Chapter One

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In the traditional teaching learning process students preferentially take in and process information in different ways by seeing and hearing, reflecting and acting, reasoning logically and analyzing intuitively, steadily and in fits and starts. To understand learning styles just think how a learner prefers to learn new things.

According to Claxton and Raltson (1978), "Learning styles refer to individual's response to learning environment". Dunn and Griggs (1998) describe learning style as the way an individual begins to concentrate on, processes, internalizes and remembers new information and skills. They reported that learning style is an individual's reaction to several factors.

Different authors categorized learners in different ways. Based on these various learning style models are presented. On the other hand, teaching methods also vary. Some instructors employ lecture method and others demonstration, whereas, some lead students to self-discovery, others on application, some emphasize on memory and others understanding. The difference between teaching styles of the teacher and learning styles of the students causes serious difficulties in the teaching learning process. The students may become bored and inattentive in the classes, do poorly in the test, get discouraged about the courses, change to other curricula, and dropout of the school. Teachers are confronted by low grades, unresponsive or hostile classes, poor attendance and dropouts. They begin to wonder if they are in right profession. Thus, society looses potentially excellent professionals.

Traditional instructional strategies seem to be out dated, especially for science subject because of the 'nature of the subject'. Students translate many abstract concepts in science into concrete mental images. Thus, instruction is not catering to their learning styles. The NCERT (1990) recommended that appropriate instructional strategies are expected to be adopted in classroom, which would lead to spread scientific awareness among the learners. The National Science Education Standards, USA (NRC,1996) demonstrate as one of its main principles of notion that Science is for all students and curriculum content must be designed to meet the interest, abilities, experiences, understandings and knowledge of students. Accepting diversity in learning styles is accepting the belief that all students can learn (Guild, 1994). In an attempt to match the teaching styles and learning styles Richard Felder (1996) developed a parallel model of teaching styles (appropriate instructional strategies) according to learning styles of students that seems to apply well on students in technical discipline. This needs to be explored in science subject and particularly at high school level.

1.1 SCIENCE INSTRUCTION IN THE CLASSROOM

Science is one of the activities that human beings have created to gratify certain needs, interest and desires. It is a disciplined way of seeking knowledge. For an education built up on reasoning, experimentation and problem solving skills, Science is considered particularly suitable. According to NCERT (1990), science is taught as an essential part of school education up to secondary level because of the organized need of scientific literacy.

1.1.1 Objectives of Teaching Science at High School Level

Following are the objectives of teaching science at secondary school level given by Joshi.S (2005) derived from the recommendations of NPE-86 and NCF- 2005.

(1) To provide deeper insights of facts and principles of science.

(2) To develop their ability to perform scientific experiments more skillfully.

(3) To help them to get better insight into the application of the science.

(4) To provide essential base for higher specialized studies in the field of science.

(5) To develop understanding and attitude for scientific appreciation.

(6) To provide essential base for further studies in higher classes.

(7) To equip students with all the basic scientific knowledge and skills helpful in day to day life.

1.1.2 Status of Science Instruction

The subject deals with many abstract concepts, phenomena and equations. Generally, it is observed that instruction given in the science subject in most of the schools is (lecture based) verbal, intuitive and highly deductive, causes serious difficulties to students in grasping the subject. Umashree.P (1999) found that lecture method was used by 70% of teachers teaching science in secondary schools of Vadodara. According to Armstrong (1994) "for most Americans, the word classroom conjures up an image of students sitting in neat rows of desks facing the front of the room, where a teacher either sits at a large desk correcting papers or stands near the blackboard lecturing the students. He further reveals that this method of classroom arrangement is neither the only nor the best method for

implementing a variety of instructional strategies in the classroom. According to Hofstein (1990), considering that not all the learners may peruse science at higher level, it becomes imperative to meet the needs of both science centred and non-science centred learners. According to Marzin (1987),Rigden (1991),Smith (1991) nature of the subject matter and content have been stated to be important for selection of appropriate instructional strategies. Results have shown that the teachers find the lecture method as most appropriate method for the transaction of curriculum in classroom. In this context, it should be recalled that traditional positivistic presentation of science knowledge and teaching are considered to be inadequate as means of understanding the social aspects (Fleck 1979, Latour 1989, Tobin et al 1990). In case of science teaching, it is important to stress on different aspects of science as a body of knowledge and as a way of thinking (NCERT, 1990, NPE-86). In this context, lecture method as an instructional strategy, is said to have limitations in developing the connection between the experimental evidential supports as expressed by Sinner (1992).

Thus, it is very necessary to adopt such instructional strategies in science subject , which match with the learning styles of students. Lena Ballone and Charles Czerniak (2001) found following advantages and disadvantages of implementing variety of instructional strategies to meet the needs of different learning styles in the science classroom for K-12 science teachers.

Advantages:

- It will make science a good learning experience for all students.
- It will increase student success in the class.
- It will encourage all students to become participants.

- Needs of the students will be met.
- Create students interest.

Disadvantages:

- It may be difficult because of behavior problems.
- Require more planning time and effort for teachers.

1.2 LEARNING STYLES

Learning in a structured educational setting may be thought of as a two-step process involving the reception and processing of information. In the reception step, external information (observable through senses) and internal (arising introspectively) become available to students, who select the material they will process and ignore the rest. The processing step may involve simple memorization or inductive or deductive reasoning, reflection and action, and introspection or interaction with others. The outcome is that the material is either "learned" in one sense or another or not learned.

Learning style has been comprehensively defined as the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. The learning styles diagnosis gives the most powerful leverage yet available to educators to analyze, motivate, and assist students in the schools. It is a foundation of a truly modern approach (National Association of Secondary Schools Principals, USA (NASSP), 1979, p. 132). According to NASPP (1979), "the ability to map learning styles is the most scientific way we know to individualized instruction".

To provide frameworks for growing number of learning styles theories different learning styles models are presented. Models stressing personality include Witkin's (1954) and Myers-Briggs Type Indicator (Myers, 1978). Information processing is the individual's preferred intellectual approach to assimilating information, which include Schmeck's (1983), and Kolb's (1984) models. Multidimensional and instructional preference address the individual's preferred environment for learning and encompass the Human Information Processing Model, Keefe (1989), Dun & Dun(1978) and Felder-Silverman (1988) models. These models are similar because they stress the importance of identifying and addressing individual differences in the learning process. Among all models most commonly used models are (MBTI Mayer-Briggs Type of Indicator), Kolb's Learning style model, Herrmann's Brain Dominance Instrument and the Felder-Silverman model particularly for science education.

1.2.1 Felder-Silverman Model of Learning Styles

Felder and Silverman synthesized findings from a number of studies to formulate a learning styles model with dimensions that should be particularly relevant to science education. Taking the inspiration from many well-known models Richard M. Felder a Chemical Engineering Professor at North Carolina University and Linda K.Silverman an Educational Psychologist at the University of Denver developed a comprehensive learning styles model. It is known as Felder-Silverman model of learning styles.

According to Felder- Silverman learning styles model (1988) a students' learning styles may be defined in part by answering the following five questions.

1) What type of information does the student preferentially perceive: sensory (sights, sounds, physical sensations) or intuitive (memories, ideas, insights)?

2) Through which modality is sensory information most effectively perceived visual (pictures, diagrams, graphs, demonstrations) or verbal (sounds, written and spoken words and formulas)?

3) With which organization of information is the student most comfortable: inductive (facts and observations are given, underlying principles are inferred) or deductive (principles are given, consequences and applications are deduced)?

4) How does the student prefer to process information: actively (through engagement in physical activity, discussion) or reflectively (through introspection)?

5) How does the student progress towards understanding: sequentially (in a logical progression of small incremental steps) or globally (in large jumps, holistically)?

Following are the dichotomous dimensions of the Felder-Silverman model of learning styles.

(1) Sensing and Intuitive perception

(2) Visual and Verbal inputs

(3) Inductive and Deductive organization

(4) Active and Reflective processing

(5) Sequential and Global understanding

The proposed learning style dimensions are neither original nor comprehensive. For example, the first dimension is one of four well-known dimensions of Karl Jung's theory of Psychological type and fourth dimension is a component of Kolb's learning styles model.

1) Sensing and Intuitive Perception

People are constantly being bombarded from both their senses and their subconscious mind. The volume of this information is much greater than they can consciously attend to. They therefore, select a minute fraction of it, admit to their "working memory" and the rest of it is effectively lost. In making this selection sensing learners (sensors) favor information that comes in through their senses and intuitive learners (intuitors) favor the information that arise internally through memory reflection and imagination.

Sensors tend to be practical while intuitors tend to be imaginative. Sensors like facts and observations, intuitors prefer concepts and interpretations. A student who complains about the course nothing to do with real world is almost certainly a sensor. Sensors like to solve the problems using well established procedures, don't mind detailed work, and don't like unexpected twist and complications, while, intuitors like variety in their work, don't mind complexity, and get bored with too much detail and repetition. Sensors are careful but may be slow; intuitors are quick but may be careless. Sensing learners learn best when given facts and procedures, but subject like Science and Maths mostly focus on the abstract concepts, theories, and formulas putting sensors at a distinct disadvantage. Moreover, sensors are less comfortable than intuitors with symbols. Since most of the words and algebraic variables are symbolic, sensors must have to translate them into concrete mental images in order to understand them. This process can be lengthy one. The net result is that sensors tend to get lower grades than intuitors when information is given through lecture method.

2) Visual and Verbal Input

Visual learners get more information from visual images (pictures, diagrams, graphs, demonstrations) than from verbal material (written and spoken words and mathematical formulas). If something is simply said and not shown to visual learners (e.g. in a lecture based class) then there is a chance that they will not retain it.

Presumably, most of the students in the classes are visual learners while the information presented in almost every lecture course is overwhelmingly verbal, written words and formulas in text and on the chalkboard, spoken words in the lectures, with only an occasional use of diagrams, charts or demonstration breaking the pattern. Teacher should not be surprised when many of their students cannot reproduce information that was presented to them not long before. It may have been expressed but it was never heard.

3) Inductive and Deductive Organization

Inductive learners prefer to learn a body of material by seeing specific cases first (observations, experimental results, numerical examples) and working up to governing principles and theories by inferences, while deductive learners prefer to begin with general principles and deduce consequences and applications. Since deduction tends to more concise and orderly than induction, student who prefers to learn structured presentation are likely to prefer deductive approach while, those who prefer less structured are likely to favor induction.

Researches show that of these two approaches to education, induction promotes deeper learning and longer retention of information and gives students greater confidence in their problem solving abilities. On the other hand, it is observed that generally our instruction is,

highly deductive may be because deductive presentations are easier to prepare, control, and allow more rapid coverage of material.

4) Active and Reflective Processing

Active learners tend to learn while doing something actively, trying something active, bouncing ideas of others, while, reflective learners do much more introspectively, thinking things through before trying them out. Active learners work well in groups while reflective learners prefer to work alone. Unfortunately, most of the lecture courses do very little for either group. The active learner never gets to do anything and the reflective learners never have time to reflect. This leads to inattention and passivity.

In a number of studies comparing instructor centered classes (lecture and demonstration) have been compared with student centered (problem solving and discussion), lectures are found to be more effective when students are tested on short-term recall of facts but the active classroom environments are found superior when the criteria involved comprehensive, long-term recall, general problem solving ability, scientific attitude and subsequent interest in the subject. Benefits are also cited for teaching method that provides opportunities for reflection, giving students time in class to write brief summaries and formulate written questions about the material just covered.

5) Sequential and Global Understanding

Sequential learners absorb information and acquire understanding of material in small connected chunks, while, global learners achieve understanding in large holistic volume. Sequential learners can solve the problem with incomplete understanding of the material but they may find difficulty in grasping the big picture, the broad context of a body of

knowledge and it is inter relationships with other subjects and disciplines. Global learners learn in a more all-or-nothing fashion and many appear slow and do poor in their homework and test until they grasp the total picture, but once they have it they can often see connections to other subject.

Before global learners can master the details of a subject they need to understand how material being presented relates to their prior knowledge and experiences, but only exceptional teacher routinely provides such a broad perspective on their subjects.

1.2.2 Other popular Learning Styles Model

Before Felder-Silverman model of learning styles different authors presented many models. Some of them are very popular and frequently used to determine the learning styles of a person or learning styles profile of the group.

1.2.2 (a) VAK Model of Learning Styles

The Visual-Auditory-Kinesthetic learning styles model or 'inventory', usually abbreviated to VAK, provides a simple way to explain and understand your own learning style (and learning styles of others).

'Learning style' should be interpreted to mean an individual mixture of styles. Everyone has a mixture of strengths and preferences. No-one has exclusively one single style or preference. Please bear this in mind when using these ideas.

Alternatively, the model is referred to as Visual-Auditory-Physical, or Visual-Auditory-Tactile/Kinesthetic (or Kinesthetic). Some people also extend the model to VARK (Visual-Auditory-Reading-Kinesthetic) or VACT (Visual-Auditory-Kinesthetic-Tactile), and you can decide yourself about the usefulness of such adaptations.

The VAK learning styles model provides a very easy and quick reference inventory by which to assess people's preferred learning styles, and then most importantly, to design learning methods and experiences that match people's preferences:

Visual learning style involves the use of seen or observed things, including pictures, diagrams, demonstrations, displays, handouts, films, flip chart, etc.

Auditory learning style involves the transfer of information through listening: to the spoken word, of self or others, of sounds and noises.

Kinesthetic learning involves physical experiences - touching, feeling, holding, doing, and practical hands-on experiences.

1.2.2 (b) The Myers-Briggs Type Indicator (MBTI)

This model classifies students according to their preferences on scales derived from psychologist Carl Jung's theory of psychological types. Students may be:

extroverts (try things out, focus on the outer world of people) or **introverts** (think things through, focus on the inner world of ideas); **sensors** (practical, detail-oriented, focus on facts and procedures) or **intuitors** (imaginative, concept-oriented, focus on meanings and possibilities); **thinkers** (skeptical, tend to make decisions based on logic and rules) or **feelers** (appreciative, tend to make decisions based on personal and humanistic considerations); **judgers** (set and follow agendas, seek closure even with incomplete data) or **perceivers** (adapt to changing circumstances, resist closure to obtain more data). The MBTI type preferences can be combined to form 16 different learning style types. For example, one student may be an ESTP (Extrovert, Sensor, Thinker, and Perceiver) and another may be an INFJ (Introvert, Intuitor, Feeler, and Judger). Today in traditional teaching-learning process teacher usually orient their courses toward introverts (by

presenting lectures and requiring individual assignments rather than emphasizing active class involvement and cooperative learning), intuitors (by focusing on engineering science rather than design and operations), thinkers (by stressing abstract analysis and neglecting interpersonal considerations), and judgers (by concentrating on following the syllabus and meeting assignment deadlines rather than on exploring ideas and solving problems creatively).

1.2.2 (c) Kolb's Learning Styles Model

This model classifies students as preferring 1) **concrete experience** or **abstract conceptualization** (how they take information in), and 2) **active experimentation** or **reflective observation** (how they internalize information). The four types of learners in this classification scheme are

Type 1 (concrete, reflective) A characteristic question of this learning type is "Why?" Type 1 learners respond well to explanations of how course material relates to their experience, their interests, and their future careers. To be effective with Type 1 students, the instructor should function as a motivator.

Type 2 (abstract, reflective) A characteristic question of this learning type is "What?" Type 2 learners respond to information presented in an organized, logical fashion and benefit if they have time for reflection. To be effective, the instructor should function as an expert.

Type 3 (abstract, active) A characteristic question of this learning type is "How?" Type 3 learners respond to having opportunities to work actively on well-defined tasks and to learn by trial-and-error in an environment that allows them to fail safely. To be effective, the instructor should function as a coach, providing guided practice and feedback.

Type 4 (concrete, active) A characteristic question of this learning type is "What if?" Type 4 learners like applying course material in new situations to solve real problems. To be effective, the instructor should stay out of the way, maximizing opportunities for the students to discover things for themselves.

Traditional instruction focuses almost exclusively on formal presentation of material (lecturing), a style comfortable for only Type 2 learners. To reach all types of learners, a teacher should explain the relevance of each new topic (Type 1), present the basic information and methods associated with the topic (Type 2), provide opportunities for practice in the methods (Type 3), and encourage exploration of applications (Type 4). The term "teaching around the cycle" was originally coined to describe this instructional approach.

1.2.2 (d) Herrmann Brain Dominance Instrument (HBDI)

This method classifies students in terms of their relative preferences for thinking in four different modes based on the task-specialized functioning of the physical brain. The four modes or quadrants in this classification scheme are

Quadrant A (left brain, cerebral) Logical, analytical, quantitative, factual, critical;

Quadrant B (left-brain, limbic) Sequential, organized, planned, detailed, structured;

Quadrant C (right brain, limbic) Emotional, interpersonal, sensory, kinesthetic, symbolic;

Quadrant D (right brain, cerebral) Visual, holistic, innovative.

Today most of the teachers are found strongly Quadrant A dominant and would like their students to be that way as well, according to Edward and Monika Lumsdaine, traditional instruction consequently focuses on left-brain Quadrant A analysis and Quadrant B methods and procedures associated with that analysis, neglecting important skills

associated with quadrant C (teamwork, communications) and quadrant D (creative problem solving, systems thinking, synthesis, and design). This imbalance is a disservice to all students, but particularly to the 20-40% of entering engineering students with strong preferences for C and D quadrant thinking.

1.3 REVIEW OF RELATED LITERATURE

Review of related literature is one of the significant aspects of the research. It enables the researcher to know the amount of work done in the concerned area. It is necessary that the researcher is aware of the knowledge generated and ongoing process of knowledge generation for better clarity of problem and an insight into methodological issues. For any researcher review forms the basis for the problem under the investigation and helps him/her arrive at the proper prospective of the study.

According to sukhia (1996) "For any worth while study in any period of knowledge, research worker needs to adequate familiarity with the library and its many resources. Only then will an effective search for specialized knowledge be possible".

The research came across many studies related to learning styles and their effectiveness in teaching learning process. The overall reviewed literature is classified into three categories.

1) Studies related to learning styles and its' effectiveness in teaching –learning process.
2) Studies related to instructional strategies adopted by teachers for teaching of Science.
3) Studies related to learning styles in Science.

1.3 (a) Studies Related to Learning Styles and Its' Effectiveness in Teaching- Learning Process

According to Keefe (1979) Learning style has been comprehensively defined as the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. One of the challenges in teaching any discipline is trying to meet the needs of a variety of students. Our style of learning, if accommodated, can result in improved attitudes toward learning and an increase in productivity, academic achievement, and creativity. The most effective learning occurs when the learning activities most closely match the learners' preferred style and that some learning activities are more helpful for particular learners. Similarly, just as different learning styles require different learning techniques; different learners with varied motivations also require different learning styles.

Reid (1987) Hypothesis: A mismatch between teaching and learning styles causes learning failure, frustration and demotivation.

Data Collection: Data were collected through Reid's questionnaire, interviews and tests using 206 EFL students and 46 EFL teachers at a Hong Kong university.

Major Findings: (1) It was found that learners favored Kinesthetic and Auditory and disfavored Individual and Group styles, while teachers favored Kinesthetic, Group and Auditory styles and disfavored Tactile and Individual styles; Western teachers also disfavored Auditory styles. There was therefore a mismatch regarding Group and Auditory styles. (2) Interviews revealed that 72% of the students were frustrated by a mismatch between teaching and learning styles; 76% said it affected their learning, often seriously;

and 81% of the teachers agreed with Reid's hypothesis. (3) The correlations between learning style, proficiency and discipline were also checked. Learners who favored Group styles were significantly less proficient. Conclusions are that EFL teachers should teach in a balanced style in order to accommodate different learning styles.

Riding and Sadler-Smith (1992) investigated an interaction between mode of presentation and style and their effect on learning performance. They believed that structure and organisation of the contents might interact with the wholist/analytical dimension of style. Their conclusion was that the mode of presentation has important effects on learning performance.

Kwok and Jones (1995) carried out an experimental study with a computerised 'front-end' study preference questionnaire (based on Ford, 1985) in order to suggest to the user a suitable navigation method through the system. They found that students at the far extremes of the learning style spectrum needed the navigational guidance, and it helped raise their interest in the material.

According to Pamela Sims (1997) it is needless to place children into special education classes because they learn in a variety of ways like visual, auditory, kinesthetic etc. Teacher must use variety of techniques to satisfy the needs of all their students. When they do not, they some times create failures. In this mismatch between teaching and learning styles, not intelligence often determines how a child will learn.

Graff (1999) tested the relationship between three different hypertext structures (linear, hierarchical and relational) and the performance of the students with wholist-analyst cognitive styles. He suggested that providing different linking structure to individuals of

different cognitive styles would make the learning from hypermedia more effective. No significant differences on recall of information were found.

Alkesh Patel (2000) The characteristics of good language learner in multi lingual context: An investigation in to learning styles of Gujarati learners of English at undergraduate level

Major Findings: (1) The better language learners were found consistent in the use of cognitive strategies than good language learner. (2) It would be wrong to prepare the same kind of instructional material for all language learners (3) It is necessary to prepare specific instructional material keeping in mind the learning styles of various groups.

Ford and Chen (2001) explored relationship between match and mismatch of instruction presentation style with student's cognitive style (field dependent and field independent). They found significant differences in performances on conceptual knowledge for students under two different conditions.

Schroder et al (2002)

Objective: To identify the learning styles of the students entering in the institute

Sample: 4000 entering students in the institute

Tool: Mayer Briggs Type of Indicator (MBTI)

Findings: (1) Students have different learning styles. (2) By utilizing the information about learning styles we could achieve grater congruence between teaching styles and learning styles. If students' learning styles are compatible with the teaching style of their instructors', they tend to retain more information, effectively apply it, and have a better attitude towards the subject.

Namira Bagraktarevic et al (2002) Evaluating what impact the incorporation of learning-styles within educational hypermedia courseware has on learning outcomes. In this study, with its emphasis on GCSE students, the main hypotheses postulated, regarding the mean scores difference, were found to be particularly pertinent and well founded. The findings suggest that students benefited from the learning materials being adapted to suit their learning preferences. The results revealed that students have obvious different preferences for lesson presentation type. The results suggest that the learning outcomes can be improved if designers of hypermedia courseware provide a different sequence and presentation of materials to accommodate individual learning style differences. Hence, possibilities for promoting learning that is more effective are realised. These solid results indicate that learning styles provide a good basis with which to adapt hypermedia to individual needs. Hypermedia design features, based on student's learning styles, such as structural and linking mechanisms, have significant bearing for the future development of adaptive hypermedia systems. The next stage of this experiment is to develop a more adaptive version of the system that automatically tailors itself to users' learning needs. It combines the learning styles described in this experiment with a variety of learning strategies. It provides adaptive navigational guidance and it supports cognitive learning strategies. The system prototype is currently being evaluated.

1.3 (b) Studies Related to Instructional Strategies Adopted by the Teachers for Teaching of Science.

Umashree (1999) Science curriculum and its transaction: An exploratory study in secondary schools of Baroda, Gujarat

Objectives: (1) To study the intentions of science curriculum at the secondary level under operation in schools at Vadodara. (2) To study the curriculum transaction in science in the classroom situation in schools at Vadodara. (3) To gather the teacher's opinion about different aspects of science curriculum (Objectives, Instructional practices, Textbooks) through classroom observations, questionnaires and interviews. (4) To evaluate the congruence between intended and transacted curriculum

Sample: 16 secondary schools of Vadodara city, covering 50 teachers and 240 class sessions of Science in standard VIII, IX and X.

Findings related to classroom instruction:

(1) Lecture method was used in 70% cases.

(2) Lecture cum discussion in 10% cases.

(3) Lecture cum activities in 6% cases.

(4) Non- conventional approaches in 6% cases.

(5) In majority of classes teachers talk predominates say 26 out of 35 minutes, taking a major part of a period without students participation

(6) The investigator noted that even topics, which could easily be related to daily life and experience, were also taught through lecture method only.

Lena M. Ballone and Charlene M. Czerniak (2001) Teachers' belief about accommodating students' learning styles in Science classes.

Objectives: (1) To determine the relationship between the belief structures of K-12 science teachers regarding the use of variety of instructional strategies to meet the different learning styles. (2) To study the relationship between these beliefs and perceived implementation of their relationship in their classroom.

Sample: Two samples of teachers were used for study. 28 teachers from urban, rural and suburban school districts in Northwest and Northeast Ohio. Selected purposively.

For second sample two hundred fifty K-12 teacher were selected on random basis from the list of 4200 names.

Major findings: (1) Teachers believe that implementing a variety of instructional strategies to meet the needs of different learning styles will increase students' success, meet all students' need, motivate students and make science a good learning experience for all students. It will also encourage the students and create interest in science. (2) In order to implement a variety of instructional activities, the teachers express concern with lack of necessary planning time, material, resources and money. The teachers are also concerned with an increase in teacher effort as well as students' behavioural problems. (3) The teachers possess positive attitudes about implementing a variety of instructional strategies to meet the learning styles.

Rathod Shailendra (2004) Identification of the gaps between the teaching styles of the teacher and the learning styles of the students and exploring the possibilities of bridging these gaps through technology

Objectives: (1) To identify the learning styles of the learners with respect to auditory, visual and kinesthetic (2) To identify the teaching styles of the teachers with respect to auditory, visual and kinesthetic (3) To identify the gaps between the teaching styles and learning styles (4) To explore the possibilities of bridging these gaps through technology

Sample: From all the Gujarati medium students of Std. VIII following GSEB syllabi 40 students were selected as a sample using cluster-sampling technique.

Tools: Learning styles inventory available on www.howtolearn.com, observation schedule

Major Findings: (1) 34% students differed significantly when tested on equal probability hypothesis (2) In Science subject 46% of students differed significantly with respect to their Science teacher's teaching styles (3) The learning styles of majority of students differed significantly with respect to their Social Studies teacher's teaching styles (4) All the teachers are not catering to the kinesthetic learners.

1.3 (c) Studies Related to Learning Styles in Science

Okebukola (1986) in his review of preferred learning styles on co-operative learning in science education. Students' preference for competitive or co-operative learning was measured using Learning Preference Scale (LPS). He found students who showed preference for co-operative learning achieved significantly better in a co-operative learning environment than those who were mismatched. This is the evidence of favoring the use of co-operative learning in science. He concluded science teachers must realize that the mode of acquiring knowledge by students is not universal.

Felder R.M. et al (1990) A longitudinal study of engineering student performance and retention. V. comparisons with traditionally taught students.

Sample: For experimental group 123 students who enrolled in the introductory chemical engineering course in the fall 1990, while 189 students enrolled in CHE 205 in the fall 1992 were selected as comparison group

Methodology: Felder and his fellow divided students into experimental group and comparison group. The instruction in the experimental course sequence include extensive active and cooperative learning open ended questioning, multidisciplinary problem formulation and solution exercise, criterion referenced grading and other features designed to address a full spectrum of students learning styles and for comparison group they taught through traditional method.

Major Findings: (1) Retention in the chemical engineering curriculum was higher for the experimental group than for comparison group. (2) The experimental offering of the introductory course served as better gateway to the chemical engineering curriculum than did the comparison offering of the course. The experimental group out performed comparison group in the achievement. (3) The experimental group developed higher critical skill levels. (4) The experimental instructional approach led to better peer interactions.

Foriska (1992) In spite of findings from learning styles research, "Educators use the same traditional environments, instructional practices, and methods, showing little concern for academic potential of students except those with gross deficits". Educators of the new generation must change their beliefs and break from convention. Foriska (1992) illustrated the use of learning styles profile and its implication in the science classroom. Using

cognitive data of seventh grade science students furnished by the learning styles profile, cognitive skills deficiencies were identified. Through the profile data of students, the deficit areas of sequencing, memory, and discrimination were enhanced through effective instructional design. Instructional interventions through new approaches and resources resulted in overall class achievement increased. The scores in the science class that received intervention surpassed those science students who did not received instructional intervention.

Tobias Sheila in Felder.R (1993) " Reaching the Second Tier: Learning and Teaching Styles in college Science Education" . She identified two tires of entering college students (1) Those who go on to earn the science degree (2) Those who have the initial intention and ability to do so but instead switch to non scientific fields. She found following reasons for second tier.

Findings: (1) Failure to motivate interest in science by establishing its' relevance to students' lives and personal interests. (2) Relegation of students to almost complete passivity in the classroom. (3) Emphasis on competition of grades rather than cooperative learning. (4) Focus on algorithmic problem solving as opposed to conceptual understanding.

According to Felder, Richard (1993) in his article "Reaching the Second Tier: Learning and Teaching Styles in college Science Education". The mismatch between the prevailing teaching style in most science courses and the learning styles of most of the students have several serious consequences. Those students whose learning styles is not matched with instructor's teaching styles, they tend to get lower grades than students whose learning styles are better matched to the instructor's teaching style. They also less likely to develop

an interest in course material. If the mismatches are extreme, the students are apt to lose interest in science altogether and be among the more than 20000 who switch to the other field each year after their first year collage course in United States of America.

1.3.1 An Overview of the Reviewed Literature

All the reviewed studies can be classified into mainly three categories. 1) Studies related to learning styles and its effectiveness in teaching –learning process. 2) Studies related to instructional strategies adopted by teachers for teaching of Science. 3) Studies related to use of learning styles knowledge in Science.

The studies of **Know and Jones (1995), Pamela Sims (1997), Alkesh Patel (2000), Schroder et al. (2002)** revealed that students have different learning styles. As a teacher, you have to identify these learning styles. Thus, Teachers must use a variety of techniques to satisfy the needs of all learners.

According to **Keefe (1979), Reid (1987), Riding & Smith (1992), S. Montgomery et al. (1996), Pat Wayman (2003)** learning styles could be used to predict what kind of instructional strategies or methods would be most effective for a given task. They further concluded, if students' style of learning are accommodated then it can result in improved achievement and positive attitude towards the subject.

Susan Montgomery (1994), Graff (1999), N. Bagraktarevic et al. (2002), S.J. Rathod (2004) emphasized use of computer software, multimedia , hypermedia and other technology (ICT) to match teaching and learning styles in multi varied setting of classroom

The studies of **Okebukola (1986), Felder. R. et al. (1990), Foriska (1992), Felder.R. (1993), Tobias Sheila (1993)** revealed that the use of varied instructional strategies

according to students learning styles in science classroom results in higher achievement and positive attitude towards the science.

According to **Lena Ballone & Charlene Czerinak (2001) and Umashree.P (1999)** lecture method is used by most of the teachers for teaching science in classroom. In order to implement variety of instructional strategies to meet diverse learning styles, the teachers express concern with lack of necessary planning time, material, resources and money.

1.3.2 Implications for the Present Study

From the above review of related literature, it is clear that students have different learning styles. The knowledge of students' learning styles could be used to design appropriate instructional strategies in the classroom. Moreover, it improves students' achievement and attitude towards the subject.

Some studies have been conducted to study the role of computer software, hypermedia and multimedia in bridging the gaps between teaching and learning styles. However a very few studies have been conducted to study the implications of learning styles knowledge to design instructional strategies in science subject. Especially in country like India, there is a huge students' enrollment at secondary school level. Many of them find difficulties in grasping the subjects like Science and Maths because of their abstract nature. The review also indicates that by utilizing the information about learning styles a teacher can achieve grater congruence between teaching styles and learning styles. If learning styles match with teaching styles, it results in greater achievement and positive attitude towards the subject. Therefore, It is desirable to conduct a study on learning styles in the science subject at secondary school level. While going through available literature the researcher

found that most of the studies related to learning styles were carried out side India. Therefore, there is a great scope of learning styles research in Indian context.

1.4 RATIONALE OF THE STUDY

In the multivariate setting of a classroom, it is very difficult for a teacher to take care of all students equally according to their individual needs. Teacher cannot satisfy all the students while instructing in the classroom. Unfortunately, most of us have been accustomed to traditional teaching learning process, where one who knows (teacher) presents ideas to one who does not know (students), where the focus is on convergence of materials. The lecture method tilts heavily towards the small percentage of students who are intuitive, verbal, deductive, reflective and sequential. The imbalance puts sizable fraction of the students' population at disadvantage. Sensing, visual, inductive, active and global learners rarely get their educational needs met in their school subjects. If the mismatches are extreme between teaching styles and learning styles students are apt to loose their interest towards the subjects.

A teacher is expected to have a teaching style that will apply to all the students effectively. For that, it is essential to understand 'how each student or class learns best' (learning styles) and design instructional strategies accordingly to the broad spectrum of learning styles. According to (NPE-86), the instruction be individualized to optimize the learning. This means adopting variety of instructional strategies to realize the goal.

Especially Science subject is full of abstract concepts, such as movement of electrons, cell division, astronomy, atoms, molecules etc. Therefore, students find difficulty in understanding the concept if it is not presented visually. Similarly, there are some equations, which should be derived from concrete information inductively, and one of the

aims of Science Education is that it should be related to day-to-day life. However, in most of the schools the instruction is passive, lecture based, deductive and intuitive. According to Umashree (1999) two third of the total population of science teachers are using lecture method for transaction of the content. Thus, society looses the potentially excellent professionals and scientists. Therefore, it is very necessary to design instructional strategies in science subject, which cater to the broad spectrum of learning styles.

The review of literature suggests that similar studies are conducted in this area but most of the studies are carried out abroad and in Engineering field. Similar study taken up by Felder.R.(1990), found that the method constituted the experimental instruction approach using students' learning styles profile have shown significant positive effect on students academic performance, motivation to learn, attitude towards the subject and they have experienced greater improvement in their basic creativity and problem solving ability. Forisk (1992) designed the intervention program based on students learning styles profile and found that the scores in the science class that received intervention surpassed those of science students who did not received instructional intervention. Thus, it is needed to explore it at school level. In India, secondary school level is very important for any student to build the career and further interest towards the subjects. Std VIII is the doorstep of secondary level and from the year 2004 GSEB (Gujarat State education Board) introduced a new CBSE(Central Board of Secondary Education) pattern syllabus in Std. VIII. So, it is necessary to conduct this type of study right from the beginning of secondary level to develop students' interest towards the Science subject.

1.5 RESEARCH QUESTIONS

(1) What is the learning styles profile of Std. VIII students?

(2) What are possibilities of designing the strategies catering to the learning styles of the students?

(3) What is the effectiveness of designed instructional strategies in terms of students' achievement in science subject?

(4) What is the effectiveness of designed instructional strategies in terms of students' attitude towards science subject?

1.6 STATEMENT OF THE PROBLEM

Evolving Instructional Strategies on Science Subject Catering to the Learning Styles of Standard VIII Students

1.7 OBJECTIVES

1) To identify the learning styles of Std. VIII students.

2) To design instructional strategies on science subject catering to the learning styles of Std. VIII students.

3) To study the effectiveness of the designed instructional strategies in terms of achievement of students.

4) To study the attitude of students towards the science subject after the implementation of designed instructional strategies.

1.8 HYPOTHESES

(1) There will be no significant difference in the adjusted mean achievement scores of experimental group and control group.

(2) There will be no significant difference in the attitudes of experimental group and control group towards the science subject after the implementation of designed instructional strategies.

1.9 OPERATIONAL DEFINITION OF THE TERMS USED

Learning Style: It is composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment.

Evolving: It stands for designing, developing and implementing instructional strategies in the context of present study.

Instructional strategies: Instructional strategies are suitable methods and media, employing the potency of ET and ICT.

1.10 DELIMITATIONS OF THE STUDY

The present study was delimited to Std. VIII Gujarati medium students of Kalarav School, Halol in the year 2006-2007. The instructional strategies were designed on only Science subject.