CHAPTER II

REVIEW OF LITERATURE

2.1 Introduction

Survey of related literature is very important in research. It is a valuable guide to defining the problem, recognizing its significance, suggesting promising data-gathering devices, appropriate study design, and sources of data. “The review of related literature helps the researcher to reports of studies of closely related problems that have been investigated, design of the study, including procedures employed and data-gathering instruments used, populations that were sampled and sampling methods employed, variables that were defined, extraneous variables that could have affected the findings, faults that could have been avoided, and recommendations for further research” (Best and Kahn, 2006).

“The literature in field forms the foundation upon which all future work be built. He also observes that if one fails to build this foundation of knowledge provided by the review of the literature his/ her work is likely to be shallow and native and will often duplicate work that has already been better by someone else” (Borg and Gall, 1989).

2.2 Purpose of Review of Literature

Complete survey of related literature gives the researcher necessary insight into the problem that leads him to think about his approach for the study. Good (1972) analysed the following purposes of the survey of related literature.

- To provide ideas, theories, explanation or hypotheses valuable in the formulating the problem.
- To avoid the risk of duplicating the same study already undertaken.
- To suggest methods of research appropriate to the problem.
- To locate comparative data useful on the interpretation of results.
- To contribute the general scholarship of the investigation.

In this chapter, the investigator attempts to present a brief overview of the matters, which are relevant to the study, based on the previous literature. Basing on these studies, the investigator has attempted to work on this subject.
The important aspects of the present study are very relevant to the field of education. It is an attempt to study the effect of Brain-Based Learning Strategy on academic achievement and creativity among secondary school students. This chapter is presented in two heads.

2.3 Theoretical Perspective of Brain-Based Learning Strategy

2.4 Studies related to Brain-Based Learning Strategy

2.3 Theoretical Perspective of Brain-Based Learning Strategy

Theoretical Perspective of Brain-Based learning Strategy is given below:

The great mystery in this universe is the human brain. All brains are unique and are the products of interactions with different environments generating a lifetime of different and varied experiences. It performs an incredible number of tasks such as the power to think, plan, speak, imagine etc. New neural pathways are created whenever we use our brain in linking through problems, but are lost forever if we do not use them.

2.3.1 Brain and Learning

To understand how the brain learns, a basic understanding of the anatomy and physiology of the brain is necessary. The largest and the most highly evolved part of the brain is called the cerebrum or the neocortex. Higher order thinking and decision making occurs here. The cerebrum is composed of two hemispheres which connects the neural highway by the corpus callosum. Information travels along the corpus callosum to each hemisphere so that the whole brain is involved in most activities. Each cerebrum is composed of four lobes: frontal, parietal, temporal, and occipital. Each lobe depends on communication from the other lobes, as well as from the lower centers of the brain, to complete its specific activities.

The neurons and interneurons work together, due to which our daily learning experiences are created. The multiple areas of the brain communicate and work together for the learning to occur. According to Fishback (1999), “the creation of neural networks and synapses are what constitutes learning”. There are billions of neurons, and the number of synapses is more than 10,000 times the number of neurons (Hill, 2001). Thereby the network of synapses makes possible cognition of human learning. Communication between neurons at a synapse is accomplished by the release of chemicals and electrical signals. At the synapse, an axon sends messages to the next organ or nerve by releasing
hormones or neurotransmitters such as adrenaline and dopamine. These transmitters tell the organ or nerve what to do. Axons modify and grow in response to any brain activity, such as learning. Learning puts demands on the brain, and the brain responds by developing new circuits to connect new information to current or past knowledge.

The midbrain area is deep inside the cerebrum controls to where incoming information goes (Jensen, 2000). The brain stem is the most primitive and deepest part of the brain which is responsible for our instinctual or survival behaviours. This area of the brain is the first to respond to trouble, and is the area of the “flight or fight” response. When a student feels threatened the brain can ‘downshift’ to the brain stem making the learning impossible.

2.3.2 Left and Right Sides of the Brain

The two hemispheres of the brain, involved in higher cognitive functioning have their own unique specialisation. Left brain is the logical hemisphere. It recognizes letters, words and numbers, detects time and sequence, assists, and also evaluates factual material in a rational process. The left brain engages learners in visualization and goal-setting activities, decision-making scenarios, and exercise that require logical thinking, brainstorming, and mind mapping.

The right brain is the intuitive hemisphere. The right brain people will seek a more creative environment. They may prefer group discussions rather than being dictated to by a teacher and assemble information more from images than from words. It clarifies language through content and voice in mind rather than through literal meanings. Listening to what someone speaks may seem like a left-hemisphere activity since the left side processes words, definitions, and language (Jensen, 2000). On the contrary, however, evidence suggests that the right hemisphere process the inflection, tonality, tempo, and volume of the communication elements that are actually more critical to the meaning of a conversation than the words themselves.

Within the brain, all parts always interact. In other words, the left brain processes are enriched and supported by right brain processes. Because learners make connections best when learning materials are embedded in meaningful life events and in socially interactive situations. Vygotsky (1978) also emphasized the learning in social activities
should be highly brain compatible. So, teachers should create brain friendly environment through Brain-Based Learning.

2.3.3 Brain-Based Learning

The ‘Decade of the Brain’ spawned a multitude of brain research and educational theories known as Brain-Based Learning. This Brain-Based Learning theory includes certain principles which are significant for the teaching-learning environment. Brain-Based Learning is an instruction which takes into consideration how brain takes, processes, interprets information; makes connection, stores (like making connection, coding, constructing matrix), and remembers the messages (Greenleaf, 2003). It is also an active process where students are actively engaged in constructing their own knowledge in a variety of learning situations and contexts (Caine and Caine, 1994, 1997; Caine and Caine and Crowell, 1999).

Experiences, thoughts and memories are always embedded in emotions and corresponding physiological and psychological states making the students find out and justify the answers themselves. This is the essence of Brain-Based Learning. The best learning comes true with making use of the variety of experiences which is intensively stimulated, music, role-playing, drama, art, colors, graphics, figures and metaphors (Sylwester, 1995; 2000; Jensen, 2000; Dhority and Jensen, 1998; Duman, 2004).

2.3.4 Core principles directing Brain-Based Learning

Researches on the brain, has identified the following 12 basic principles as the essential structure stones of Brain-Based Learning (Caine and Caine, 2000; Aziz-ur-Rehman, 2011).

1. **The brain is a parallel processor**

   The brain does multi-tasking functions simultaneously like seeing, thinking, listening, speaking responding etc. without any disturbance. Teachers should make use of diversified approaches to elaborate the concepts and satisfy the needs of brain.

2. **Learning engages the entire physiology**

   Brain-Based Learning has a strong belief that a healthy body possesses a functional brain and vice versa. Teacher should display a chart of balanced diet in the classroom and inform learners periodically about nutrition and hydration. Moreover, free physical movements decrease stress levels and generate new pathways to memory.
3. The search for meaning is innate

Human beings seek meaning and purpose during topics of interest through an instinctual drive (Frankl, 2006). In case of rote memorization or threatening situations, the brain ceases functioning normally and goes into the state of downshifting. Downshifting is a psycho-physiological modified state of brain wherein it feels itself in a helpless condition. To get out of a downshifted state, the brain gets relief to do a task repeatedly. Teachers need to relate the content to student interests in order for deep cognition to occur. Students must be encouraged to reflect on their mistakes and learn from them thereafter.

4. The search for meaning occurs through “patterning”

Learning process should be organized in a way so that brain creates patterns themselves. Teachers should encourage the grouping of information through student experiences, asking questions, problem solving and projects. Sufficient time must be given to students for generation of patterns.

5. Emotions are critical to patterning

Emotions and learning are mutually correlated. The moods, biases, prejudices, feelings, self-esteem, social interactions and psychological needs generate emotions to function accordingly, thereby determining the depth of understanding and mastery. Teachers should present information to students in a way that encourages a positive emotional connection to the material.

6. The brain processes parts and wholes simultaneously

The brain has the ability to integrate steps of a task when the skill is given as a whole. Brain works systematically and absorbs incoming data by disintegrating the complex information into smaller pieces, which are further blended back into easy-to-understand form. The left and right brain capacities may also involve in creating parts and wholes as well.

7. Learning involves both focused attention and peripheral perception.

Learning by focused attention occurs during classrooms where teachers impart fresh ideas and learners gain information through processing them by their brains. The peripheral perception occurs unknowingly during classroom sessions and observant brain records apparently less important looking data automatically. Teachers should engage the
students in learning, as well as create a physical environment that indirectly conveys the message of the content being taught.

8. **Learning always involves conscious and unconscious processes**

Conscious learning is analogous to focused attention learning and unconscious learning is analogous to peripheral perception learning. This promotes metacognition, whereby encouraging a higher order of thinking. Teachers can promote higher-levels of thinking in students by incorporating reflection of learning and questioning results.

9. **We have (at least) two types of memory systems: spatial and rote learning**

   The brain has both short and long-term memories. Memorization makes poor understanding of concepts. In short term memory, the information is faded away after some time due to absence of its regular rehearsals. Teacher should take measures to enhance the spatial memory storage of learners by recognizing their emotions, creating sensory associations, relating learning personally to students, using creative repetition, remembering the importance of start and end of a lesson; and teaching specific recall techniques (Prigge, 2002).

10. **The brain understands and remembers best when facts and skills are embedded in natural spatial memory**

    The strengthening of natural spatial memory results in a permanent storage of information which can be retrieved any time. Classroom interactive environment and absence of threat or fear activates the connection formation of brain considerably and learning takes place as it must be. Teachers can use progressive learning approach, incorporating reflective learning activities.

11. **Learning is enhanced by challenge and inhibited by threat**

    The brain works well in a challenged situation and downshifts in a threatened atmosphere. Teacher should generate an atmosphere that is low in threat and high in challenge. Teachers can focus on student-centered, hands-on activities that foster positive peer-social interactions, and ensure students’ success.

12. **Every brain is unique**

    Each brain is made up of a mix of unique genetics and experiences. Teachers must acknowledge the individual differences of learners. Diversified learning activities must be introduced so that all individuals may extract meanings of their own levels.
2.3.5 **Aim of Brain-Based Learning**

The aim of the brain-based learning is to pass from memorizing through meaningful learning. Approaches of brain-based learning integrate the engagement of emotions, nutrition, enriched environments, music, thematic learning, integrating curriculum, movement, meaning making, and the absence of threat for maximum learner participation and achievement.

It requires use of three interactive elements (Caine and Caine, 1990).

- Orchestrated Immersion
- Relaxed alertness
- Active processing

The details of these techniques are given as follows: (Aziz-ur-Rehman, 2011)

- **Orchestrated Immersion (OI)**

  In Orchestrated Immersion, the learner is exposed to a variety of teaching-learning activities. The main focus of orchestrated immersion is to make the learners grasp the gist of the subject meaningfully. As a result, retention level of the new input will be increased. Making learning contextual and related to student interests; structuring learning around real problems; and aiding learning with humour are also helpful in Orchestrated Immersion (Lucas, 2004). To trigger creativity among learners, Caine and Caine suggest ‘*dynamic gestalts*’ must be offered to them. Dynamic gestalts are the comprehensive patterns of understanding which incorporate fragments of information into a cohesive meaning and thereby students can explore more and more facts. Following opportunities may be given by-

  a) Allow students to physically interact with what is to be learned.
  b) To extract meaningful patterns, students must be provided diversified opportunities so that neurotic connections are maximized.
  c) Both students and teachers mutually plan the teaching lesson.
  d) Making associations with what is being experienced and linking it to what one already knows.
  e) Formulating questions, raising doubts and sharing views.
f) Performing in variety of ways like expressing thoughts through pictures, drawings, poetry, story and

g) Receiving feedback from others.

h) The activities which involves hand, heart and head leads to meaningful learning.

❖ Relaxed Alertness (RA)

Relaxed Alertness means the brain is alert but relaxed, confident, comfortable and intrinsically motivated. It enables the learners to receive information from a friendly teaching learning environment, free of threat or negative stress, and it is rather highly challenging for the learners.

Caine and Caine (1997) proposed the following elements of instruction that incorporate Relaxed Alertness into teaching.

a) Students’ responses to different stimuli within classroom depend upon thinking and feelings of the teacher.

b) Relaxed Alertness prevails under two conditions, namely the childlike state and passive listening.

c) Relaxed Alertness helps in inculcating information naturally. The themes must be presented intelligently along with the social interactions of learners which are consistent with real-life experiences.

d) Meditation and focusing exercises improve physical functioning of body and attention level of learners.

e) Evaluation techniques instead of grading and testing must be reconstructed and educative feedback must be introduced.

f) Orderliness makes students creative, excited and spontaneous.

❖ Active Processing (AP)

Active processing is a continuous process of deep understanding where the individual tries to relate it with the stored information, consolidate and internalize it by actively processing for learning. Active processing does not occur at a specified time or in a single instance but is reshaped or reconstructed meanings with experience in an exploring way. Active processing of information involves:
a) Detailed sensory observation;
b) Deliberate practice and rehearsal;
c) Making links to previous learning;
d) Multiple modes of questioning;
e) Incorporation of expert knowledge;
f) Analysis of data and sources;
g) Writing reflections.

According to Caine and Caine (1991), the five elements of Active Processing are:

i. **Capitalizing (benefiting from) on an experience**

   Student capitalizes on a learning experience by asking questions which enhances the intrinsic motivation.
   
   ☑️ What did I do?
   
   ☑️ Why did I do?
   
   ☑️ What did I learn?

ii. **Reflection**

   This complex process is related to higher order thinking and learning which occurs through feedback, without anybody’s assistance and personal awareness of deep meaning of a learning experience.

iii. **Contemplation**

   It is a non-analytical style of thinking which prevents learners to create misconception in understanding an idea. Focussing is a particular technique of contemplation by which a learner thinks on an idea internally and draws conclusions out of it.

iv. **Creative Elaboration**

   This idea can be done in three ways.
   
a) The experience must be reorganized in different ways and from different points of view.
b) The idea must be literally and metaphorically turned upside down to reperceive information.

c) Personal analogies must be used to elaborate an idea like compare and contrast to fit new information into already existing relevant ones.

v. Combination Process

It promotes all procedures of reflection and contemplation in different ways. Students must be encouraged to write in diaries and bring out their actual thoughts. Academic achievement and creative thinking skills must be enhanced with sufficient time reserved for teaching.

If students make efficient use of Brain-Based Learning Strategies, learning becomes contextual and the learners become well-versed in decision-making, forming cooperative groups, locating resources, and applying the knowledge.

2.3.6 Strategies of Brain-Based Learning

The various strategies of Brain-Based Learning are

- KWL
- 4 MAT
- Thematic Instruction
- Concept mapping
- Graphic organizer
- Project based learning
- Expository learning
- Mind Mapping
- Reciprocal teaching
- Real life dilemma
- Cooperative learning
- Case based learning
- Movement Education
- Real life dilemma
- Reflective Writing
- SQ3R
- Advance organizers
- Simulations
- Analogies
- Role Play
- Problem solving
- Semantic Maps Visual Maps
- Mnemonic devices
- Brain teasing games
- Word webs and puzzles
- Drawing/Artwork
- Metaphoric Activities
- Music/ Rhythm/Rhyme
- Visualization/Guided Imagery

The investigator had made use of following Brain-Based Learning Strategies in the study

1. KWL (What you Know, what you Want to know and what you Learned)

A KWL chart is a graphical organizer created by Donna Ogle in 1986. The chart is a student centered comprehension strategy used to engage students in a new topic, activate prior knowledge, share unit objectives, and monitor learning. A KWL table is divided into
three columns; the first column, ‘K’, is for what the students already know about a topic. This step is to be completed before reading. The second column, ‘W’, is for students to list what they want to learn about the topic during reading. This step is also to be completed before reading. The third column, ‘L’, is for what the students learned from reading. This last step is done after finishing the reading. The KWL chart can also be used in reading instruction at the beginning of a new unit. Further, the teacher is able to find out what the students have learned by the end of their lessons.

2. **Integrated Thematic Instructions (ITI) Model (Thematic learning)**

   Integrated Thematic Instruction (ITI) is a comprehensive brain-compatible instructional model designed by Susan Kovalik in 1982. Pedagogy emphasises on choosing a specific theme for teaching one or many concepts to increase student performance.

   Teachers incorporate thematic instruction through research-based strategies such as:

   a) Choosing authentic themes strengthens students’ ability to build fluency between school subjects and apply them in real-world contexts.

   b) Employing cooperative grouping to support problem-solving and cooperation.

   c) Designing inquiry-based learning experiences.

   d) Allowing students to construct new knowledge, promote self-direction, autonomy and collaboration.

   e) Creating a multiple resource-rich classroom environment.

   f) Extend and connect classroom to the local surroundings and environment.

   g) Collaborate with teachers by sharing content expertise.

   h) Provide timely, instructive and authentic feedback.

   i) Link authentic assessment to real-world performances.

   j) Employ appropriate technology tools effectively for students to explore ideas, engage in simulations, and make new connections.

3. **Concept Map**

   A concept map is a graphical tool for organizing and representing concepts. The technique was developed by Joseph D. Novak and his research team at Cornell
University in the 1970s. Concept maps connect multiple words or ideas, usually represented as boxes or circles, are connected with labelled arrows in a downward-branching hierarchical structure. Thus a concept map is a convenient and concise representation of conceptual framework about any type of knowledge and can hence be defined as an ‘interlocking’ network of “newly & previously acquired knowledge” of the learners.

**Steps of Concept mapping**

1. Select key concepts. This is a recognition process that activates relevant knowledge, and assists in topic identification.
2. Write the key concepts.
3. Make an attribute list of the key concepts.
4. Relate key concepts in a spatial relationship.
5. Rearrange spatial representations.
6. Compare representation to the text.

**4. Graphic Organizers**

A graphic organizer is a visual and graphic display that depicts the relationships between facts, terms, and or ideas within a learning task. Graphic organizers come in many different forms, each one best suited to organizing a particular type of information.

The following are types of graphic organizers.

**Relational Organizers**

- **Descriptive or Thematic Map** Suitable for mapping hierarchical relationships.
- **Fishbone Map** Suitable for complex and non-redundant cause-effect relationships.
- **A Network Tree** Organizes a hierarchical set of information, reflecting superordinate or subordinate elements.
- **Cycle Map** Useful for organizing information that is circular or cyclical, with no absolute beginning or ending.
• **Event Chain Map** Involves a linear chain of events, with a definite beginning, middle, and end chain of events

• **Comparative and Contrastive Map** Helps students to compare and contrast two concepts according to their features.

• **Venn diagram Map** Useful for examining the similarities and differences between two items.

**Concept Development Organizers**

• **Problem and Solution Map** Organizing information which contains cause and effect problems and solutions.

• **Star Map** Ideal for investigating attributes associated with a single topic.

5. **Project based learning (PJBL)**

   John Dewey initially promoted the idea of ‘learning by doing’. Project Based Learning emphasizes student-centered instruction by assigning projects to construct their own learning and culminates in realistic, student-generated products. Students form their own investigation of a guiding question, allowing students to develop valuable research skills as students engage in design, problem solving, decision making, and investigative activities. PJBL provides the students' problem solving, decision making, investigative skills, and reflection that includes teacher facilitation, but not direction.

   To implement Project-Based Learning, the following six steps are used:

   1. Start with the essential question
   2. Design a plan for the project
   3. Create a schedule
   4. Monitor the students and the progress of the project
   5. Assess the outcome
   6. Evaluate the experience

6. **Expository teaching**

   Expository teaching strategy is basically direct instruction. Expository instruction involves one-way communication; that is, communication from the teacher or expert to the student. A teacher is in the front of the room lecturing and students are taking notes.
Students are being told (expository learning), what they need to know. It involves presenting clear and concise information in a purposeful way that allows students to easily make connections from one concept to the next. The structure of an expository lesson helps students to stay focused on the topic at hand. Generally the expository teaching begins with an introduction and overview of the topic before providing more specific information and detail. This expository strategy sets up the lesson and prepares the students for what is to come. By moving from the general to the specific, it allows students to understand the increasingly detailed explanations of the information and link those explanations to information that was presented previously as part of the general overview.

7. Mind Mapping

A mind map is a diagram used to generate, visualize, structure, and classify and represent words, ideas, tasks, or other items linked to and arranged around a central key word or idea. The term ‘mind map’ was first popularized by Tony Buzan as an aid to studying and organizing information, solving problems, making decisions, and writing. Mind Maps encourage creative problem solving, and they hold information in a format. Mind maps generally take a hierarchical or tree branch format, with ideas branching into their subsections. Mind maps differ from concept maps in that mind maps focus on only one word or idea.

Steps of Mind mapping

1. Generate a topic. Decide the focus of your thinking. It can be word or image.

2. Center First. Placed a word or image that symbolizes what you want to think about in the middle of the page. Write it in bold letters. Circle or place a square around the topic.

3. Start writing what comes to mind. As you generate thoughts, draw a branch from the main topic. Keep it to as few words as possible.

4. Begin branching. Try to extend your thoughts from one idea to the next. Draw lines between thoughts to create lateral thinking. As new ideas come forth, draw a different branch from your topic.

5. Repeat branching until all your ideas appear on the map.
6. When finished mapping, carefully study the connections that you have made between your thoughts and ideas and try to relate them.

8. **Reciprocal teaching**

   It is an instructional reading technique in the form of a dialogue between teachers and students regarding segments of text for the purpose of constructing the meaning of text. The students take turns assuming the role of teacher. Reciprocal teaching is most effective in the context of small-group collaborative investigation, which is maintained by the teacher.

   Brown and Palincsar (1986) identified four basic strategies specific reading strategies that are actively and consciously used to support comprehension.

   The *prediction* phase involves readers in actively combining their own background knowledge with what they have gathered from the text. With a narrative text students imagine what might happen next. With an informational text, students predict what they might learn or read about in subsequent passages.

   When using the *questioning* strategy, readers monitor and assess their own understanding of the text by asking questions. Questioning involves the identification of information, themes, and ideas that are central and important enough to warrant further consideration. The questioner will pose questions about unclear parts, puzzling information, connections to other concepts already learned.

   *Clarifying* involves the identification and clarification of unclear, difficult, or unfamiliar aspects of a text. These aspects may include unclear sentence or passage structure, unfamiliar vocabulary, unclear references, or obscure concepts. Clarifying provides the motivation to remediate confusion through re-reading.

   *Summarizing* is the process of identifying the important information, themes, and ideas within a text and integrating these into a clear and concise statement that communicates the essential meaning of the text. Summarizing may be based on a single paragraph, a section of text, or an entire passage. Summarizing provides the impetus to create a context for understanding the specifics of a text.

9. **4 MAT Model**

   The 4MAT (4 Mode Application Techniques) system of instructional design is a brain-based teaching method that emphasizes diverse learning styles, honours learner
individuality, teaches concepts as well as facts, and improves student thinking and performance on traditional as well as high-stakes assessments. It involves the use of the learner’s “natural learning cycle” in the classroom. The 4MAT System, designed by Dr. Bernice McCarthy is defined as, “... an eight step cycle of instruction that capitalizes on individual learning styles and brain dominance processing preferences”. This instructional system moves students through activities appropriate for the four types of learners as well as through activities that encourage left/right brain development and also makes learning a continual process. This is a student centered model based on learning styles occurring based on the relation between the brain and learning and also centering the learning cycle.

**Steps of 4MAT Model**

Each of the following eight steps of the 4MAT System model emphasizes one of the learning types and alternates from right- to left-mode information processing

1. Create an experience or connect students to past experiences (Type 1 Learner, Right Brain Mode).
2. Analyze the experience (Type 1 Learner, Left Brain Mode)
3. Integrate reflections into concepts and visualize the concepts (Type 2 Learner, Right Brain Mode).
4. Define concepts- traditional lecture (type 2 Learner, Left Brain Mode).
5. Try out concepts- hands-on experience or supervised practice (Type 3 Learner, Left Brain Mode).
6. Extend learning- students mess around with the concept, practice and add something to them (Type 3 Learner, Right Brain Mode).
7. Evaluate their own application- students analyze usefulness, relevance, and originality of a final project (Type 4 Learner, Left Brain Mode).
8. Integrate application and experience- students complete a final project and share what they have accomplished in the class (Type 4 Learner, Right Brain Mode).

**10. Cooperative learning**

It is an approach to organizing classroom activities into academic and social learning experiences. It differs from group work, and it has been described as ‘structuring positive interdependence’. Students must work in groups to complete tasks collectively toward academic goals. Students learn by depending on other resources and skills
(asking one another for information, evaluating one another’s ideas, monitoring one another’s work, etc.). Furthermore, the teacher’s role changes from giving information to facilitating students’ learning. It gives the learners the opportunity to share and construct knowledge, problem solving and develop social and interpersonal skills.

Five essential elements are identified for the successful incorporation of cooperative learning in the classroom (Johnson and Johnson, 1994)

- Positive interdependence
- Face-to-Face interaction
- Individual and Group Accountability
- Social Skills
- Group Processing

There are various strategies of cooperative learning.

i) **Think- pair- share**

Think, pair, share strategy is a cooperative learning technique that encourages individual participation, promoting critical thinking and articulate communication in the classroom. Students’ ideas become more refined through the three-step process:

a) **Think**: Students think independently about the question that has been posed, forming ideas of their own.

b) **Pair**: Students are grouped in pairs to discuss their thoughts. This step allows students to articulate their ideas and to consider those of others.

c) **Share**: Student pairs share their ideas with a larger group, such as the whole class. Often, students are more comfortable presenting ideas to a group with the support of a partner.

**Steps of Think- pair- share**

1. Teacher poses a problem or asks an open-ended question to which there may be a variety of answers.

2. Teacher gives the students -think time and directs them to think about the question.
3. Following the ‘think time’ students turn to face their learning partner and work together, sharing ideas, discussing, clarifying and challenging.

4. The pair then shares their ideas with another pair, or with the whole class. It is important that students need to be able to share their partner’s ideas as well as their own.

ii) Round Robin Brainstorming

Brainstorming is a relaxed, informal approach to problem solving with lateral thinking. A question is posed with many answers and students are given time to think about answers. After the ‘think time’, members of the team share responses with one another in round robin style. The recorder writes down the answers of the group members. The person next to the recorder starts and each person in the group, give an answer until time is called. It encourages and engages all members of the team equally and presents a non-hostile environment for the generation and collection of ideas. Some of these ideas can be crafted into original, creative solutions to a problem, while others can spark even more ideas. Therefore, during brainstorming sessions, people should avoid criticizing or rewarding ideas. Judgment and analysis at this stage stunts idea generation and limit creativity.

Steps of Round Robin Brainstorming

Step 1 – Team is gathered together around a table. Give each person some cards, so that people can record their ideas on individual pieces of card.

Step 2 - Explain the problem that is to be solved. The goal in this step is to allow individual people to think creatively without any influence from others.

Step 3 - Have each team member, think on idea and write it down on the card.

Step 4 - Once everyone has written down an idea, each person pass their idea to the person next to them. Everyone should now be holding a new card with their neighbour’s idea written down on it.

Step 5 - Have each person use their neighbour’s idea as inspiration to create another idea, which they then write on a fresh card. Then ask each person to hand in their neighbour’s card, and pass their new idea to the person next to them to repeat step 4.
**Step 6** - Continue this circular idea swap for as long as is necessary to gather a good amount of ideas. When the time is up, gather up all the ideas.

You can now collate them, eliminate any duplicates, and discuss them further as required.

**11. Case based Learning**

Case-Based learning (CBL) is a student-centred instructional design model that is a variant of project-oriented learning. It engages students in discussion of specific scenarios that resemble or typically are real-world examples. The instructor’s role is that of a facilitator while the students collaboratively analyze and address problems and resolve questions that have no single right answer.

**12. Role-playing**

It refers to the changing of one’s behaviour to assume a role. In role-playing, students explore human relations by enacting problem situations and then discussing the enactments (Joyce et al., 2009). Together students explore feelings, attitude, values and problem solving strategies.

Role playing activity consists of nine steps.

1. Warm up the group
2. Select participant
3. Set the stage
4. Prepare observers
5. Enact
6. Discuss and evaluate
7. Re-enact
8. Discuss and evaluate
9. Share experience and generalize

**13. Problem solving**

Problem solving is a mental process which includes problem finding and problem shaping. Problem solving has been defined as a higher-order cognitive process that requires the modulation and control of more routine or fundamental skills.
**Steps of problem solving**

There are seven main steps to follow when trying to solve a problem. These steps are as follows:

1. Define and identify the problem.
2. Analyze the problem.
3. Identifying possible solutions.
4. Selecting the best solutions.
5. Evaluating solutions.
6. Develop an action plan.
7. Implement the solution.

**14. Movement Education**

Movement in learning is a teaching method based on the concept that humans learn better through movement. This teaching method can be applied to students, who should have the opportunity throughout a class period to move around to take “brain breaks” to refocus their attention so they can learn new material. Brain breaks involves deep breaths and movements which helps to deliver richly oxygenated blood to the brain keeping it fully alert and function optimally. Cross lateral brain activities activates both the hemispheres. The basic idea behind Brain Gym is that the brain will develop, and learning will be enhanced, by certain bodily movements. Brain Gym was created in the 1980’s by Dr. Paul Dennison and Gail E. Dennison. The comprehensive and enjoyable learning-skills program empowering learners to notice how they move so they can draw out their innate potential is called Educational Kinesiology (Edu-K).

**2.3.7 Difference between Brain-Based Learning Strategy and Conventional Method of teaching**

Biller (2003) developed the following differences between Brain-Based Learning Strategy and Conventional Method of teaching. Brain-Based Learning Strategy engages brain in the learning process by considering the natural functioning of its various parts whereas conventional teaching method promotes rote-memorization of facts (Aziz-ur-Rehman, 2011). The difference between Brain-Based Learning Strategy and conventional method of teaching is given in Table 2.1.
Table 2.1 Difference between Brain-Based Learning Strategy and Conventional method of teaching

<table>
<thead>
<tr>
<th>Brain-Based Learning Strategy (A Brain-Friendly Classroom)</th>
<th>Conventional Method of teaching (A Brain-Unfriendly Classroom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation of threat-free environment.</td>
<td>Threatening of students by physical punishments and rewards like grading individually</td>
</tr>
<tr>
<td>Use of positive language.</td>
<td>Use of negative language on and off</td>
</tr>
<tr>
<td>Distribution of students in small groups.</td>
<td>Limiting students to give a single answer or pin-drop silence.</td>
</tr>
<tr>
<td>Incorporation of individual ideas of students into teaching learning activities.</td>
<td>Instructions given collectively for the most of time.</td>
</tr>
<tr>
<td>The instant feedback by the teachers.</td>
<td>Delayed and indefinite feedback.</td>
</tr>
<tr>
<td>Joyful learning linked with real life situations.</td>
<td>Learning for the sake of certificates.</td>
</tr>
<tr>
<td>Encouraging questioning of students. Highlighting suggestions, quarries and discussion of students most part of the time.</td>
<td>Students having little liberty to talk infer or demand.</td>
</tr>
<tr>
<td>Stimulation of brain through music, physical movement or aromas.</td>
<td>No physical movement of students.</td>
</tr>
<tr>
<td>Evaluation to acquire mastery.</td>
<td>Examinations and tests used to pass final examinations only.</td>
</tr>
<tr>
<td>Inter-linkage between different subjects.</td>
<td>No inter-linkage between different subjects.</td>
</tr>
<tr>
<td>Shaping learning creative, fun and easy.</td>
<td>Learning is fun restricted. Shaping divergent end of traditional</td>
</tr>
<tr>
<td>End of learning session in a celebrative way</td>
<td>End of a sessions end soon after the allotted time finishes</td>
</tr>
</tbody>
</table>

(Aziz ur Rehman, 2011)

2.3.8 Advantages of Brain-Based Learning

The advantages of brain-based learning are: (Chavhan, 2012)

1. **It engages whole body and mind**

   The comprehensive approach promotes creating art to encourage active individual expression. Rather than assessing a child’s progress based on his homework or test scores, Brain-based learning uses student demonstrations and portfolios of his writings and artwork to track his progress. It embraces the concept that attention follows emotion. Music is often used to create calm, relaxing atmosphere for certain activities.
2. Teaching through practical experiences

Brain-based learning immerses a student in a subject. Students learn more when they learn lessons of a practical nature or through practical experiences.

3. The Immersion advantage

In brain-based learning, the student benefits from a wide variety of stimuli which are incorporated in order to make the experience as real and engaging as possible. Self-directed learning leads naturally to further exploration and higher levels of complexity in problem-solving skills.

4. Stress-free learning environment

The brain-based learning provides supportive learning environment which includes physical exercises for relaxation and emotional engagements. It provides freedom of learning and hence leads to encouraging learning, enhancing creativity and memory retention.

5. Individualization

Provide individualized and multisensory approach by fostering learning as a process of discovery, deepening learning. A number of approaches and methods of problem-solving are encouraged so the student learns in an experiential and personal manner. Brain-based learning has influenced different aspects of personality of students.

2.4 Studies Related To Brain-Based Learning

For this purpose, the investigator tried to review almost all the available studies carried out in India and foreign countries pertaining to Brain-Based Learning. The reviewed literature and researches are categorised into:

2.4.1 Studies on Brain-Based Learning in General
2.4.2 Studies on Brain-Based Learning in Classroom Environment and Curriculum
2.4.3 Studies on Brain-Based Learning in Other Subjects
2.4.4 Studies on Brain-Based Learning in Science Subject
2.4.5 Studies on Brain-Based Learning and Creativity
2.4.1 Studies on Brain-Based Learning in General

Banchonhattakit et al. (2015) investigated the effectiveness of Brain-Based Learning (BBL) and animated cartoons on video compact discs (VCDs) in enhancing the
healthy habits of school children. The study included a multistage random sample of 1085 in the first through the third grades. As a single-intervention technique, BBL on its own led to a greater improvement in healthy practices than VCD, but the addition of BBL to VCD made no difference, and there was no difference between BBL and VCD in terms of improvements in knowledge. The conclusions drawn from the study, both BBL and VCD are effective, but VCD requires fewer resources.

**Sharma (2015)** conducted a research on VII class science students who were taught with the brain-based instructional strategies. The findings revealed that the students taught with these strategies improved their achievement in science as well as self esteem. Similar study was conducted by her with the students having different types of learning styles. The findings revealed that students with accommodation and divergent learning styles scored better in science as compared to students with convergent and assimilation styles.

**Ozturk (2014)** in the paper a brief review of theory and research on Brain-Based Learning aims to shed light on the need of brain-based learning to be utilized in classrooms. It, also, resents the criticism, voiced in the literature, against the understanding of brain-based learning in order to evaluate it more objectively and to presents implications for future research.

**Kapadia (2014)** surveyed to determine the level of awareness measured as knowledge, beliefs, and classroom practices about brain-based learning among school teachers of Greater Mumbai. The results revealed that the teachers showed above average amount of knowledge in the area of brain-based learning. The results showed that teachers do Brain-Based Learning but need proper orientation indicating that knowledge about it would help them practice it in their classrooms.

**Reid and Niekerk (2014)** in their paper that learners prefer brain-compatible cyber security educational material, over traditional presentation methods. A prototype brain-compatible cyber security educational system was evaluated using a survey. The findings indicated presenting cyber security material in a brain-compatible manner is an effective way to stimulate the learners’ interest, engages them in the learning experience and motivates them to learn.
Sabitzer and Pasterk (2014) discussed in their article that brain-based teaching is neither a method nor a concept. It is rather a way of teaching that tries to support the whole learning and memory process by considering how the brain works. The concept of ‘Brain-based programming’ is an attempt of putting neurodidactical principles into practice in order to improve the learning outcomes in introductory programming courses.

Valipour and Araghi (2014) examined the effectiveness of brain based learning strategies in the framework of University level students that administer reading comprehension test. Participants were 20 students in Islamic Azad University, Tonekabon, Iran, in reading comprehension class, 10 as control group and 10 as experimental group. The results showed that the experimental group had higher scores on the given test in comparison with the control group.

Zaudeh and Al Astal (2014) investigated the effectiveness of brain-based learning strategies profile on the multiple intelligences of children living under stressful conditions in Gaza. A case control study was conducted with a purposive sample of 93 students, 45 as experimental group and 48 as control group. The post test results indicated significant differences in all domains except in musical and intrapersonal intelligences. Brain-based learning strategies are effective and useful for linguistic, mathematical, spatial, kinesthetic, interpersonal and naturalist intelligences.

Kaur (2013) studied the effectiveness of brain based learning strategies on enhancement of life skills among primary school students with internal and external locus of control. 2x2x2 factorial design was used in the study. The results indicated that the experimental group performed significantly better in life-skills in comparison to control group.

Mitra (2013) focussed on mind mapping technique that can enhance the cognitive instruction along with some other effective principles of Brain-Based Learning. She discussed that Brain based learning is organized around some visual pattern and graphic organizers help in bringing up this associated information.

Varghese (2013) conducted an experimental study on ‘Brain-based learning- A compatible equation for stress management of students’. The study was carried out on a sample of 240 students from 4 schools employing pre-test, post test quasi-experimental design. The findings revealed significant difference in the post-test scores on academic
stress, Examination stress, social stress of experimental and control groups. The effect size was found to be high indicating brain-based learning strategy to be very effective.

**Al Ghraibeh (2012)** aimed at exploring the brain based learning and its relationship with multiple intelligences. The sample consisted of 300 students randomly chosen who study the course of psychology. The findings indicated that more repeated method of learning and thinking is based on the left hemisphere of the brain. In addition, the results that are related to the dominance of the multiple intelligences indicated that personal intelligence and physical intelligence are the highest respectively. Whereas, musical intelligence scores the lowest mean value. The study also showed that there is an equal relation with a function at the statistical function of between the musical intelligence with the right hemisphere and the logical intelligence with the left hemisphere. It is also clear that there is an equal relation between both of (the bodily and the linguistic intelligences) with the left hemisphere and the spatial intelligence with the right hemisphere.

**Nisha (2012)** explored the elements of brain-based education in the National Curricular Framework for Teacher Education (NCFTE) and concluded that the framework shows presence of brain-based elements in its various curricular and conceptual components and highlighted the brain-based foundation of the NCFTE 2010.

**Panse (2012)** made a study on the development of brain based program for enrichment of oral communication of first standard deprived students in Pune. The program was implemented for 116 hours on 82 girl students through direct interactions between researcher and students. Besides this, support programs such as, games, cards, study material of group work etc. were provided. The study revealed that Brain Based program for enrichment of oral communication for 1st standard deprived students was effective.

**Siercks (2012)** conducted a qualitative study of strategies used by teachers understanding and achieving brain-based instruction in the elementary classroom. Teachers were given a survey to voice their opinions about brain-based instruction and how they incorporate it into their classrooms. The findings revealed through the use of movement and/or music, 63 per cent of teachers feel that they are effectively reaching all students because student achievement seems to be higher when these techniques are being
utilized. Approximately 44 per cent of teachers involved in this study referenced differentiating instruction as a brain-based strategy that they turn to often when planning lessons and teaching students.

Wachob (2012) made a survey to determine K-12 teachers’ knowledge, beliefs, and practices of brain-based learning strategies in western Pennsylvania. A sample of 256 public school teachers from three selected school districts. The data was collected by using the Brain-Based Learning Survey Questionnaire (BBLSQ), developed by Shelley Klinek (2009), and was administered electronically using an online survey software program called Qualtrics. The results indicated that teacher’s knowledge of learning strategies are related to their beliefs and their instructional practices. It was further determined that teachers had positive attitudes towards learning new strategies.

Tilton (2011) employed quasi-mixed-method to assess the effectiveness of Brain-Based Teaching Strategies on learning of 62 adult professionals. The findings revealed that the additional brain-based teaching interventions had no significant effect on participant outcomes; however, student-centered teaching techniques resulted in significant learning.

Denton (2010) conducted a case study on the professional development of elementary teachers related to brain research and the strategies used to help struggling readers. Results of the study showed that there was a positive relationship between the Brain-based sessions and the teachers’ subsequent implementation of reading strategies and also acknowledged that because of the brain-based sessions, they viewed their teaching differently and their attitude towards brain-based education had changed and/or improved.

Morris (2010) examined instructional methodologies of urban school teachers to determine the implementation of brain based instructional strategies among 40 teachers serving at elementary, middle and high school within the Memphis city school district. It was found that elementary teachers applied more of the surveyed brain-based practices than middle or high school teachers. Also, teachers with 0-10 years of experience used significantly fewer of the surveyed brain-based practices than teachers with more experience. The mean scores suggested that National Board Certified teachers used each of the surveyed brain-based practices more often than other teachers.
Cowan (2009) studied on brain-based model for students who struggle with reading. 20 brain-based practices were used in the classroom. The study also included the understanding of current teacher knowledge and use of brain-based practices by 30 local elementary teachers. The findings indicated that the teachers did not sufficiently utilize most of the brain-based practices such as varying teaching strategies based on individual students’ needs and alternating high thinking and low thinking learning activities.

Klinek (2009) examined quantitatively the knowledge, beliefs, and practices of college Education faculties in the Pennsylvania State System of Higher Education. The results indicated a relationship between knowledge and beliefs and knowledge and practices.

Koenen (2009) investigated educator’s perceptions regarding the use of, knowledge, attitude toward, and support given for the use of brain compatible instruction. The findings revealed positive teacher attitudes, yet a lack of overall emphasis or cultural change to support use of brain compatible instruction, a discrepancy between the responses of administrators and teachers, and the impact of administrator’s leadership and repeated exposure to professional development opportunities about the use of Brain compatible instruction.

D’Alesio et al. (2007) conducted a research to improve student vocabulary acquisition through a multisensory, direct instructional approach. The study involved three teachers and a target population of 73 students in second and seventh grade classrooms. Three interventions based on brain research were implemented: specially designed graphic organizers, classical music, and brain gym exercises. The results showed that a multisensory, direct instructional approach improves student vocabulary acquisition.

Soonthornrojana (2007) designed a teaching model for reading comprehension using Brain-Based Learning activities. 244 students of the third interval level from three schools were conveniently selected as the sample of the study. It was concluded that experimental groups were satisfied significantly and have better reading comprehension achievement than control groups.

Teague (2006) conducted a research to investigate parents’, teachers’, and students’ perception of performance projects being used as an additional or alternative
form of assessing student achievement. The secondary purpose was to view paper/pencil, high-stakes standardized tests, in addition to projects, through the lens of brain-compatible learning theory. Two school sites were chosen for this study. One site was located in an affluent, suburban neighbourhood, and the other was located in an economically deprived, urban neighbourhood. The research study is authentic and unique in that it provides scientific findings as reported in the literature that support the perceptions of the parents, teachers, and students that participated.

2.4.2 Studies on Brain Based Learning in Classroom Environment and Curriculum

Binulal and Aravind (2013) in their article ‘Brain based learning- Feel the difference in meaningful learning’ suggested to make the classroom learner centered, teachers must develop students’ understanding of course content by enriching the classroom environment to include physical, emotional and social aspects. Brain based learning can be considered as one of the methods to create such meaningful learning experience in the classroom.

Jack (2010) explored brain-based instructional practices in secondary education classes in south western Idaho to determine whether teachers’ perceptions of their use of brain-based teaching strategies are consistent with the strategies they used in the classroom. The quantitative analysis suggested that there was no relationship between teachers’ perceptions of using brain-based teaching strategies with the strategies that they practiced in the classroom.

Bonnema (2009) in his paper enhancing student learning with brain-based research discussed brain-based learning and its relation to classroom instruction. A Microsoft PowerPoint presentation is included that is intended for use at an in-service training with the goal of providing participants with (1) an overview of research findings with respect to the information processing and memory functions of the brain, and (2) overarching areas of instructional strategies that are supported by current research. The presentation is designed for use by educators and others involved in direct instruction in both primary and secondary education. In order to maximize their teaching efficacy, educators should have a basic understanding of key memory functions in the brain, and how these functions relate to student learning.
Hutchins (2009) attempted a case study on three elementary schools in the State of Georgia that utilize brain based instructional strategies in the educational process. The results indicated that some teachers and administrators believed brain based learning will not survive the No Child Left Behind initiatives, which forces teachers to focus on standardized testing.

Bellah et al. (2008) synthesized research as it relates to brain-based learning and its relevance to the agricultural education profession. The holistic approach to learning in agricultural education programs presents a ripe environment for action research with brain-based learning practices. Professional development with agricultural educators may be needed to further encourage and support comprehensive studies that investigate the precepts of brain-based learning.

Lombardi (2008) discussed the ways in which teachers can implement brain-based research in teaching English Language Learners (ELLs). Teachers of ELLs can draw on recently developed brain-based research applied to other learners, in addition to their considerations of multicultural strategies, learning styles, and diverse needs. Equipped with an array of diverse teaching approaches, ELL teachers can tap into the best of brain-compatible learning and neurodevelopmental applications, providing innovative ways to reach students.

Schiller and Willis (2008) used brain-based teaching strategies to create supportive early childhood environments remind teachers that standards are not intended to fence in creative teachers or become obstacles for learners with special needs. To help teachers optimize learning for all children, they review brain-based research findings such as the importance of safe environments, the effect of emotions on learning, the use of multisensory practices and differentiated teaching practice, the process of sense making, and the importance of planning for meeting special needs.

Wilmes et al. (2008) in their paper addressed the need of brain based teaching strategies and making the educators aware about best quality learning environments for enhancing instruction. He concludes that sensory and brain based teaching strategies can no longer be left behind and incorporating brain research findings into classroom instruction is the need of the hour.
**Herson (2006)** implemented brain-based techniques to positively impact student learning. The study discussed brain-based methodology and how educators can use brain based techniques to impact, support, and advance cognitive growth. Brain-based learning techniques create a learning environment that fosters student learning at individual academic levels while concurrently challenging each student and promoting academic growth. Teachers can further student academic advancement through the direct manipulation of the classroom environment rather than by purchasing particular programs that promise results.

**Keto (2006)** integrated brain based learning into the college composition classroom. Brain based learning offers an alternative for college composition instructors when approaching a classroom of students with multiple goals and varied abilities. Exploring the relationships between brain based learning and other theories helps to authenticate the use of the theory in composition classes. A sample course syllabus using brain-based learning within existing composition requirements is provided along with a PowerPoint presentation for use with training classes for prospective or current instructors.

**Brown (2005)** in her article discusses ways in which elementary school media specialists can promote sensory activities to support brain based learning fostering four of the multiple intelligences: linguistic, spatial, musical, and bodily-kinesthetic. Suggestions for related classroom activities were also included.

**Madrazo and Motz (2005)** in their article “Brain research: Implications to diverse learners”, discussed how a growing understanding of the way the brain functions offers new insights into the minds of students at all stages of development. Brain-based research deals with classroom-relevant concerns, such as sensory perception, attention, memory, and how emotions affect learning. The goals for studying brain research include: reaching as many children as possible; teaching to individual differences; diversifying teaching strategies; and maximizing the brains natural learning processes. Here, the authors discussed how brain research relates to learning and teaching.

### 2.4.3 Studies on Brain Based Learning in Other Subjects

**Aries et al. (2015)** found that the implementation of brain-based learning strategies within the secondary education system will improve the achievement in
working memory tasks and reasoning abilities and that this improvement depends on the duration of the training period and on pupils’ motivation. The study concluded that a six-week training period can improve reasoning abilities of students in secondary education significantly.

**Canbulat and Kucukkaragoz (2014)** studied the effects of the brain based learning approach on 5th grade students’ academic achievement and academic self-esteem in social studies. The sample consisted of students from the middle socio-economic level of a public school in Buca district of Izmir province with an experimental and two control groups. Unsynchronized pretest-posttest control group quasi-experimental design with quantitative research design was used. The findings revealed that the experimental group had higher scores on academic achievement, and academic self-esteem than the control groups.

**Gozuyesil and Dikici (2014)** aimed is to measure the effectiveness of brain-based learning on students’ academic achievement and examined with the meta-analytical method. The findings revealed that brain-based learning had a positive but medium effect on students’ academic achievement. In addition, when compared with the studies conducted in Turkey and the USA, it drew the conclusion that there is a significant difference between the groups while there is no difference in any effect sizes in terms of education level, subject matter and sampling size.

**Faramarzi et al. (2014)** strived to investigate the effectiveness of brain based teaching on the executive functions of the three students with Mathematics learning disability in Isfahan city. The students were selected using purposeful sampling. The ‘brain based teaching’ package was taught to each single participant for 26 intervention sessions. And 1 month after intervention period follow-up test was performed. The study showed that brain based teaching improves the executive functions of the students and thus, could be used in educating children with learning disabilities.

**Thomas and Swamy (2014)** aimed to investigate the impact of Brain-Based Teaching Approach (BBTA) on the academic achievement of the secondary school students in relation to their issues related to stress. The study adopted quasi- experimental design. The sample constituted 87 secondary school students of a private aided school in Bangalore. The findings revealed that the brain based teaching approach used in the
experimental group gave better impact on their academic achievement and in reducing the stress level of the students.

**Francis and Musthafa (2013)** investigated the effectiveness of Brain-based Learning strategy on achievement in economics of higher secondary school students. Pre-test- post test non equivalent group design was employed on a purposive sample of 100 students. The findings revealed that brain-based learning strategy is more effective than the existing method. Significant difference was seen between gain scores of achievement of experimental and control group for the total sample.

**Haghighi (2013)** studied the effects of brain-based learning in sophomore students majoring in aircraft repair and maintenance on academic achievement and retention. Pre-and post test control group model, was conducted at Civil Aviation Technology College in Tehran, Iran. The study lasted 16 weeks for a total of 63 class hours. Analysis of post-test achievement and retention tests revealed a significant difference between the groups favouring brain-based learning.

**Nafa (2013)** conducted a study highlighting on the low attainment of L2, second language, vocabulary acquisition by grade 12 Arab learners of English studying at a public secondary school in Dubai. A mixed research method was used for the study. The key findings of this study proved that the brain based approach is effective in treating the problem of L2 vocabulary low attainment. Markedness had also been proven to be a useful analytic tool in analyzing the current situation of teaching and learning L2 Vocabulary. The findings had a practical pedagogical importance as they present practical brain based teaching methodologies that enhance the teachers’ and the learners’ experiences of teaching and learning L2 vocabulary.

**Aziz-Ur-Rehman et al. (2012)** studied the effectiveness of brain-based learning theory on secondary level students of urban areas. The study was conducted to investigate the effectiveness of the Innate Faculties I.F. (thinking (T), emotions (E) and memory (M)) of human brain in the subject of Mathematics. The selected 60 ninth graders were randomly divided into experimental and control groups. The performance of students enhanced significantly by activation of the I.F. It was concluded that sharpening the I.F. of brain effects the academic achievement positively.
Seyihoglu and Kaptan (2012) determined the effect of brain-based learning approach on attitudes and achievement of teacher candidates in Geography courses. The study was conducted with the participation of 131 freshmen studying at the Department of Primary School Teaching of Education Faculty at Rize University. It was found that teaching geography through brain based learning approach had a positive effect on the students’ attitude towards the course. The qualitative analysis revealed that the syllabus built in accordance with brain-based learning approach was very entertaining.

Varghese (2012) studied the effectiveness of brain-based learning on the comprehension of certain educational psychology concepts, the hemispheric dominance and learning style preference on a sample of 200 B.Ed. students. The methodology followed was the pre-test, post test quasi-experimental design. The experimental group was found to be highly effective in understanding the psychological concepts and retention rate was found to be 70 per cent more than the control group. The findings revealed a significant hemispheric dominance and learning styles preferences existed among the student teachers as accommodators, assimilators, convergers or divergers.

Awolola (2011) investigated the effect of brain-based learning strategy on the achievement regarding the learning of Mathematics of 522 Senior Secondary School Students in Oyo State, Nigeria. Pretest-posttest non-equivalent control group design was used. The result revealed significant main effect of treatment, cognitive style and significant interaction effect of treatment and cognitive style on achievement in mathematics. The result showed that brain-based instructional strategy enhanced students’ achievement in mathematics more than the conventional method.

Aziz-ur-Rehman (2011) conducted an experimental study on the effectiveness of brain-based learning method and conventional method in the teaching of Mathematics at secondary level in Pakistan. 60 students were divided equally into experimental and control groups through simple random sampling and were further categorized equally as high achievers, average achievers and low achievers through systematic random sampling. The results of the study proved that brain-based learning method is significantly more effective than conventional teaching method to teach mathematics at secondary level.
Samur and Duman (2011) conducted an experimental study to examine if there is a significant relationship between brain-based e-learning and grammar translation method in middle school students’ academic achievements and attitudes towards an English course taught in Turkey. The findings of this study indicated that the academic achievement of the experimental group in the unit with brain based e-learning were higher than the control group taught through grammar translation method. The findings no significant difference was found in terms of attitudes between students in the experimental and control groups.

Duman (2010) investigated the effects of brain-based learning on the academic achievement of students with different learning styles. The study group consisted of 68 students from the department of Social Sciences teacher education in the faculty of Education at Mugla University. The findings of the study revealed that the brain-based learning approach used in the experimental group was more effective in increasing student achievement than the traditional approach used in the control group. However, no significant difference was observed among the achievement levels of the experimental group students with different learning styles.

Lin (2010) conducted an action research to explore the effects of the whole language approach (WLA) and Brain-Based Learning (BBL) in a GEPT preparatory course on the test performance of 15 junior high school students in a cram school in Tainan. The findings revealed that the WLA and BBL motivated the students to learn English and improved their cognition of the four language skills to be applied as the GEPT taking skills.

Tufekci and Demirel (2009) determined the effect of brain based learning on achievement, retention, attitude and the learning process. Control group pre-test post-test experimental design has been applied in the research. The qualitative data related to the learning process has been reached with an interview technique. The research revealed that brain based learning environment had a positive effect on the higher level learning, retention of the learning and the attitude toward course of the university students.

Bas (2008) examined the effects of brain-based learning method on students’ achievement levels and attitudes towards the lesson in the 6th grade students’ English lesson. 60 students in two different classes participated in the study. The results showed a
significant difference between the attitude scores of the experimental group and the control group. It was also found out that the brain-based learning activities were more effective in the positive development of the students’ achievement levels.

Craig (2007) aimed to present different concepts and techniques related to the application of brain-based learning principles to athletic training clinical education. Many concepts and techniques were offered to enhance the athletic training instructor’s ability to facilitate student learning through thoughtful incorporation of brain-based learning principles.

Cengelci (2007) investigated the effect of brain-based learning on academic success and retention. The findings of study indicated that there was a significant difference between the success and retention of control group and experimental group, experimental group being more successful than the control group. The learners seemed to have positive perspectives on brain-based learning and revealed significant retention level.

Willis (2007) revealed that brain based teaching strategies improves student memory, learning and test taking success. The article described in detail, instructional practices that reflect cultural communication and natural, enjoyable learning experiences for young children.

Duman (2006) studied the effects of brain-based learning on academic achievement and motivation of sixth graders in the subject of social studies. A sample of 113 students from three different sections of same class was taken. The findings revealed significant difference between mean achievement scores of the two experimental groups and one control group. The study also revealed that no significant difference was seen between the mean achievement scores with respect to gender. The qualitative results showed that the brain-based learning activities created positive feelings and ideas among them.

Ronis (2006) integrated math learning into real-world applications, making students actively practice what they learn, make meaning out of their everyday experiences, and think mathematically for success within today's information age.

Bayiindir (2003) examined the students’ attitudes towards brain-based applications in the English Composition II course and was carried out with a group of
23 first year students at the Department of Foreign Language Education at Middle East Technical University. The findings revealed that all students had positive feelings about the brain-based applications. Accordingly, the results indicated taking this composition course resulted in highly positive feelings such as confidence, relaxation, or being valued in the students.

**Erland (2000)** conducted a longitudinal study on Brain based accelerated learning and academic achievement gain for low achieving, low cognitive skill of fourth grade students. The study found that Brain Based Learning has a favourable effect in terms of student achievement. Brain based learning had a positive impact on low cognitive deficit students. Their performance score increased to the score of aggregate class.

### 2.4.4 Studies on Brain Based Learning in Science Subject

**Demirhan et al. (2014)** investigated the effectiveness of a brain based teaching approach on biology achievement, attitude, critical thinking disposition, self-efficacy scores and opinions of science teacher trainees. A mixed method approach was used composed of two parts: Part A comprised of a sample of 65 science teacher trainees and Part B was composed of nine science teacher trainees. The results of Part A revealed no significant effect of the teaching method on achievement, attitude, critical thinking disposition and self-efficacy scores. The results of Part B showed brain based teaching to some extent affects cognitive, affective and metacognitive features.

**Mansy (2014)** implemented Brain Based Learning (BBL) techniques in teaching science. Participants included 216 K-12, full-time, regular education teachers from 8 Northeast Tennessee school systems who taught at least one science class. Data were collected by an online Survey (Survey Monkey). The results indicated that teachers’ perceptions are positively correlated to their self-reported practices. Females, in general, and elementary teachers tend to practice brain-based learning strategies in teaching science significantly more than other subgroups.

**Vyas and Vashishtha (2014)** attempted the effectiveness of the brain targeted teaching modules in Biology on the academic achievement of the 8th standard students. The gain in the achievement score was much more in comparison to the control and highly significant results was reported group by comparing the post-test scores of the control and experimental groups.
Akyurek and Afacan (2013) examined the effect of brain-based learning approach on attitudes and motivation levels in 8th grade students’ science classes. Totally 57 students, 19 in experimental group, 19 in each control groups participated in this research. The findings indicated using brain-based learning approach was found to be significant differences in favour of the experimental group.

Bawaneh et al. (2012) investigated the extent to which a brain-based teaching method could correct misconceptions and change 8th grade Jordanian students’ understanding of concepts of electricity. The students from the Bani Kenanah Directorate of Education in Jordan were randomly selected (N=357). The results indicated that the brain-based teaching method surpassed conventional method in correcting misconceptions and changing students’ concepts of electricity. However, the results also showed that meaningful learners outperformed in-between and rote learners with regard to conceptual change and that rote learners exhibited the poorest performance.

Varghese and Pandya (2012) empirically tested the effect of Brain-Based Learning on academic achievement in biology, stress and study habits of VIII standard students. The study revealed that The Mean post-test score of students of the experimental group is significantly greater than that of the control group for the variables, academic achievement, stress and study habits. The effect size of treatment was maximum with regard to the variables.

Saleh (2011) conducted a qualitative study on the effectiveness of the Brain Based Teaching Approach (BBTA) in generating students’ learning motivation towards the subject of physics amongst secondary school students in Malaysia. The findings of this study showed that the BBTA module was an effective teaching approach in dealing with the issue aforementioned. It was found that students who followed the BBTA possessed a better physics learning motivation compared to students who received conventional teaching method.

Nuangchalerm and Charnsirirattana (2010) attempted a Delphi study on brain-based instructional model in science. This study was employed with 18 panel members. The findings showed that science instructional model for brain-based learning consisted of five steps of learning organization (PRADA- Preparation, Relaxation, Action, Discussion, and Application) and provides teachers a framework to apply in science classroom and beyond to science education.
Smolinski (2010) did a research on Science-based music and student learning employing the theoretical framework of brain-based learning. The study examined on the impact of original, science-based music on perceptions and student content learning. The results confirmed that the majority of the students thought the music served as an effective learning tool and enhanced recall. This study promoted social change because students and teachers gained insight into how music can be used in science classrooms to aid in the learning of science content.

Inci and Erten (2009) investigated the effect of brain based learning on academic success, attitude and retrieval of information in Science and Technology classes. Totally 30 students in 8th grade, participated in the study. The results revealed that there was a statistically significant difference on achievement, attitude and retention, conclude of brain-based learning, between the experimental group and the control group, in favour of the experimental group.

Saleh et al. (2009) assessed the effectiveness of Brain-Based Teaching Approach Module (BBTA Module) in dealing with issues related to Newtonian Physics conceptual understanding and Physics learning motivation among 100 students from two Science secondary school in the northern peninsular Malaysia. The finding of the research showed that BBTA Module was an effective teaching approach in dealing with the issues mentioned. It was found that students who followed the BBTA Module possessed a better Newtonian Physics conceptual understanding and Physics learning motivation compared to students who received conventional teaching method.

Pociask and Settles (2007) investigated the effect of brain based strategies in increasing student achievement. The sample consisted of the students of third and fourth grade students with learning-disabilities and seventh-eighth grade science students who exhibited poor test scores, motivation, and behaviours that negatively impacted their learning. This research indicated that incorporating Multiple Intelligences (MI) into daily lesson improved students' self esteem, increased retention rates, enhanced motivation for learning, and decreased incidences of off-task behaviours.

Avci and Yagbasan (2005) studied the impact of brain-based learning method on achievement and retention of knowledge of 7th graders in science. The sample consisted of 91 students was divided into three groups. One of the groups was taken as experimental
and the other two as control groups. The brain dominance instrument disclosed that 43.3 per cent of the students of experimental group used slight preference toward the left brain, 26.7 per cent of students showed slight preference toward the right brain and 30 per cent of students were inclined to moderate preference for the left brain. One way variance analysis and Scheffe test revealed a statistical difference between experimental group and control group-I and between experimental group and control group II in the favour of experimental group. The study also concluded that there is significant difference between experimental group and control groups I and II, favouring the experimental group in both cases.

Davis (2004) used brain based learning to increase fourth grade students’ academic achievement in science and reported that with the implementation of brain based learning student displayed appropriate behaviour during learning science and displayed a positive attitude towards learning science. There was significant improvement in students’ achievement, behaviour and self esteem.

Ozden and Gultiken (2004) compared the impact of conventional teaching method and Brain Based Learning (BBL) approach on academic achievement and retention of knowledge in science course at 5th grade science in a Turkish primary school. A sample of 44 students out of 84 from two intact classes was divided equally in experimental and control groups. The study concluded that BBL approach was more effective than the conventional teaching. It was also concluded that there was significant difference between mean scores of retention tests and experimental group showed significantly better retention than control group.

Konecki and Schiller (2003) studied brain based learning and standard based elementary Science. They found that brain based learning environment limits children’s stress, providing immediate connection to the real world forms and fostering motivation for learning.

2.4.5 Studies on Brain Based Learning and Creativity

Aparna and Smita (2014) in her article fostering student creativity using brain-based learning discussed the role of providing the right environment to be innovative and creative keeping in mind the physiology and the working of the brain. Creativity undoubtedly can be fostered by proper care and provision of opportunities for
creativeness and suggests certain classroom strategies based on the principles of Brain-Based Learning.

**Jausovec and Jausovec (2011)** in their paper Brain, Creativity and Education aimed to answer the question: Has neuropsychology anything to say about teaching for creativity? The complexities involved in creativity suggest that there is probably no single teaching approach for its development. The review therefore first provides a “neuro” perspective of psychological constructs. Next the possibility of improving ability with training and neurofeedback is discussed. Finally, some suggestions for further research and implication on teaching for creativity were provided.

**Parker et al. (2007)** presented in his paper that the system of Brain Education for Enhanced Learning (BE) is a powerful, innovative approach to education for grades pre-K to 12. Founded in South Korea over twenty years ago, BE promotes health, happiness, peace, productivity, creativity and academic achievement. BE is congruent with important scientific findings about learning and the following: physical movement, emotions and stress, and cooperation and altruism. Research studies of BE impact on student performance and behaviour tend to support these benefits. BE can be implemented by schools using a BE curriculum consisting of a series of 30 lessons, and can be taught to teachers and adapted to the needs of the schools and classroom teachers. In the past year, BE has been occurring in 49 schools, where 186 teachers have been trained in BE, and the lives of 4,650 students have been impacted by BE.

**Becktold (2001)** implemented Brain Based Instruction in correctional settings: Strategies for teachers. Brain-based learning strategies (learner choice, movement, small groups) may be inappropriate in corrections for security reasons. Problems encountered in correctional education (attention deficit disorder, learned helplessness) complicate the use of these strategies. Incorporating brain-based instruction in these settings requires creativity and time.

### 2.5 Analogy of Studies

The investigator came across several studies on Brain-Based Learning. Majority of the studies were done using experimental method. Random sampling technique was followed in the collection of data and the size of the selected samples ranged from 3 to 1085 samples. In majority of the studies, the investigators have developed their tools
based on their objectives of the studies. Different statistical techniques like Mean, Standard Deviation, Correlation Coefficient, ‘t’ test, F-test, and Factorial Analysis were used in most of the studies.

The findings of various studies revealed that the students have higher scores in Academic Achievement when taught by Brain Based Learning (Canbulat and Kucukkaragoz, 2014; Demirhan et al., 2014; Gozuyesil and Dikici, 2014; Thomas and Swamy, 2014, Vyas and Vashistha , 2014; Francis and Mustafa, 2013; Haghighi, 2013; Seyihoglu and Kaptan, 2012; Vargheese and Pandya, 2012; Awolola, 2011, Aziz-ur-Rehman, 2011; Samur and Duman, 2011; Duman, 2010; Tufekci and Demirel, 2009; Inci and Erten, 2009; Bas , 2008; Pociask and Settles, 2007; Duman,2006; Avci and Yaghabasan, 2005; Davis, 2004; Ozden and Gultiken, 2004).

The findings of Becktold, 2001 revealed that incorporating Brain Based Learning requires creativity. Aparna and Smita, 2014 found that creativity can be enhanced by Brain Based Learning.

2.6 Conclusion

There are several articles written expressing the necessity to incorporate brain-based learning strategy in the classroom teaching. Outcome of the effect of Brain-Based Learning Strategy have been studied in General, Classroom Environment and Curriculum, Other subjects, Science subject and Creativity.

After careful reviewing of the studies, it was perceived that only a few studies were conducted in India among secondary school students using Brain-Based Learning Strategy. It also encourages teachers to find out which method will be effective in enhancing academic achievement and creativity. The review of related literature brings into light that Brain-Based Learning is an effective teaching learning strategy that takes into account the diversity of learners. The empirical studies lead the investigator to conclude that Brain-Based Learning is a challenging task, involving all techniques in learning environment. This comprehensive review is followed by the methodology of the study in Chapter III.