vidyakunj Primary English School
11.	Good Shepherd Mission School
12.	Don Bosco Public School
13.	Shrimati L. P. Sawani Vidya Bhavan
14.	J. H. B. Sardar Primary English School

II. Bhagal – Katargam Zone identified as *Vashisth Sankul*

Sr. No.	School
1.	Shri. S. J. Gajera Primary School
2.	Gurukul Vidyapith V. T. Choksi English Medium School
3.	V. N. Godhani Kanya Vidyalaya
4.	Gajera International School
5.	Ankur English Adacemy School
6.	Shri. Swaminarayan Gurukul Primary School
7.	Sir J. J. Primary School
8.	Matrubharati Vidhabhavan
9.	Sunbright School
10.	Shri. C. G. M. M. V Primary Girls' English School, Dhingli Falia.

II. Bhagal – Katargam Zone identified as *Vashisth Sankul*

Sr. No.	School
11.	K. S. Joshi Primary School
12.	Jamia English School
13.	Memon Primary School
14.	Shri. C. G. S. M. V. Ambaba Primary Girls' English School, Limda Chowk
15.	Mahidharpura Urban Society Primary English Medium School
16.	Madressa Tayyabah English Primary School

III. Nanpura – Bhatar -- Athwalines Zone identified as *Maharshi Vishavamitra Sankul*

Sr. No.	School
1.	Lourdes Convent School
2.	Sanit Xeviers School
3.	Shrimati Rukshmani Sitaram, Sarvajanik Experimental School
4.	C. C. Shah English Primary School
5.	T & T. V High School
6.	Sheth Dhanjisha Rustam Umarigar Memorial School
7.	Bai Sundar Narayan (Vishvakarma) Lokbharti English School
8.	Sardar Vallbhbhai Patel Primary School
9.	Shardayatan Primary School
10.	Divine Child School
11.	Lancers Army Primary School
12.	Vani Niketan
13.	E. M. Charitable Trust, Radiant English Academy
14.	Shri. Chanmal Sahani Vidyabharati English Vidyalaya
15.	Saint Thomas English Medium School
16.	Adam English Primary School
17.	Shri. Satya Sai School
18.	Royal Pride School
19.	Ramlal Bagadia Primary School
20.	Dr. Premila V. T. Kanya School
21.	Simga English School

III. Nanpura – Bhatar -- Athwalines Zone identified as *Maharshi Vishavamitra Sankul*

Sr. No.	School
22.	Fountain Head Primary School
23.	South Indian Talent English Medium School
24.	Chandrika Vidyalaya
25.	L. P. Sawani Academy, Vesu

IV. Udhna – Pandesara -- Bamroli Zone identified as *Parashar Sankul*

Sr. No.	School
1.	New Model School
2.	Samiti English Medium School
3.	Matrubhumi Primary School
4.	Sungrace School
5.	Pawan Primary School
6.	Tinkle Star School
7.	Saint Public School
8.	Mary Mata Public School
9.	Jivanvikas Vidyalaya
10.	Sunflower English School
11.	Little Flower School
12.	Saint Andrews Public School
13.	Shrimati Jashwantirani Luthra English School
14.	Khyati Vidyalaya
15.	Sunlight Modern English School
16.	D. L. English Vidyalaya
17.	Samrat Vidyalaya
18.	Sharada Vidyalaya
19.	Samta Vidyalaya
20.	Seventh Day Adventist’s English School
21.	Gyandip Vidyanagar
22.	Shanti Niketan Ideal Academy
23.	Modern English School
24.	N. D. Kothari Primary School
25.	Gujarat Chaitanya Vidyabhavan
26.	Adams Public School
27.	Saintflowers English School

IV. Udhna – Pandesara -- Bamroli Zone identified as *Parashar Sankul*

Sr. No.	School
28.	Shri. Shreyas Vidayalaya English Medium School
29.	G. B. English Medium School
30.	Saint Joseph School
31.	Shri. Acharya Tulsi Vidyalaya

V. Varachha - AK Road - Amroli Zone identified as *Ved Vyas Sankul*

Sr. No.	School
1.	Little Flower English School
2.	Joyce Primary English School
3.	Suncity English School

VI. Puna - L. H. Road Zone identified as *Jamadgni Sankul*

Sr. No.	School
1.	Arihant Vidyalaya Academy
2.	Surbhi Vidya Niketan

APPENDIX - IV

TEST PAPER

APPENDIX IV TEST PAPER

STANDARD V SCIENCE AND TECHNOLOGY

Student's Name: **Total Marks 50**

Roll No:

Division:

Instructions

-Attempt all questions. All questions are compulsory.
-Write answers in the space provided under each question.
-Numbers shown in brackets on the right side of the each question show marks.

Q 1. Encircle the true choice from the given choices for the answers of the following questions. (10)

(1) Indicate the characteristic that is similar between chalk and milk.

(a) Shape (b) Appearance (c) Colour (d) Taste

(2) Give the name of plant whose flowers bend down in the evening.

(a) Touch-me-not (b) Sunflower (c) 'Ratrani' (d) Rose

(3) Name the force that makes windmill work.

(a) Wind (b) Electricity (c) Water flow (d) Coal energy

(4) Select the substance that floats over water.

(a) Milk (b) Orange juice (c) Lemon extract (d) Oil

(5) Name the scientist who proved that music affect the growth of plants.

(a) Newton (b) Raman (c) Bose (d) Graham Bell

(6) Give the name for the process of converting steam into water drops by cooling.

(a) Condensation (b) Evaporation (c) Boiling (d) Excretion

(7) Mention the plant used for medicinal purpose.

(a) Sag (b) Tulsi (c) Shoe-plant (d) Jasmine

(8) Indicate the smallest unit of length.

(a) Kilometre (b) Millimetre (c) Centimetre (d) Metre.

(9) Pick up natural source of light.

(a) Venus (b) Candle (c) Star (d) Torch

(10) Indicate the food item that is not grouped into cereal.

(a) Wheat (b) Maize (c) Rice (d) Gram

Q 2 Answer the following questions in short. **(18)**

(1) Explain with giving two examples that indicate light is necessary to see an object.

(2) How will you determine the presence of air and water in soil?

(3) Seeds do not germinate, if water is logged in the field after sowing the seeds. Explain.

(4) Why is there less chance to find out well in desert areas?

(5) Animals are useful in dispersal of the seeds.-Explain with two examples.

(6) Write two reasons for the judicious usage of coal, petrol, and diesel.

(7) Give two reasons to conserve plant kingdom.

(8) Suppose you are keeping the rose flower in dark box for 8-10 hours where light and water are not given to rose flower. Draw the picture of rose flower with two leaves showing the changes in it.

(9) Suppose your metre-rule is broken and it does not have zero. In such case, how will you measure the length of match-stick using the same metre-rule?

Q 3 (A) Describe the situation of plant, animal and human being in the absence of sun. **(3)**

Q 3 (B) Classify the following plants into herb, shrub, and tree. **(3)**
Basil, Sunflower, Aasopalav, Pipal, Rose plant, Neem, Grass, Vinca

Q 4 (A) Draw the water cycle. Write a note on 'Your life without water'. **(4)**

Q 4 (B) Prepare the daily food menu for yourself and give one reason for it. **(4)**

Break fast:

Lunch:

Dinner:

Reason:

Q 5 Answer the following questions in only one sentences. (8)

(1) Write two names of water soluble substances.

(2) Convert 100 meters into kilo metre.

(3) Three cardboards with holes in the centre of each are placed together with a distance of 5 cm from each. A candle is placed near to the first card board is also seen from the third cardboard. Therefore, what can you say about the property of light?

(4) Write the reason for not comparing the length of bench when its length is measured by two students using their finger and span.

(5) Write any one property of air.

(6) Why do we keep ball and beads in one group?

(7) What is a monocot seed?

(8) How can you say plant shows respiration?

APPENDIX - V

OPINIONNAIRE

APPENDIX V OPINIONNAIRE

Student's Name: **Date:**

Grade: V

Instructions:

1. Read the statements carefully. Put tick (√) mark in any one box from—'Agree', 'Cannot say', and 'Disagree' on the basis of your level of agreement to the statement. Remember to tick (√) mark with relation to science teaching only.

2. This is not your exam. Therefore, there is no right or wrong answer.

1.Paragraph writing activity in science improved writing skill.

Agree = ☐, Cannot say = ☐, Disagree = ☐

2. Breathing in and out and physical exercises made me ready to learn science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

3. Group activity helped in generating new ideas in science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

4. Drawing germinated seeds, plants, and earthworm helped to observe carefully.

Agree = ☐, Cannot say = ☐, Disagree = ☐

5. Listening music of movie clips related to science increased my interest to learn science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

6. I could realise that plants are living when I touched the 'touch-me-not plant'.

Agree = ☐, Cannot say = ☐, Disagree = ☐

7. Observing things in reality was useful to understand the important concepts in science class.

Agree = ☐, Cannot say = ☐, Disagree = ☐

8. Measuring height of plants made me relate plants as living.

Agree = ☐, Cannot say = ☐, Disagree = ☐

9. I could draw the path of light when I arranged the cardboards in a specific way.

Agree = ☐, Cannot say = ☐, Disagree = ☐

10. I felt to take care of animals after watching the movie clip of circus.

Agree = ☐, Cannot say = ☐, Disagree = ☐

11. Knowledge of oneself was useful to develop interest in science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

12. Exercise to think in images gave new ideas.

Agree = ☐, Cannot say = ☐, Disagree = ☐

13. Writing about my own understanding in science class was useful to focus my attention on important concepts taught.

Agree = ☐, Cannot say = ☐, Disagree = ☐

14. Writing characteristics of the living and the non-living in two overlapping circles were helpful to understand differences between living and non-living.

Agree = ☐, Cannot say = ☐, Disagree = ☐

15. Activities in group were beneficial in learning science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

16. Singing songs with clapping was useful to remember science topics easily.

Agree = ☐, Cannot say = ☐, Disagree = ☐

17. Writing conclusion / inference in the activity sheet was useful in arriving at common understanding.

Agree = ☐, Cannot say = ☐, Disagree = ☐

18. I could understand science clearly when I had to relate science topic with myself.

Agree = ☐, Cannot say = ☐, Disagree = ☐

19. Activities to observe germination in onion and *mung* seeds were helpful to understand growth of plants.

Agree = ☐, Cannot say = ☐, Disagree = ☐

20. Doing experiment myself was useful in understanding basic science topics.

Agree = ☐, Cannot say = ☐, Disagree = ☐

21. Learning science was enjoyable when I heard the songs of science clips.

Agree = ☐, Cannot say = ☐, Disagree = ☐

22. Questions asked in science class made me think step by step.

Agree = ☐, Cannot say = ☐, Disagree = ☐

23. Discussion in peer groups helped in clarifying concepts in science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

24. I could understand differences in plants when I observed different leaves.

Agree = ☐, Cannot say = ☐, Disagree = ☐

25. Watching movie clips and PowerPoint Presentation helped to visualize concepts of science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

26. Writing a daily log was useful to correct my mistakes in science class.

Agree = ☐, Cannot say = ☐, Disagree = ☐

27. Encouragement provided by the teacher to sing the songs helped me to remember important science topics.

Agree = ☐, Cannot say = ☐, Disagree = ☐

28. Interpreting graphical data was useful in learning science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

29. The activity of finding words from word-block increased curiosity to learn new words in science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

30. By working in a group helped me know my classmates closely.

Agree = ☐, Cannot say = ☐, Disagree = ☐

31. I could express what I learnt in science when I wrote answers in the activity sheet.

Agree = ☐, Cannot say = ☐, Disagree = ☐

32. Model making was useful activity in understanding concepts in science.

Agree = ☐, Cannot say = ☐, Disagree = ☐

APPENDIX - VI

FOCUS GROUP INTERVIEW

APPENDIX VI FOCUS GROUP INTERVIEW

Following are the questions of focus group interview.

1. Give your views on learning science based on different activities.
2. Did you enjoy performing different activities in science class or at home? What was your experience?
3. How did science learning help you to clarify science topics?
4. What suggestions would you give for further improvement in science learning?

APPENDIX - VIII

PRE TEST - POST TEST

MARKS OF CONTROL GROUP

APPENDIX VIII PRE TEST - POST TEST MARKS OF CONTROL GROUP

Sr. No.	Pre Test	Post test
1.	5	19
2.	4	13
3.	7	28
4.	6	21
5.	5	27
6.	9	24
7.	4	8
8.	4	15
9.	4	21
10.	2	13
11.	7	35
12.	5	7
13.	5	13
14.	7	19
15.	3	6
16.	2	9
17.	6	17
18.	8	15
19.	8	24
20.	3	20
21.	4	27
22.	3	10
23.	5	13
24.	5	12
25.	6	25
26.	6	15
27.	5	15
28.	13	35
29.	8	34
30.	9	27
31.	5	17

APPENDIX VIII PRE TEST - POST TEST MARKS OF CONTROL GROUP

Sr. No.	Pre Test	Post test
32.	5	34
33.	6	13
34.	6	34
35.	10	37
36.	7	18
37.	4	16
38.	9	21
39.	9	29
40.	8	33
41.	9	15

APPENDIX - IX

PRE TEST - POST TEST

MARKS OF EXPERIMENTAL GROUP

APPENDIX IX PRE TEST - POST TEST MARKS OF EXPERIMENTAL GROUP

Sr. No.	Pre Test	Post test
1.	9	20
2.	7	26
3.	9	33
4.	5	39
5.	4	21
6.	4	18
7.	6	19
8.	3	17
9.	5	14
10.	8	15
11.	5	29
12.	10	42
13.	9	26
14.	7	23
15.	3	13
16.	10	40
17.	5	41
18.	5	20
19.	6	15
20.	7	24
21.	11	38
22.	7	15
23.	6	17
24.	3	32
25.	3	17
26.	4	18
27.	6	21
28.	6	40
29.	11	48
30.	5	26
31.	6	20

APPENDIX IX PRE TEST - POST TEST MARKS OF EXPERIMENTAL GROUP

Sr. No.	Pre Test	Post test
32.	5	36
33.	11	18
34.	6	37
35.	10	20
36.	8	45
37.	3	23
38.	12	42
39.	9	43
40.	6	31
41.	6	20
42.	9	44
43.	10	44
44.	6	32
45.	5	27
46.	6	14

APPENDIX - X

MI PROFILE OF CONTROL GROUP

APPENDIX X MI PROFILE OF CONTROL GROUP

Sr. No.	Ling-	Logi--	Spa-	Inter-	Intra-	Musical	Bodily-
1.	5	5	3	7	2	1	5
2.	5	1	3	5	2	5	7
3.	3	3	7	2	5	3	5
4.	3	2	6	6	1	6	4
5.	5	6	5	4	1	3	4
6.	6	5	7	3	2	1	4
7.	6	3	6	5	3	3	2
8.	3	4	5	3	5	4	4
9.	5	3	4	4	3	4	5
10.	7	5	5	2	4	2	3
11.	6	3	3	2	2	6	6
12.	4	3	6	3	2	7	3
13.	4	5	5	4	4	1	5
14.	6	3	5	4	5	2	3
15.	5	4	3	6	1	4	5
16.	4	5	6	3	3	3	4
17.	5	5	4	5	1	2	6
18.	5	3	6	3	5	1	5
19.	6	5	6	2	4	2	3
20.	4	5	2	3	3	6	5
21.	3	6	3	4	2	5	5
22.	4	4	6	4	1	4	5
23.	7	8	4	2	2	3	2
24.	4	4	5	1	5	5	4
25.	4	7	3	1	6	4	3
26.	5	5	5	5	4	3	1
27.	6	4	4	3	3	5	3
28.	6	2	5	1	5	4	5
29.	2	3	6	2	7	3	5
30.	3	3	5	6	2	5	4
31.	7	2	3	3	3	5	5

(Ling- = Linguistic, Logi- = Logical-mathematical, Spa- = Visual-spatial, Inter- = Interpersonal, Intra- = Intrapersonal, Bodily- = Bodily-kinesthetic)

APPENDIX X MI PROFILE OF CONTROL GROUP

Sr. No.	Ling-	Logi--	Spa-	Inter-	Intra-	Musical	Bodily -
32.	6	4	5	2	1	4	6
33.	5	3	4	5	6	3	2
34.	6	3	5	1	2	4	7
35.	5	6	2	1	4	3	7
36.	6	6	5	4	1	5	1
37.	2	6	3	5	3	4	5
38.	4	7	5	2	2	5	3
39.	3	2	3	6	3	6	5
40.	3	2	7	5	3	4	4
41.	5	6	6	4	2	2	3

(Ling- = Linguistic, Logi- = Logical-mathematical, Spa- = Visual-spatial, Inter- = Interpersonal, Intra- = Intrapersonal, Bodily- = Bodily-kinesthetic)

APPENDIX - XI

MI PROFILE OF EXPERIMENTAL GROUP

APPENDIX XI MI PROFILE OF EXPERIMENTAL GROUP

Sr. No.	Ling-	Logi--	Spa-	Inter-	Intra-	Musical	Bodily-
1.	3	3	5	8	1	5	3
2.	5	6	4	4	1	4	4
3.	6	5	6	3	3	1	4
4.	5	7	2	5	1	4	4
5.	7	4	3	4	2	2	6
6.	4	7	2	4	3	2	6
7.	3	1	6	5	4	5	4
8.	5	2	3	7	3	3	5
9.	4	4	5	4	2	4	5
10.	6	5	5	1	5	3	3
11.	3	1	3	5	3	6	7
12.	5	6	6	3	3	2	3
13.	6	6	6	3	2	2	3
14.	2	6	7	3	3	5	2
15.	6	5	5	2	1	4	5
16.	5	5	5	4	2	4	3
17.	5	2	4	5	5	4	3
18.	5	2	5	5	4	3	4
19.	1	4	4	6	5	1	7
20.	1	4	7	5	2	4	5
21.	7	8	4	2	1	2	4
22.	3	5	3	3	4	4	6
23.	4	2	5	2	6	5	4
24.	5	2	4	3	6	4	4
25.	7	8	3	4	1	3	2
26.	8	4	4	2	3	4	3
27.	4	3	4	3	3	7	4
28.	3	4	5	5	4	3	4
29.	7	6	4	4	1	3	3
30.	8	4	6	3	1	2	4
31.	5	8	2	6	2	3	2

(Ling- = Linguistic, Logi- = Logical-mathematical, Spa- = Visual-spatial, Inter- = Interpersonal, Intra- = Intrapersonal, Bodily- = Bodily-kinesthetic)

APPENDIX XI MI PROFILE OF EXPERIMENTAL GROUP

Sr. No.	Ling-	Logi--	Spa-	Inter-	Intra-	Musical	Bodily -
32.	6	6	5	2	3	5	1
33.	4	2	4	3	5	4	6
34.	7	5	5	3	2	5	1
35.	6	1	6	3	1	7	4
36.	4	6	3	3	2	5	5
37.	4	3	6	6	2	3	4
38.	5	7	5	2	2	2	5
39.	4	2	8	2	4	5	3
40.	5	3	6	3	1	7	3
41.	7	4	7	1	2	3	4
42.	6	7	2	3	5	3	2
43.	5	7	5	4	2	2	3
44.	6	3	4	4	1	3	7
45.	6	4	3	4	3	1	7
46.	2	1	6	6	5	3	5

(Ling- = Linguistic, Logi- = Logical-mathematical, Spa- = Visual-spatial, Inter- =Interpersonal, Intra- = Intrapersonal, Bodily- = Bodily-kinesthetic)