Introduction
CHAPTER - 1

1.1 INTRODUCTION

In the era of globalization, everybody wants to leap ahead in all the areas to lead successful life. Parental expectations are so high that every parent want their child to be a doctor or engineer. Such parental expectations have burdened the children to score good in their academic subjects. This has led to a paradigm shift in researches conducted in the field of education. Most of the educational researches now focuses on the ways of teaching that can enhance the academic achievement of the students using the best available resources. Researches have been conducted to use a number of new teaching learning approaches in order to improve the performance of the learners. Learning as we know is a psychological phenomenon; no two learners in a class are alike. Every learner is distinct from another with respect to the physical and mental features, every one of those are having their own ways of learning styles. Classroom environment which is heterogeneous and contextual where students with different learning styles are found some of them are burdened with parental expectations and build low self-esteem which in turn results into faking student behavior. In such a scenario best of teaching practices cannot yield the desired output. There is a need to change the teaching strategies to improve student learning. Learning will become more enthusiastic when the learning is in their preferred style which therefore can improve the learners’ performance and improve the self-esteem of students. According to Jensen, an educator should expose learners to a variety of styles. He also indicates that to build a successful brain-based learning style approach one should provide a variety of approaches and offer choices.

In brief, the framework of all learning styles and formats if available with teacher, is the most valuable asset to help her determining whether her teaching approach/methodology covers all learners. Teacher has an important role in creating such classroom environment where she can link her teaching with learning experiences. The link should be so consistent that there appears a flow of knowledge and experiences in a constant manner. The flow must involve all the types of pupils. The classroom environment is dynamic and its participants’ characteristics are heterogeneous. In order to cater to the needs of diverse learners and improve their academic achievement, research today has shifted its focus from autocratic and teacher oriented instructional strategies to democratic teaching strategies wherein pupils are given due importance.
in putting their views in front of teacher. Apart from physical participation of students in the
class, it is important to involve their minds and ideas into teaching. Teaching strategies must
cater to the developmental needs of the students. Brain-based instructional strategies are pioneer
in implementing such teaching in classroom that utilizes the developmental principles of human
brain and its needs. These instructional strategies have developed from a new learning theory,
called brain-based learning. Brain based learning is an interdisciplinary theory which has
emerged out of the researches conducted in the areas of cognitive sciences, neurosciences,
educational psychology, sociology, philosophy, technology, etc. The most important
commonality that links neurology, psychology and pedagogy appears to be their overall
objective. Where individually all these disciplines deal with different areas i.e. neurologists
mainly focus on the brain, psychologists on the mind, and educators deal with teaching-learning
process, they all coincide at a point when it comes to human learning. Modern technology has
advanced to an extent that one can have the glimpse of the functioning of human brain. This
research can be in turn helpful in educational field. Information such as functioning of human
brain can be helpful in improving the performance of the learners in different situations. A
number of teaching techniques have been developed as an outcome of the researches in areas
such as cognitive sciences and educational sciences. The researches in all these disciplines had
lead to formation of an interdisciplinary approach termed as Neuro-education. It challenges the
current teaching practices used in the classrooms and calls for a reality check on traditional
beliefs about the teaching-learning process, especially by relating it to developmental principles
of brain. Through brain based instructional principles teachers can apply the scientific
information about brain to the educational context in order to adjust teaching practices that can
improve teaching as well as learning. Though neuroeducation is not an acknowledged discipline
yet, but its impact on defining the parameters of human learning are tremendous. It gives answer
to all such questions of educational field such as:

How do students learn best?

What is individual human potential?

How do we ensure we reach it with every learner?

Such questions have been posed by psychologists, philosophers and neurologists as well.
Neuro-education is beneficial to teachers as well as learners as it provides teaching efficacy to
teachers and ultimate success to the learners. The combination of brain research learning theory
with mankind’s natural curiosity yields into a new horizon of beliefs about teaching-learning process. Therefore neuroeducators are
(a) Educators who know about the brain and how it learns best; and
(b) Psychologists and neuroscientists concerned with improving teaching practices.

Teachers need to learn about neuroeducation because mostly teachers working in our classrooms are trained to focus exclusively on how to teach rather than on how students learn best. On the other hand, neuroscientists and psychologists need neuroeducation because their focus is exclusively on learning and learning theories, rather than improving upon teaching techniques or mechanisms. The focus of learning today has been shifted in the hands of learner keeping in mind the psychological needs of diverse learners. Brain-based learning theory is such a platform for many of the reform efforts in teaching-learning process today. Often teachers do not take into account all the learning differences in their classrooms nor understand the importance of applying different brain-based techniques in different situations. However neuroeducators are staunch believers of the fact that if teaching techniques are linked with the principles of neuroscience, the consequences can be best for teachers as well as learners. Brain-based learning strategies are changing the entire process of teaching-learning as it is practically aware of the dependence of different variables such as physical development on achievement and language acquisition etc. The techniques based on neuroscientific principles takes into account individual learning style by utilizing different strategies. However brain based instructional strategies is not entirely a new approach. Many of the strategies that come under brain based learning are familiar to the teachers today. Therefore it is a reality check to those who are already employing different strategies but are unaware of various facts related to brain. In the name of technology integration or use of ICT in classrooms- instead of books now students read points from power point presentations. Old wine in new bottle. Few decades ago, good teaching was defined as lectures, content-laden classes, reading out the lessons loudly sitting on the benches. Students become passive listeners, they do not learn best in this way. The old traditional autocratic approach of teaching does not fit in today’s learning environment. There is a dire need of changing the process of teaching in order to improve the learning process. Educators need to combine the findings of brain research and understand the concept of brain based learning to
strengthen their teaching techniques. The concept of brain based learning can be discussed as follows.

**Brain based learning**

Brain-based learning aim at improving teaching-learning process keeping in mind the needs of diverse learners. The main objective of brain based learning is to move from memorizing information to meaningful learning. Among currently emerging and advanced learning theories, one of the important learning theories is called brain-based learning theory. This theory offers an alternative understanding of learning by bridging educational practices to the rapidly emerging field of neurobiology. Jensen (2008) describes the resulting concept of brain-based education in these following terms:

The brain is intimately involved in different learning experience. Students’ brains are connected with everything that educators and students usually conduct at school. Brain-based education is best understood in three words: brain based principles, effective brain based teaching strategies, and student engagement. Emerging proponents of the brain-based learning theory favor activities such as goal-setting, using visualization techniques, exercises that require brainstorming, logical thinking, and mind mapping technique etc in the lesson planning process. It is a learning theory which suggests the way of thinking about the learning process. In words of Jensen, 2000 brain based learning basically involve a brain based principles, knowledge and skills, utilizing which we can improve the learning process. It is a learning theory that involves an eclectic mix of teaching techniques. Currently, these techniques are allowing teachers to connect learning to students’ real life experiences. It encompasses such educational concepts as:

- Mastery learning,
- Multiple intelligences,
- Cooperative learning,
- Practical simulations,
- Experiential learning,
- Problem-based learning,
- Movement education.
Brain based learning theory explains that students need to learn the whole and the small pieces of information together. Teaching students about multiple intelligences, learning styles and how their brain functions may help with metacognition. Brain-based teachers consider planning lessons to accommodate students' individual needs (Cain et al., 2005; Sprenger, 2002, 2003). Brain based learning theory incorporates the concept of multiple intelligences. This concept caters to individual needs and fosters important skills. Different types of intelligence are somehow associated to different learning styles. In the book Differentiation through Learning Styles and Memory (2003), Marilee Sprenger explains how differences in learning styles occur: Just as most of us develop a preference for using one hand or the other, and that becomes ‘dominant,’ many people likewise appear to have dominated sensory pathways with which they learn or experience. This difference in learning and intelligence levels of students probably itself explain the need for teachers to use eclectic approach such as brain-based instructional strategies at differentiated levels to account for individual differences. Teachers need to get the knowledge of developmental principles associated with human brain so as identify the situations when student learning is not happening. Knowing how the brain chunks and categorizes information is useful to teachers in helping students connect new information to prior knowledge (Erlauer, 2003; Jones, 2003; Wolfe, 2001). Brain-based learning theory describes brain's natural potential for creativity, use of emotions in enhancing learning and positive stress free environment. Our brains are constantly observing new information, arranging meaningful content, and searching for a pattern. This plasticity or the capacity of the brain to add the new learning experiences to the past is very helpful for teachers in linking theory to practice. Over the years, a number of strategies have been employed in classrooms to improve the teaching learning process, brain based learning theory has just put an order to those activities as per the needs of human brain. It has been demonstrated that enriched environments increase brain’s capacity to learn, grow the number of neurons, and make stronger connections between different neurons leading to increased capacity of brain for learning, which is termed as plasticity. Plasticity relates to learning by adding or removing connections, or adding cells. Brain based learning theory therefore lay stress on providing novel and experience enriched environment for learning keeping in view the plastic nature of brain. Learning in this manner the brain finds connections and develops patterns of information. A number of researches have been conducted in neuroscience field that has important implications in the field of education.
Researches in the area of neurosciences and education

Advancement of technology has enabled the researchers today to analyze the brain activity in real time. It is therefore reasonable to suggest that cognitive neuroscience has advanced to an extent that it has lead to invention of sensitive apparatus called Neuro-imaging technique. This technique can contribute important and practical insights to classroom teaching and learning process and hence of education. Most of researches in neurosciences have been done in laboratory settings which do not have a direct connection to classroom practice. However the findings of these researches can actually be helpful in improving the process of teaching learning.

The researches conducted in the field of neuroeducation fall into two broad categories:

- Studies related to a specific, isolated skill or ability
- Studies focused on cognition as a whole.

Studies related to specific or isolated ability category involves the researches on metabolic changes in the brain under a particular stimulus. Stimulus oriented studies such as Transcranial Magnetic Stimulation (TMS) has been used to measure the changes in motor activities (Butler & Wolfe, 2007)

Researches that focus cognition as a whole includes studies such as how the brain learns, how it is able to read and recognize different words. This research can be helpful to guide teachers in a better understanding of the intricacies of reading sub-skills.

Neuro imaging is an important area which has been helpful in improving educational practices with its extensive research. We may quote the extensive studies that have been helpful to improve the educational process. A research conducted in neuroimaging on how a child solves a mathematics problem explains the neural mechanisms behind the task and this can ultimately help the teachers about better understanding how to teach. Similarly, research of bilingual brains through the technique of neuro imaging helps in clarifying the functions of a monolingual brain.

In spite of the above quoted studies a number of studies have been conducted at Max Planck Institute for Human Cognitive and Brain Sciences with the help of neuro-imaging techniques to find out different areas of the human brain helpful to distinguish between semantic errors (between word choice) and syntactical errors (order of words). It was found that the brain has different systems to manage words or semantics, whereas another system for grammatical structure (Friederici, 2003). This explains why some second-language learners may find it a
difficult to memorize long lists of vocabulary but do miserably learning the grammar of a new language. It has also suggested monolingual teachers that different neural mechanisms are involved in learning to various languages.

Apart from neuroimaging some important areas of neuroscience that is neurogenesis and neuroplasticity are also helpful to inform neuroeducation. Neurogenesis discusses the ways of enhancing new cell growth in brain which can be helpful in improving the learning process of the individuals suffering from neural syndromes. Future studies in neurogenesis may possibly confirm ways to enhance new cell growth in the brain, reducing the fear of losing memory in old age. Research in neuro plasticity has confirms that learning takes place throughout life and not just in the early childhood stage once speculated. (Shore, 1997) the evidence from this research can be practically helpful in influencing our educational policies and life-long learning programs.

Brain research has also provided the evidences that movement or physical activities by the human body enhance the learning experiences. Human brain uses 20% of blood’s oxygen which is helpful in clear thinking of the individual. Under lethargic conditions lesser oxygen flows into brain which causes drowsiness and inattention. Lecture method has been proved to be a less effective teaching technique in higher school because of the same reason i.e. passive reception of information on the part of learner decreases their energy level. Studies conducted by Sholey, Greenleaf and Moss, 2003 on the role of movement in learning have lead to the evolution of an emerging concept of active learning in the field of education. The important tenets of active learning concept include increased students movement which consequently leads to oxygenation of brain that in turn improves the attention span as well as retention (Wolfe, 2001).

Such researches have been helpful in informing the teachers about neuro-education which has given the implications of neurosciences in the field of education. On the basis of the above researches instructional process in the present study has been modified as per the individual needs. Every learner has different abilities in the classroom; the brain based instructional process has kept in mind the needs of human brain and its development. The concept of brain based instructional strategies implemented in the present study is explained below.
Brain based instructional strategies

The brain based instructional process has its primary focus on understanding the learning process by synchronizing it with the brain’s functionality. These instructional strategies lays emphasis on what a learner is performing in the classroom and not on the kind of lecture prepared by the teacher. The learner and his learning process is the focus of brain based instructional strategies. In fact these strategies have been developed in a manner that all the developmental principles related to human brain are used practically. The key concept behind the brain based instructional strategies lies in providing challenging as well as supportive environment wherein the teacher act as facilitator and not as an autocratic administrator (Caine and Caine,).

Giving hands on interactive learning to students is found to be helpful in increasing retention. Prigge, 2002 has suggested some of the strategies which can actually improve the students’ achievement. The strategies suggested are as follows:

- Teaching students about their brain
- Discussing about the Proper sleep hours required for better retention
- Telling importance of water and glucose for human brain.
- Making students aware about different learning styles.
- Establishing positive and interactive atmosphere.
- Integrating media in classroom teaching
- Encouraging students ideas about learning
- Using movement and music
- Utilizing first and last minutes of teaching involving students

Neuro-education has categorized brain based instructional strategies into three domains which are as under:

1) Orchestrated immersion
2) Relaxed Alertness
3) Active Processing

The main focus of orchestrated immersion is to make the gist of the subject meaningful and vivid in learners’ minds. If learners grasp the gist through various sense organs, retention level of the provided information will be increased. Immersion uses different strategies such as using
music, visualization techniques etc for maximum involvement of the learners. It helps in establishing patterns and associations in pupils' brains. (Matema, 2000).

The relaxed alertness implements such strategies that keep in mind the comfort level to be given to pupils for better learning. It focuses on the environment to be provided. The environment should be such that it is meaningful as well as challenging to the learners. However, challenge should be put forward in a way that students should not feel threatened. (Caine & Caine, 1995). Learners need to feel secure and relaxed so that they can take up risks to undertake that challenge. This domain is helpful in changing the thinking and learning styles of learners through establishing associations between the old and new knowledge (Pool, 1997).

Active processing is the theoretical organization and internalization of the meaningful information by learners (Caine & Caine, 2002), it include such teaching strategies that focus on memorizing the content by active and conscious involvement of the learner. Using mnemonics, chunking etc. are the best strategies. Apart from these, efforts made by learner in making creative aids for better learning are also part of active processing domain. As Matema (2000) states, the brain struggles to form meaningful patterns from experiences as it processes information.

Learners make associations to link newly encountered information with previous learning and storing it for the further use. Learning based on these techniques helps the brain to build new connections and consolidate new information. Brain based instructions functions best with hands on interactive learning. BBIS provides academically a fear free environment resulting in superior understanding of the educational material. These strategies increase brain thickness, i.e helps in growing the number of neurons, and the number of connections between neurons leading to increased plasticity of brain. Thus, brain based instructional strategies stimulates students' continual interest in learning. The use of brain-based research would be most effective when combined with previously established frameworks for teaching and learning. BBIS strive to ensure that pupil receive the individualized education that will help them enhance their innate strengths and overcome difficulties they may encounter in school. We must acknowledge this emerging strategy for diversity of minds and usher in a new era of neuroeducational research. (Renate and Caine, 2004)
The theoretical principles of brain research can be put into practice by finding out the strategies meeting the needs of the human brain. Brain based principles can be applied in the educational field with the help of supporting material that can improve the teaching practices. The principles of brain based learning; their educational implications and the material used for supporting the teaching are described below:

**Educational implications of the brain based principles**

<table>
<thead>
<tr>
<th>Principles of brain based learning</th>
<th>Educational Implications</th>
<th>Supporting material for brain based lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>The human brain act as a parallel processor of information.</td>
<td>Teachers should select and utilize variety of learning resources keeping in mind this principle.</td>
<td>Learning resources such as visual aids, clips, charts, auditory aids should be used.</td>
</tr>
<tr>
<td>Learning can be improved by involving entire human physiology.</td>
<td>Ample opportunities should be given for solving a particular problem with the help of discussion and experimentation.</td>
<td>Students learn best when discuss with their friends. They enjoy activities. Therefore activities such as drama etc. should be included to engage their physiology.</td>
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<tr>
<td>Human brain learns the content quickly if it is meaningful.</td>
<td>Teachers should provide a rich environment that is meaningful and challenging for all types of learners.</td>
<td>Light music, seating arrangement, and practical experiences should be given. Application of the subject must be taught as it becomes meaningful for the learner.</td>
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<td>Tendency of the brain for searching the meaning is innate.</td>
<td>To connect and make a pattern, learning must be linked to the previous learning.</td>
<td>Previous knowledge testing should be encouraged. Link the learners knowledge with new learning using themes and aids.</td>
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<tr>
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<td>Human brain processes the information wholly as well as partly.</td>
<td>Teaching must involve students. Students should make the teaching aids for the lessons. Skills should be developed apart from the theoretical knowledge of the concepts.</td>
<td>Demonstrations should be given for the practical topics. Frequent feedback on knowledge is important.</td>
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<tr>
<td>Human brain learns best under focused attention conditions.</td>
<td>Teaching should be interest arousing and must involve the students.</td>
<td>Use charts, mind-maps, music, art exhibits, illustrations, field trips etc.</td>
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<tr>
<td>Human Brain has a tendency to learn consciously as well as unconsciously.</td>
<td>Teacher should engage students in problem solving. Students’ experiences should be shared while teaching.</td>
<td>Experience sharing; think share pair techniques can be helpful.</td>
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<tr>
<td>Brain has two memory systems, one system for rote memory &amp; another for spatial Memory.</td>
<td>Situations should be provided for learning at both spatial level and theoretical knowledge should be given.</td>
<td>Use mnemonics for the matter to be crammed and provider real life experience for maximum topics.</td>
</tr>
<tr>
<td>Humans understand best when facts &amp; skills are consolidated in the memory.</td>
<td>Interdisciplinary approach should be followed. Real life situations should be created in front of students.</td>
<td>Field trips should be organized, role plays are effective in provoking the thought process.</td>
</tr>
<tr>
<td>Human brain loses its capacity to retain new information under threatened conditions,</td>
<td>Teachers should create a relaxed and comfortable learning environment that is challenging.</td>
<td>Use humor, calming techniques, assign leaders in group for the evaluation process.</td>
</tr>
<tr>
<td>Every brain is uniquely structured to learn and retain information.</td>
<td>Teachers should allow students to express in different ways.</td>
<td>Provide learners with options and choices, &amp; allow time for questioning &amp; reflection.</td>
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Scientific development has changed the life of human beings in almost all the spheres. Since education is the pivot of any developing country, it directs the life of all, hence cannot ignore the emerging strategies to improve the teaching-learning process. Educators are now relying more and more on the new instructional strategies as a platform for delivery, communication and interaction. Educationists have attempted to study the relationship of complex human behavior with the processes of the nervous system, particularly of the brain. Modern cognitive psychology views human beings as actively constructing their minds through their exploration into the physical and the social world. Where Piaget suggest that child constructs its mind independently, Vygotsky is of view that mind is a joint construct which emerge as the interaction with the child and adults. The advent of modern cognitive psychology brought a paradigm shift in teaching methods by providing a new platform for teaching and learning from about half a century. In the present scenario, it can be said that there is less than optimal cooperation between neuroscientists, psychologists and teachers. While there are a number of dedicated educators, psychologists and neurologists seeking to construct points of commonality between their fields to and try to utilize the major researches of one discipline in order improve the other disciplines. Brain based learning is one of such platforms that has emerged from the research in neurosciences. One advantage of this new platform is that it takes into account the individual differences among the learners in different learning settings.(Gayle and Carolyn,2002) Just as each learner is unique and one size doesn’t fit all, teachers realize that they need a wide repertoire of instructional strategies from which to pick and choose, adjust and modify. Keeping in mind individual differences, number of new teaching strategies is emerging in order to improve on student achievement. The ideas and processes that a few years ago were foreign to teachers are gaining widespread understanding and are used in the profession today. Studies have shown that to enhance achievement of diverse learners teacher must engage the students in teaching-learning process in a manner that there is a continuous flow of ideas among teacher and learner. Studies on teaching effectiveness (Rosenshine and Frust, 1990) indicate that following attributes should be included in the instructional environment:

a) Frequent feedback to learner
b) Variability in classroom activities
c) Enthusiasm
d) Task oriented instructions  
e) Motivational factors  
f) Tutorial relations  
g) Clarity of presentation.

These attributes if present while teaching process would certainly help in improving achievement of students. Many of the above mentioned attributes can be brought into teaching process by adopting Brain-Based strategies emerged from neuroeducational research. The importance of the valid findings about the brain and learning is immense and these finding has led to development of brain-based teaching practices. Research between the late 1970s and early 1980s also established the first serious link between the brain and learning that went beyond educational psychology and into neurology (Chall & Mirsky, 1983). The goal of neuroeducation, unlike the goals of cognitive neuroscience or neuropsychology, is not only to understand how humans’ best learn, but rather, to also determine how they should best be taught to maximize their potential. The ultimate purpose of neuroeducation is to maximize every person’s individual learning potential specifically within classroom contexts as it relies on a salient feature that all brains are unique. Every learner has different tendency of retaining the information gained. Since 1972 there has been empirical evidence that if teachers give students several seconds to reply to questions posed in class, rather than quick replies, there is increased probability of qualitative answers (Chun & Turk-Browne, 2007). Standards in neuroeducation would ensure that information about the brain’s attention span and need for reflection time would be included in teacher training. The skills, such as reading ability and problem solving in math, are extremely complex and it needs a variety of neural pathways and mental systems to work correctly. Neuroeducational standards make teaching methods and diagnoses more precisely to help teachers in developing such complex skills. Brain-based instructional strategies suggest that there may be several different regions related to different skills. Teacher must observe the student behavior first before arriving at any conclusion about particular skill. These skills should be built in pupils by utilizing students’ talents.

Researches have shown that teachers who use variety of instructional strategies add novelty, choice and individuality allows the diverse learners to find a size that fits and suits and
to engage in practice and rehearsal to deepen understanding through as many learning styles as they can. Brain research shows that when a student’s needs are met, retention of what is taught increases. This improved retention power is attributed to the positive interaction between the student and his or her environment. Therefore educators might benefit from having a basic understanding of the relationship between the brain and the learning environment as well as how to better develop and create a positive classroom environment. Moreover BBIS is based on the idea that instructional strategies are more effective if they occur in an environment compatible with the fact that brain is designed to learn (Sousa, 2001) Teachers can also enhance the classroom environment by introducing specific objects into the room. Proper ventilation by opening the windows and keeping plants in classrooms to increase oxygen levels are advantages for brain-based classrooms, as oxygen is critical for brain function. Make such seating arrangements that it is feasible for all the students to view the demonstrations clearly without congestion. (Jensen, 1998).

**Brain-Based learning and science teaching**

Science is inseparable unit of various academic fields (e.g. Physics, chemistry, biology, mathematics) and is intermingled with real life experiences. Students come across various theories of physical science, definitions of chemical composites, and cell structures. They also come up with anxieties about the ecosystem, earthquakes and volcanic events. Extraterrestrial life, the movements of the planets and solar and lunar eclipses attract students’ attention throughout their lives. It is only natural that they are affected by these events. In order to comprehend the continuous developments in the field of science, students should be aware of the basic science terms and they should gain the science skills throughout their schooling process (Fogarty, 2002). Impact of science can be felt in all human endeavors.

Teaching of science can justify its place in the curriculum only when it gives emphasis on certain important changes in young pupils, changes in their way of thinking, in their habits of action and in the values they endure. Keeping in mind the importance of science in the present world teachers must ensure effective science teaching in order to develop scientifically literate society. The learning and teaching process in science courses should be based on exploration and inquiry. Since the brain inquires meaning and attempts to set associations in a natural way,
exploration and inquiry based science teaching might function compatibly with the principles of brain-based learning approach (Mangan, 1998). Brain based learning aids teachers in facilitating the learning and teaching process. One way of relieving the process is to give learners more responsibilities for their own learning and encourage them to establish associations with the formerly learned subjects and new knowledge in order to form the learning. In order to establish this easiness in the learning and the teaching process, metaphors, thematic teaching, integrated teaching and open ended questions should be used in the learning environment. Education in science serves a very significant role in pupils’ growth. For example, it prepares students to study science at higher levels of education i.e. in graduation. Moreover it prepares students to enter the workforce and excel by taking up careers in the field of science. Further, it prepares them to become scientifically literate citizens of their country. Brain based technique of teaching helps educators catering to all the three purposes of science education successfully.

The process of science teaching, according to the brain-based learning approach, should employ thematic learning skills with a rich language which should be natural but complex at the same time. It should also include long-term structured projects and various evaluation techniques (Holloway, 2000). The use of abovementioned elements of brain based learning yields three important effects on learners and learning process. First of all, learners grasp the gist of how learning takes place since they are involved in the learning process actively. Secondly, they discover that learning depends on their abilities to externalize their knowledge rather than focus on the marks they get in their exams. Finally, they understand that knowing how to think will support their studies. Brain-based instructional strategies are based on some principles which are as follows.

**Principles underlying brain-based teaching**

1. The brain is an organ that processes the information in a parallel manner. It can perform several activities at once.
2. The brain perceives whole and parts simultaneously.
3. Information is stored in multiple areas of the brain and is retrieved through multiple memory and neural pathways.
4. Learning engages the entire body of learner. Learning takes place with movement, good food,
The principles of brain-based learning propose that effective learning could occur only through practicing real life experiences. Learning becomes more expressive when the brain supports the processes in search of meaning and patterning. Accordingly, it enables the learners to internalize and individualize learning experiences. Therefore, it is essential that learners be encouraged to participate in the learning and teaching process actively and that teaching materials be chosen according to their learning preferences. Various teaching strategies which enable learners to feel secure in the learning environment, to enrich learning and to assist the learning process should be utilized. Moreover, classroom activities should be encouraging and should eliminate the learners’ redundant fears and anxiety. In short, brain-based learning puts forward some basic principles such as practicing real life experiences in the learning environment, establishing an effective communication with learners, and guiding learners through their learning processes. By putting these principles into practice, the quality of learning and the level of implementation of the objectives will be promoted. The process of science teaching based on the above principles yields three important effects on learners and learning process. First of all, learners grasp the gist of how learning takes place since they are involved in the learning process actively. Secondly they discover that learning depends on their ability to externalize their knowledge rather than focusing on marks they get in their exams. Finally they understand that knowing how to learn will support their studies and hence achievement. Thus
brain-based instructional strategies may provide an effective teaching and learning approach for teaching science.

Moreover, it has been a common observation that students’ achievement in any subject plays a significant role in providing high self-esteem and in turn a higher self-esteem can be enhanced by effective teaching strategies as an effective teaching methodology can improve on students’ academic achievement which in turn can improve the self-esteem of students. Individuals differ not only physically, mentally and emotionally but they also at the different abilities such as learning a task or skill. These abilities makes learner distinguished on the basis of their achievement, self-esteem and learning styles. Present study has been conducted to see the effect of brain based instructional strategies on achievement and self-esteem of science students with different learning styles. It is therefore important to understand the concept of self-esteem and learning styles.

**Concept of Self-esteem**

Self-esteem is arguably one of the most important constructs in psychology. It has continued to be a topic of theoretical interest among psychologists since the late 19th century. In addition to being a central component of theories of personality, self-esteem has been incorporated also into a number of social psychological processes, including cognitive dissonance, social comparison, and conformity etc. It is a term used in psychology to reflect a person’s overall evaluation or appraisal of his or her own worth. Self-esteem encompasses emotions such as triumph, despair, pride and shame. We all experience problems with self-esteem at certain times in our lives — especially during our teens when we're figuring out who we are and where we fit in the world. Psychologists usually regard self-esteem as an enduring personality characteristic, though few exceptions exist. Self-esteem can be broadly defined as the overall evaluation of oneself in either a positive or negative way. Self-esteem is the one key ingredient that affects the level of proficiency in all fields of endeavor. Self-esteem has been correlated to: success at workplace, academic achievement, compatibility, and internal happiness. Self-esteem construct is recognized today to be a major factor in learning outcomes. Research has consistently shown a positive correlation between how people value themselves and the level of their academic attainments.
The students, who have self confidence, are better achievers, while those who lack self-confidence are low achievers. Whilst the majority of students are likely to have low self-esteem as a result of feeling inadequate over not being able to read, write or spelling, they may have low self-esteem as a result of other experiences, such as beginning in childhood (Lawrence, 2000). There are several studies on self-esteem, a number of which will explore that self-esteem affects the achievement of students.

In the words of Briddle M.J (1985) it is operationalized in terms of a relatively one-dimensional scale comprising generalized characteristics as confidence, competence and worth that are subordinate not specific to particular domain. Self-esteem is defined as appreciating one’s own worth and importance and having the character to be accountable for oneself and to act with responsibility towards other individuals. Self-esteem is person’s global orientation towards self and is majored by the degree to which the person endorses various evaluative statements about the self.

I. Multi Dimensional and Psychological Concept
Self-esteem is a multi dimensional concept as it exists in degrees. Thus an individual might have high self-esteem in interpersonal relations yet can lack esteem with regard to mastery of academics. Esteem is also related to one’s personality identity as William Glaser has noted in reality therapy. According to glaser people have a need to develop a “success identity versus a failure identity”

II. Humanistic phenomenological concept
To understand behavior regarding the concept of dignity, worth and respect as essential core in human beings. Raymond F.G (1969) believed that feelings of worth, adequacy and social approval are very closely related to psychological needs. Thus, we learn and apply society’s values and standards in evaluating ourselves through “reflected appraisal”. Hence, we try to measure out so that we can approve, respect and have faith in our self and feel worthy. If see our self as falling short in these self appraisal we tend to feel worthless, guilty, anguishes and insecure behavior conditions tend to be self destructive rather than self maintaining.
Self-esteem has its early grounding in the mastery of successive developmental tasks, in successful problem solving and coping behavior, receives continual psychological nourishment
from a feeling of competency in areas that gain us social approval. Lacking a sense of personal worth, we tend to become negative in our general approach to living, to criticize and to belittle ourselves, to be discouraged and apathetic and to find little meaning or challenge in life.

III. Self-Evaluation Maintenance Model Concept
Esteem is often affected by how well or poorly a person performs, particularly in comparison to others. According to the self evaluation maintenance model (Tesser, 1988) the impact of relative performance on self evaluation is determined by psychological closeness of self and other and the relevance of the performance dimensions to one’s self definition.

IV. Cognitive Dissonance Concept
According to theory of cognitive dissonance (Aronson, 1980), doing something that is inconsistent with an important belief or value may be threatening to the self and motivates the individual to retain consistency.
Research conducted by (Steele, 1988) suggests that self-esteem is, indeed a unitary process and not a collection of independent process. If we think of each of these mechanism as a stream, self-esteem is the confluence where they come together to influence one another. More work is needed to help us understand the precise process by which this influence comes about.

V. Modern view
Harten, S. (1982) opined that modern theorist believe that children can differentiate between different aspects of themselves (cognitive, social, physical) and self-esteem in making self-evaluation.
According to Magill (1996) self-esteem is a relatively permanent positive or negative feeling about self that may become more positive or negative as a person encounters success or failure in daily life. Sense of personal worth varies from time to time, depending on all kinds of influences. It is related to so many aspects of life that it is difficult to make generalizations about cause and effect.
To summarize self-esteem can be viewed as the personal judgment made by an individual and maintained by him.
Definitions of self-esteem vary in their breadth and sophistication. But all agree that high self-
Esteem means that we appreciate ourselves and our worth. It means:

- We have a positive attitude
- We value ourselves highly
- We feel confident of our own abilities.
- We feel ourselves competent enough to control our own lives.

Positive self-esteem is important because when people experience it, they feel good, they are effective and productive, and they respond to others in quite healthy positive and growing ways. We build our own brands of self-esteem from our ingredients fate, the positive feelings, negative things life offers and our own decisions about how to respond to the fate, the positive and the negative. (Healy, 2002)

According to Branden (2005), there are six pillars of self-esteem: conscious life style, self responsibility, living purposefully, self acceptance, personal integrity and self assertiveness. The signs of high self-esteem are pleasant ones. People with high self-esteem are:

- Accept and learn from their own mistakes
- Confident enough to prove their worth
- Listen to the criticism
- When questioned they are not over defensive
- Remove the obstacles carefully.
- Do not put others down
- Assertive in communicating the needs
- Do not prove themselves aggressively
- Able to tackle things seriously.

In contrast, the signs of low self-esteem include: rejecting compliments, testing, lots of anger, jealousy, conceit, poor school and few friends. Low self-esteem can be linked to dangers in adolescence from depression to isolation, dependency to suicide. The stakes are high, all right but for building and maintaining self in the adolescents is a tough and complicated process.

**Types of self-esteem**

A number of theories have already suggested that self-esteem is a basic human need or motivation. Even an eminent psychologist Abraham Maslow has included self-esteem as one of the important needs in his hierarchy of needs. He has explained two different types of esteem:
1. Firstly the need for respect from others
2. Secondly the need for self-respect, or inherent self-esteem.

The need for respect from others can be in the form of acceptance, recognition, appreciation, and status. This type of self-esteem has been found to be more fragile i.e. can be easily lost than the inherent self-esteem. According to him, an individual cannot grow or excel in life without either type of self-esteem described in his hierarchy of needs. Modern theories of self-esteem explore the reasons humans are motivated to maintain a high regard for themselves.

Another important theory i.e. Sociometer theory believes that self-esteem is a measure or check of an individual’s level or status. In other words it is measured by the acceptance of a person in his social strata or group.

**Major factors of self-esteem**

Four major factors that contribute to development of self-esteem are:

- **Significance**: the way they feel are loved and approved by people important to them;
- **Competence**: performing tasks they consider important
- **Virtue**: Attainment of moral or ethical standards; and
- **Power**: the extent to which they influence their own and others’ lives. People may draw favorable pictures of themselves if they rate high on those measures and low on others.

**Aggression and self-esteem**

Though actually no need is thwarted, but one is humiliated unnecessarily and need to restore one’s adequacy through which aggression is created. Now it is one’s problem as to how one will regain the self-esteem and vent one’s hostility without landing oneself in the jail. Most surviving organisms have attained their survival only through the aid of vigilant ego, an ego that is excessively suspicious and touchy.

**Affection, self-esteem and independence**

Teachers have many opportunities for developing wholesome affectionate relationships with their pupils. But this does not mean that the selection of a teacher’s pet or the lavishing of affection on children; but rather the warm sympathetic mutual regard which is a positive mental health influence on both teachers and pupils. Self-esteem is favorably affected by the respect and
admiration of pupils and parents, perhaps reaching a high point when former students return for a visit.

**Cultural factors**
Culture appears to play a large role in determining how one construes the self. According to Markus and Kitayama (1991), western cultures differ markedly in self construal the former is associated with an independent view of self, the latter with an independent view of self.

**Self-esteem, grades and relationships**
From the late 1970's to early 1990's many Americans assumed as a matter of course that students' self-esteem acted as a critical factor in the grades that they earn in the school, in their relationship with their friends and their success in life in the later years. Given this assumption some American created programs which aimed to increase the self-esteem of students. The research undertaken till 1990 has not validated previously made assumptions. Recently some researches have indicated that inflating students' self-esteem has no positive effect on academic grades. One study has even revealed that inflating self-esteem by itself can decrease the academic grades.

High self-esteem has been found to be highly correlated highly to happiness. However it is not clear that which of the variables affects the other. In addition to this, self-esteem has been found to be related to another variable i.e. forgiveness.

The relationship involving self-esteem and academic results does not signify that high self-esteem contributes to high academic results. It simply means that high self-esteem may be accomplished due to high academic performance.

The concept of self-esteem has become one of the most commonly and widely used psychological terms of the present. Considering how important a variable of self-esteem is, it has been included in the present study. There is a strong connection between self-esteem and academic achievement, keeping this point in mind it was important to the researcher to find out the effect of brain based learning on academic achievement in science. Thus BBIS can help students in attaining high self-esteem by improving teaching learning process.
Concept of Learning Styles

In the recent years there has been a lot of research on learning styles of students at various levels of education. Learning styles are employed to illustrate the application of rigorous qualitative analysis in investigating the actual tasks undertaken by students in the area of higher learning, leading to the description of qualitative differences in learning outcomes. The concept of learning style has been treated as a potential individual difference that might be employed by the teacher to enhance students’ learning. Learning style is simply a way, a method or approach by which students learn. It is the way in which individual begin to learn, internalize and concentrate in order to retain new information. Vermunt (1992-95) Describe the concept of learning style as consisting of four aspects.

1) Processing strategies
2) Regulation Strategies
3) Mental Models of learning
4) Learning Orientation

According to Aggarwal (1982) Learning styles are sum total of Physical, Social, Emotional and environmental elements which affects and helps and individual in course of learning. Since there may be number of combinations of these factors for different persons, there will always be a unique learning style of every individual.

Garger and Gluid (1984) Defined learning style as stable and persuasive characteristics of an individual expressed through the interaction of one’s behavior and personality as one approaches a learning task.

Mcdermott and Betman (1984) stated that learning styles defines the descriptive ways in which a child characteristically goes about the learning process. They include observable problem solving strategies, decision making behaviors and the child reactions to the expectations and limitation of school learning situations in their analysis.

Keefe(1987) opined that the term learning styles customarily refers to the usual cognitive processes through which a learner perceives, codes, organizes and remembers. Styles of learning may also refer to characteristics of the physical environment in which an individual carries on learning. The style is most pervasive phenomenon of the contemporary society. It may be
observed to describe the grace of a gymnast, or the game of football team, the manner and cut of new fashion on the modeling catwalk, the approach used by a commercial company to organize itself, or even the way a person think, learn, talk or teach (Rayner and Riding, 1977). However in the field of psychology, it has been developed in a number of different areas for example, cognition, perception, personality, communication, motivation, learning, teaching, behavior, leadership, management and decision taking etc.

**Learning styles**

A learning style is an individual’s predisposition to learn in a particular way. The ways in which an individual characteristically acquires retains and retrieves information are collectively termed the individual’s learning style. The term "learning styles" refers to the preferred way(s) in which individuals take in new information under the three domains of learning or instructional objectives given by Bloom namely: cognitive (knowledge), and affective (attitude) and psychomotor (skills). In other words, your preferred learning style is simply **how learn best**.

Some of the definitions of learning styles are mentioned below:

- Dunn and Dunn (1975) analyzed learning style as those environmental, emotional, sociological and physical characteristics through which individual learn most easily.
- Claxton and Ralston (1978) defined that learning style as a student's consistent way of responding to and using still in the context of learning.
- Lycock (1978) is of the view that learning style is an individual’s characteristic way of responding to certain variables in instructional environment.
- Gregorc (1979) held that cognitive learning styles are distinctive behaviors which serve as indicators of how a person learns and adapts to the environment.
- In the words of Hayden and Brown (1980) learning style in general can be described as a set of factor behaviors and attitudes which facilitate learning for an individual in a given situation.
- Cornett (1983) holds that learning styles are distinctive behaviors overall pattern that provide a direction to learning and teaching.
Aggarwal (1981) defined learning styles as sum total of physical, social, emotional and environmental elements which affect and help an individual in the course of learning. Since there may be a number of combinations of these factors for different persons there will always be a unique learning style of every individual.

Schmechk (1983) define learning style as a predisposition of the learner to adopt a particular learning strategy regardless of specific demands of the learning style task.

Accordingly to Kaulback (1984), learning styles may refer solely to sensory modality.

Kolb (1984) holds that learning styles are relatively stable attributes of preferences or habitual strategies used by an individual learner to organize and process information for problem solving.

Garger and Gluid (1984) define learning style as stable persuasive characteristic of an individual Expressed through interaction of one’s behavior and personality as one approaches in a learning task

Keefe and Monk (1986) classified learning style as the characteristic cognitive, affective and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with and respond to learning environment.

Dunn and Dunn (1992) define learning style as those emotional, social and physical characteristics of an individual through which he learns most efficiently. In other words these are the ways in which individual begins to concentrate upon a concept, internalize it and finally retain new academic information.

According to Sternberg (2001) learning styles are habitual patterns or preferred ways of doing something that are consistent over long periods and across a variety of activities. Sternberg has given five dimensions of learning styles:

- Functions
- Forms
The common theme of these definitions as well as several others that exist, is that an individual’s learning style is primarily an interactive process between that individual, child or adult and his interaction between the biologically inherent learning propensities and specific environmental demands of the particular situation with which the individual is confronted. It is therefore clear from the definitions that in general, it is a way in which a learner approaches a problem or deals with learning situation.

Models of learning styles

There are many learning models and approaches to learning styles. Corner (2005) has grouped various models of learning styles under the following categories:

Personality dimensions: assess the influence of one’s personality on their preferred approaches to acquiring and integrating information.

Information-processing: based on students preferred cognitive approach to understanding and assimilating information.

Social interaction: looks at how students engage with peers in the classroom.

Multi dimensional and instructional preference: looks at the students preferred environment approach for learning.

Classification of learning styles

Students in a given classroom may vary not only in the things they know and in their capabilities for learning but also in ways in which they approach and deal with a given task.

Experts have proposed several taxonomies for learning styles.

Visual, Auditory, Kinesthetic

Although the theorists may disagree on the vocabulary to describe the four basic types of learning styles, the following are representative categories:

- visual (learn by seeing),
- aural or auditory (learn by hearing),
- Kinesthetic or practical (learn by doing).

Everyone has a learning style. Our actual learning style if invented accurately can result in
improved attitudes toward learning and an increase in productivity, academic achievement, and creativity. Those individuals who do not demonstrate any one or two strong learning style preferences are described as multi-modal learners.

**Dimensions of learning styles**

There are different dimensions of learning styles which differentiates different types of learners. These are discussed as under.

1. The first dimension—sensing versus intuitive—distinguishes between learners who prefer the concrete (sensors), and those who prefer the conceptual (intuitors).

2. The second dimension distinguishes between learners who prefer pictures, diagrams, or charts (visuals) and learners who prefer written or spoken explanations (verbals).

3. The third—active versus reflective—distinguishes between learners who prefer working things out, often in groups (actives), and those who prefer thinking things through, usually alone (reflectives).

4. Finally, sequential-versus-global divides those who prefer linear, orderly learning (sequentials) from the ones who are more comfortable with holistic approaches and learning in large leaps (globals).

Knowing and understanding our learning style helps us to learn more effectively. According to Kolb and Kolb, the concept of the learning style describes individual differences in learning based on the learner’s preference for employing different phases of the learning cycle. Several studies have shown that academic performance of students is related to their learning styles. It is important for teachers to be able to identify early the learning styles of their students and could then alert the students on their potential academic weaknesses and suggest mechanisms for them to cope and adapt their learning at institutions of higher learning after leaving.

Different individuals perceive and process information in different ways leading to distinct learning styles. Diagnosing learning styles help educators to make better program development and instruction decision. It also helps the individual having with different problems in learning, and provides them opportunities to improve upon how to learn better. In the present study learning style has been classified into four types i.e.

Accommodation
Assimilation
Convergent
Divergent

The effect of the brain based instructional strategies on these learning styles is investigated in the present study.

1.2 SIGNIFICANCE OF THE STUDY

In ideal teacher taught relationship subtle and advanced knowledge is imparted by the guru and received by the shishya with all the respect, commitment, obedience and devotion. The student eventually masters/imbibes the knowledge and skills that the guru embodies. A guru shows equal concern to all the students whether gifted, average or an underachiever. Emerging instructional strategies seem to be moving towards authenticating the same when we general concern is seen in educational field regarding the academic performance of students.

Brain based learning has pioneered the teaching learning process in entirely new terms. New teaching Strategies are being developed keeping in mind the functionality of brain development. This new knowledge contributes not only to better teaching practices, but also point ways of unlocking human potential within the classroom setting. While quality information about the brain and learning may exist, teachers might have used all these strategies at some point of time in their classroom but they were unaware of this new area and use of those strategies as per brain development in human beings. If neuroeducation standards become more widely applied, teachers will improve their practice and hence would improve the entire teaching learning process.

By using these strategies teachers can improve their practice, students will gain from an important paradigm shift in education and ultimately society will be the greatest beneficiary. As suggested by one of the thought leaders of the emerging field “no one will consider educators as true professionals until they act like professionals in applying and analyzing the research (Wolfe, 2006).

Present study rests upon a handful of previous attempts to create new standards in teaching practices, and in order to respond to the call for better standards in teaching-learning process. This research is important because it not only theory of how the field has emerged, but also shows where it is heading when applied in the Indian context. The findings of the studies conducted outside India have resulted in positive contributions of this area to the pedagogical
field as they offer proven ways to maximize student learning. The researcher is keen to see the effect of BBIS in classroom context as per Indian conditions, for practical reasons. Much research has been done on BBIS outside India the present study will provide empirical evidence of the effectiveness of this strategy in Indian context.

1.3 STATEMENT OF THE PROBLEM
EFFECT OF BRAIN BASED INSTRUCTIONAL STRATEGIES ON ACHIEVEMENT AND SELF ESTEEM OF SCIENCE STUDENTS IN RELATION TO THEIR LEARNING STYLES

1.4 OBJECTIVES
1. To develop instructional material based on brain-based instructional strategies (BBIS)
2. To study and compare the effect of BBIS and Conventional method on achievement of class VII students.
3. To study the interaction between instructional strategies, achievement in science and learning styles.
4. To study and compare the effect of BBIS and Conventional method on achievement in science of students with Accommodation learning style (LS1).
5. To study and compare the effect of BBIS and Conventional method on achievement in science of students with Assimilation learning style (LS2).
6. To study and compare the effect of BBIS and Conventional method on achievement in science of students with Convergent learning style (LS3).
7. To study and compare the effect of BBIS and Conventional method on achievement of in science of students with Divergent learning style (LS4).
8. To study and compare the effect of BBIS and Conventional method on self-esteem of class VII students.
9. To study and compare the effect of BBIS and Conventional method on self-esteem of class VII students with respect to different learning styles.
10. To study the interaction between instructional strategies, self-esteem and learning styles.
11. To study and compare the effect of BBIS and Conventional method on self-esteem of students with Accommodation learning style (LS1).
12. To study and compare the effect of BBIS and Conventional method on self-esteem of
students with Assimilation learning style (LS2).

13. To study and compare the effect of BBIS and Conventional method on self-esteem of students with Convergent learning style (LS3).

14. To study and compare the effect of BBIS and Conventional method on self-esteem of students with Divergent learning style (LS4).

1.5 HYPOTHESES: In the light of above formulated objectives, following hypotheses were formulated in the present study.

HYPOTHESES FOR ACHIEVEMENT IN SCIENCE OF CLASS VII SCIENCE STUDENTS

H₁ The two instructional treatments will yield equal mean gain scores on achievement in science of class VII students.

H₂ The students with different learning styles will yield equal mean gain scores on achievement in science.

H₃ There will be no significant interaction between instructional treatments and learning styles of science students with respect to achievement in science.

H₄ There will be no significant difference in the achievement of students of experimental and control group with respect to Accommodation learning style (LS₁).

H₅ There will be no significant difference in the achievement of students of experimental and control group with respect to Assimilation learning style (LS₂).

H₆ There will be no significant difference in the achievement of students of experimental and control group with respect to Convergent learning style (LS₃).

H₇ There will be no significant difference in the achievement of students of experimental and control group with respect to Divergent learning style (LS₄).

HYPOTHESES FOR SELF-ESTEEM OF CLASS VII SCIENCE STUDENTS

H₈ The two instructional treatments will yield equal mean gain scores on self-esteem of class VII students.

H₉ The students with different learning styles will yield equal mean gain scores on self-esteem.

H₁₀ There will be no significant interaction between instructional treatment and learning
styles of science students with respect to self-esteem.

\[ H_{11} \] There will be no significant difference in the self-esteem of students of experimental and control group with respect to Accommodation learning style (LS1)

\[ H_{12} \] There will be no significant difference in the self-esteem of students of experimental and control group with respect to Assimilation learning style (LS2)

\[ H_{13} \] There will be no significant difference in the self-esteem of students of experimental and control group with respect to Convergent learning style (LS3)

\[ H_{14} \] There will be no significant difference in the self-esteem of students of experimental and control group with respect to Divergent learning style (LS4)

1.6 DELIMITATIONS OF THE STUDY: Present study was delimited to following areas:

1) The study was conducted on class VII science students only.
2) The BBIS was developed for few topics of science from prescribed syllabus of class VII of CBSE/NCERT
3) The experiment was limited to about two months of the academic session.
4) The study was delimited to a Jawahar Navodaya Vidyalaya school of Chandigarh.