CHAPTER 1
INTRODUCTION

“It often seems that we are trying to prepare young people for life in the twenty-first century, using teaching methods developed in the twentieth century and a design for schools that emerged in the nineteenth century”

~Fuller (2012)

Organised education system aims at effective teaching and learning. Teachers have been exploring creative ways of engaging learners for achieving the objectives of teaching. The learning should be planned based on knowledge about the learners, their previous knowledge, abilities, interests, needs or preferences. Knowing the learners helps us to understand that one size does not fit all. Since many years the learners are taught with the teaching methods that have been perceived as boring and learners tend to lose interest in subject. With such teaching learning process, learners are expected “to adjust to the learning when the learning should really be adjusted to the learner” (Gregory & Chapman, 2002). Each learner is different and hence needs classroom environment where they can be prepared for lives by becoming self-directed, productive problem solvers and thinkers. For achieving this goal, there is a need to provide such a classroom environment where learner should own responsibility of their leaning and behaviour. They need to realise what they learn is useful, relevant and meaningful for them. Also a teacher in a classroom needs to believe in potential of each student as they play crucial role in learning, Caine and Caine (1997) state “Teachers’ belief in and about human potential and in the ability of all children to learn and achieve are critical. These aspects of the teachers’ mental models have profound impact on the learning climate and learners’ states of mind that teachers create. Teacher need to understand students’ feelings and attributes will be involved and will profoundly influence student learning”. An effective teacher understands that what they do and say has effect on learners and the way their learners perceive success. She believes in the potential of her students and creates an environment where this can be realised to the optimum. Teaching approaches determine perception about classroom environment. The classroom interactions affect the self-esteem of students (Akin & Radford, 2018; Bucholz & Sheffler, 2009; Burnett & Howard, 2002;
Demirdag, 2015; Kilbride, 2014; Lawer, Isaac, Seth & Nashiru, 2016). It is said that teachers impact eternity. Effective teachers explore ways to improve achievement of students and build their confidence. Parry and Gregory (1998) have mentioned “As far as the brain is concerned, actions speak louder than words. Everything that happens in the classroom is monitored by three parts of the brain, two of which have no spoken language but are very adept at reading body language and tone of voice. Every gesture, every inflection, and every invasion of personal space is monitored by the limbic system and evaluated in terms of its threat potential. These skills allowed our ancestors to survive and they are still alive and well in all of us”. Teachers have to take cognisance of this within formal learning environment.

Understanding there cannot be one way to cater needs of each learner and realising the crucial role that teachers play in process of learning have led researchers to keep on developing different innovative strategies and methods to improve the learning by enriching the pedagogy of teaching. Most strategies fail to utilise the basic principle of growth and development. Thus, uniqueness of every individual in a heterogenous class of learners demands the variation in instructional strategies so that the process of acquiring knowledge can be more effective. Researches show that to improve learning, learners must be “engaged” during the teaching learning process ensuring an uninterrupted flow of ideas (Centre for Education Statistics and Evaluation, 2017; Gunuc, 2014; Hayam-Jonas, 2016; Irvin, Meltzer & Dukes, 2007; Lei, Cui & Zhou, 2018; Silver & Perini, 2010). A good learning environment should make the learners feel safe and secure both emotionally and socially to help them become independent and confident learners. Also the learning environment should include the varying degree of complexity to make the learning challenging but not burdensome, establishing the state of “flow” (Csikszentmihalyi, 1990) – a condition when learners are absorbed and exuberant about learning, confronted with challenges and receive pertinent and relevant criticism that anything else becomes incognisant to them, in this state they become most efficient and innovative. “People seem to concentrate best when the demands on them are a bit greater than usual, and they are able to give more than usual. If there is too little demand on them, people are bored. If there is too much of them to handle, they get anxious. Flow occurs in that delicate zone between boredom and anxiety” (Goleman, 1992). When assignments are difficult or the instructions lack clarity, learners feel unsure leading to a state where learner stops
learning. On the other hand, the environment with “eustress” or having “state of flow” creates constructive learning environment. The positive social classroom environment provides opportunities to the learners to learn to the best of their abilities through interpersonal interactions and helps to boost the confidence. The researches in the field of science have revolutionized teaching learning process as it has allowed researchers to understand the functioning of brain and how that can affect the learning. It has opened the avenues to understand how the human brain learns. The researches in the discipline of neuroscience and its application in the field of education have given rise to brain based learning. In 1998, Jensen described brain based learning and answered the question of “what is the most effective way of the brain’s learning mechanism” across the various disciplines. Various researches have shown that the methodological application of brain based instructional strategies have positive impact on student learning and achievement (Ali, Ghazi, Shahzad & Khan, 2010; Awolola, 2011; Aziz-Ur-Rehman & Bokhari, 2011; Binulal & Aravind, 2013; Chavhan, 2012; Duman, 2006; Francis, 2014; Gozuyesil & Dikici, 2014; Ololuw & Ayantoye, 2016; Panse, 2012; Ramakrishnan, 2015; Sadrabad, Ghavam & Radmanesh, 2015; Saleh & Subramaniam, 2018; Shabatat & Al-Tarawneh, 2016; Thomas & Swamy, 2014; Yasar, 2017). Various researches have been undertaken by educators and neuroscientists to understand the teaching learning process through brain based research (Sousa, 2006). The next section elaborates on the evolution of relationship between brain research and education.

1.1 BRAIN BASED LEARNING

In 1989, the U.S. scientific committee declared the 1990s as the “the decade of brain” and in the past 20 years the use of brain based imaging technology like computerized tomography, magnetic resonance imaging (MRI), functional MRI, electroencephalography and positron emission topography scans have helped the researchers to study the functions of brain by observing the level of activation of different parts of brain during various activities (Sousa, 2006). The brain scanning technology has helped researchers to study the functioning of brain like how the memory, recall, emotion, attention, pattern, context, speech, language, thinking, reasoning, speaking, reading, learning, etc. are processed (Weiss, 2000; Hari & Lounasmaa, 2000; Posner & Raichle, 1994). It has opened the ways to study extensively the biologically alive brain and the various functions and complex
processes involved during the process of learning (Goswami, 2008; Applying Brain-Based Learning in the Classroom, 2014). The advancement in neuroscience and its congruence with psychology and science of education has allowed the researchers to study the various areas of brain that get activated during learning of a concept or skill and understand how brain physically changes when it learns, opening varied avenues to education (Goswami, 2008). The brain based learning is a developing discipline which coalesce the findings of neuroscience, psychology, and pedagogy in order to maximize the output of teaching learning process (Materna, 2000; Saleh 2011; Tabibian, 2018).

The understanding of the functioning of brain and its application in the field of education has given rise to the concept of “brain based learning” (Clemons, 2005). Brain based learning has emerged as a multidisciplinary approach (Morris, 2010) and has linked neuroscience, pedagogy and the educational psychology (Tabibian, 2018).

Brain based learning is designed in such a way that the attention, memorization, understanding and meaningfulness are maximized during the learning by encouraging the natural operational principles of the brain. It is “learning in accordance with the way the brain is naturally designed to learn” (Jensen, 1996, 2000). Caine and Caine (2002) explains brain based learning as “recognition of the brain’s codes for a meaningful learning and adjusting the teaching process in relation to those codes.” Slavkin (2004) defined it as “any teaching technique or strategy that utilizes information about the human brain to organize how lessons are constructed and facilitated with emphasis placed on how the brain learns naturally”.

Brain based learning is also known as brain-compatible learning and is based on findings of neurology applied in the field of education to understand how the brain naturally learns the best (Luna, 2004). It involves designing instruction for learning which promote learning by understanding the functioning and processes of brain. These instruction strategies thus help the brain to learn better (Stevens & Goldberg, 2001).

Brain based learning is an extensive approach that applies the findings of neuroscience in education to improve the teaching learning process. Moghadam and Araghi (2013) suggested that brain based is an innate, inspiring and absolute way to expand the process of teaching and learning such that it allows the brain to learn the
best. The understanding of the development of brain and its functioning and its emergent with education and psychology has allowed to develop the learner centric classrooms for the students (Jensen, 2005, 2008).

It has been established by various researches that there is unmediated link between the brain’s structure and function and learning (Caine & Caine, 1991, 1997; Greenough, Black & Wallace, 1993; Kotulak, 1997; Majoy, 1993; Pinker, 1997; Zadina, 2004; Zull, 2002).

Although, the other teaching practices used during teaching learning process are also involving brain as no learning is possible without brain, but the brain based learning utilizes the strategies that try to exploit the maximum potential of brain by providing student centered approach where the brain is provided maximum opportunity to learn. It is done by understanding the fact that during the learning process the structure and function of brain undergoes changes in order to help learning. Using principles of brain based learning to create instructional design helps to develop and practice brain-compatible instruction rather than brain antagonistic instruction (Stevens & Goldberg, 2001). It is based on the theory that each brain continues to learn till it is not restricted from undergoing its routine processes (Caine & Caine, 1991; Jensen, 1996; Caine et al., 2005).

“The brain based teaching approach is believed to boost learning due to its holistic approach towards the learners” (Saleh 2011b). It is a student centred approach that exploits cognitive endowment of students to ensure that learning is more efficacious and deep-rooted. Brain based learning gives emphasis on meaningfulness of learning. An individual learns best if learning is “authentic” and has application in real life situations (Caine & Caine, 1991, 2003; Jensen, 1998; Sousa, 1995, 1998). As the brain is growing and developing in the young learners, it needs an enriched classroom or learning environment (Caine & Caine, 1991, 2003; Jensen, 1998; Evans, 2007). For brain to function at optimal level it is pertinent to have non-threatening environment. An enriched environment focus on teaching practices that accommodate how the brain learns best by increasing functionality of brain as per the level of the learner. Being rooted in the disciplines of neuroscience, pedagogy and psychology it integrates emotions, nutrition, enriched environments, music, movement, meaningfulness, threat free environment for optimal learning of the students (Sousa, 2004). Complete physiology of the individual is involved in learning (Caine & Caine,
Neurological Perspective

The recent researches in field of neuroscience and cognitive psychology have given a new perspective to study and understand structure and functioning of brain and how the various parts of the brain effect the learning (Southwest Educational Development Laboratory, 2007) and how learning, thinking and emotions are related. Teachers needs to know and understand that the brain is an organ responsible for thinking and learning and understanding of its structure and functions will help to develop the instructional strategies that enable efficient learning.

The human brain is divided into lobes and each lobe has certain functions. The frontal lobe is involved in thinking and planning, the temporal lobe controls sound, speech and a part of long term memory, occipital lobe controls visual processing and parietal lobe controls orientation, calculations with certain types of identification. The motor cortex controls movement of the body and in coordination with cerebellum, it leads to motor skills. The brain stem is also called reptilian brain and deals with control and maintenance of various functions of body like heartbeat, respiration, body temperature, digestion and brain’s alertness. Then there is the limbic area of brain which regulates fear conditioning and other aspects of emotional memory.

Image credit: https://psychmuseum.uwgb.org/neuro/brainlobes/

Figure 1.1. Structure of Brain
Some part of limbic area process and interpret specific memory, but the three parts of limbic area which are important to learning and memory are thalamus, hippocampus and amygdala. Thalamus is the part of limbic area where the incoming stimulus are first received, except stimulus of smell, and they are then directed to other parts of the brain. Hippocampus, consolidate learning by concerting information from working memory to long term memory through electric signals. It constantly controls the information carried to the working memory, as it helps to establish the meaning. Amygdala plays significant role in controlling emotional behaviour, specifically the response for fear. It also controls the interactions that are necessary for the organism’s survival, such as fight or flight response (Sousa, 2001, 2003). The cerebrum has two hemispheres which are connected through corpus callosum and communicate with each other to coordinate activities (Sousa, 2001, 2003). The left hemisphere of the brain controls speech, logic sequence time, and math. The right hemisphere control music, art, emotional responses, intuition, pictures and summarization (Sprenger, 2002). Each hemisphere of the brain is further divided into four lobes that (i) controls visual and auditory processing, (ii) manages feelings and touch, (iii) regulates decision making and planning, creativity and problem solving and (iv) regulates emotions, personality, working memory, attention and learning (Sprenger, 2002).
Each hemisphere of the brain has numerous neurons and have specialised activities. The right and left hemisphere of brain employ different strategies for cognitive, affective, and physical activities thus making “every brain unique” (Caine & Caine, 1994; Gazzaniga, 1998; Jensen, 2008; OCED, 2002; Walls, 1999).

A basic understanding of structure and functioning of brain gives an idea how brain is involved in the learning, thinking and emotions. For learning to take place communication between neurons is crucial. As soon the information received by neurons passes through synapse, it undergoes physical and chemical changes. These changes allow one neuron to influence another (Sprenger, 2002). The formation, reformation or dissolution of neuron – neuron interaction, called neural plasticity, causes change in structure of brain (Sousa, 2001, 2003) due to external experiences (Wolfe & Brandt, 1998; Diamond, 1988). The neurons that are not required by the brain get degraded, damaged or are removed leading to synaptic pruning.

After birth, the gray matter in brain shows growth spurt, and at age of 11 years this reaches to a maximum density of neurons and increased gray matter, followed by synaptic pruning which prevent overcrowding of neural circuits for efficient functioning of brain (Seeman, 1999). The finding of the studies done in discipline of neuroscience, pedagogy and educational psychology have confirmed that:

- The structure of human brain changes continuously with the learning
- Language learned by the brain is more through unconscious process with conscious
- Learning, memory and recall are affected by emotions
- Learning and cognitive processes are improved by involving the physiology
- Intelligence and creativity are different abilities and these can be influenced by changing the environment and teaching learning process (Sousa, 2006).

**Principles of Brain Based Learning**

Human beings have natural tendency to learn from experiences. Classroom instruction is a complex sequential exercise of directing attention of diverse ability groups and backgrounds towards the topic, hold it so that development of interest may take place. It works on the assumption that understanding would occur and formation of meaning or learning would follow. Caine and Caine (1991, 2003, 2012) have collated and
persisted in the analysis of research from the field of neuroscience, cognitive psychology, educational psychology and pedagogy. They have given 12 governing principles for brain based learning. Teachers must understand the structure and function of brain to plan teaching strategies. It is claimed that each principle is confirmed by research from several domains, is universal and applies to everyone. The principles thus evolved showed that head, heart and hands are engaged in natural learning. These principles are as follows:

1. **All learning engages the whole Physiology.**

   Physical movement when used with the teaching of subject matter, brings changes in the brain and helps in learning. Jensen (2009) claimed that “exercise increases the release of brain-derived neurotrophic factor – a protein that supports learning memory function, repair and maintenance of neural circuits, and the production of brain cells that are crucial to forming the connections the brain needs to learn”. In 1998 Jensen wrote that due to physical involvement in learning, changes in brain ‘neural plasticity’ occur that increase the communication between the parts of the brain, enhance mood and helps in long-term memory formation (Jensen, 1998). This is referred as ‘embodied cognition’. It has also been observed in various researches that dehydration negatively affects both physical and mental performance (Sousa, 2006; Jensen, 1998).

   Implication: Involvement of whole physiology induce enjoyment and formation of memories. Since individual remember physical movements and gestures better than anything else (Fuller, 2012), sitting still can be boring and counterproductive. Therefore, the physical movement, involvement of all senses, role plays, educational games, making presentations, working on projects, should be included in the teaching learning process. Previously also, multisensory learning has been the basis to support development and use of audio visual aids in classroom instruction.

2. **The brain/mind is social.**

   Gopnick, Meltzoff and Kuhl (1999) talk about “contact urge” i.e. the individual wants to contact with others. They have also found that individuals “love to learn from other people!” The brain undergoes changes when there is interaction among individuals. The changes in brain due to social interpersonal relationship are explained by mirror neurons. Mirror neurons are “a distinctive class of neurons that discharge both when an individual executes a motor act and when he observes another individual
performing the same or a similar motor act” (Acharya & Shukla, 2012). These visuo-spatial neurons indicate about human social interaction, thus making social interaction vital for learning.

Implications: As a part of social learning, it is evident that individuals learn by observation and imitation, so opportunities should be provided where learners can interact with each other, and ‘live’ with whatever is being learned.

3. **The search for meaning is innate.**

Every individual is born with ‘explanatory drive’ (Gopnick, Meltzoff & Kuhl; 1999) i.e. everything should make some sense. Each individual has inherent ability to filter input, systematically arrange information and experiences, and question about things of their interest and what they care for. At a deeper level every individual is yearning for meaningfulness and purpose. If the brain does not find learning meaningful, then that message is not stored in long term memory. The learning that has ‘survival’ value rewires the brain and gets stored in the long term memory. Jensen (2000) has mentioned that “the brain is concerned primarily with survival, not formal instruction. The brain will concentrate on instruction only if perceived as meaningful and only if the brain’s primary survival needs have been satisfied”.

Implications: The learning thus needs to be meaningful for the learner which demands to acknowledge the questions of learners. The ideas, interest and purpose of learning of learners should be identified and catered to make the information presented to them as useful.

4. **The search for meaning occurs through patterning.**

The brain has a great ability to organize all information into ‘patterns’ and it also creates new patterns or fill in knowledge to make learning purposeful. Jensen (1998) has also pointed that “There’s a tendency to try to form some kind of meaningful pattern out of our learning- this process seems innate”. It has been found that the brain has the ability to instinctively register the information which is familiar and form pattern (Restak, 1996) while seeking and responding to new stimuli and repel the information which is meaningless and isolated (Caine & Caine, 1994).

Implications: During teaching learning process information should be provided in a manner that it automatically makes the sense. Processes should be used which enable the learners to discover the pattern with what is already known to them, also create
their known patterns based on their understanding – as it makes the information meaningful and aids to learn the information. It is also maxim of teaching chaining learning by association.

5. **Emotions are critical to patterning.**

Researches in neuroscience show that emotions are strongly related with every thought, decision and response (Pert, 1997; Damasio, 1999). With every thought numerous peptides and neurotransmitters are released and interact with cells and interactions initiates “the experience of emotions”. For learning to be effective it must involve feelings. Amygdala plays an important role in emotional behaviour, as under certain conditions the emotions cause amygdala to signal regions of brain to strengthen memory. But during extreme emotions like anger, fear or joy the older limbic system, controlled by amygdala, takes major role and suspend the complex cerebral processes, there by shutting down the conscious processing but enhancing the memory of the experience. Stress hormones (Adrenaline, Cortisol, Norepinephrine) and neurotransmitters are released during such experiences and ‘mark’ such experiences as important thus giving it importance in the memory pathways. The researches have shown that in a safe and secure environment there is modest increase in level of dopamine which causes the release of acetylcholine stimulating hippocampus. The increased levels of dopamine have been found to be positively related with episodic memory, working memory, verbal processing, flexibility in thinking, creative problem solving and decision making (Caine, 2012).

Implications: Emotions play an important role in creating meaning, attention and memory (Caine, 2012), therefore learners need to be taught how to handle their emotions. New content should be introduced to the learners in an interesting manner, so that learners can discover and form an emotional link with the content and convert this association in love and passion for the learning.

6. **The brain/mind processes parts and whole simultaneously.**

The brain is structured hierarchically. Everything that is presented in parts is integrated by the brain and is seen as the portion of the whole. To construct meaning, the brain processes both the part and the whole simultaneously. The prefrontal cortex, also known as integrative cortex, is engaged in integrating the operations of all the other regions of the brain. This region of brain is engaged in memory formation,
reassembly of sensory data, and assembly of plans for action, directing the action of
the rest of the brain, organizing actions and activities of the body (Zull, 2002). Any
information that is learned is not only recognized as a separate information by the
brain but is also considered by the brain as a part of whole, so the brain sees every
information as a part and whole both at the same time.

Implications: Learners understand and master any skill or concept better when there is
congruence between definite components and the complete approach or skill.
Learners need to be presented with information in the natural settings where they
identify with the information as ‘part’ and ‘whole’.

7. Learning involves both focused attention and peripheral perceptions.

Everything that an individual learns involves firstly, attention and emotional
engagement and secondly, it is learned indirectly from the background – the context.
Claxton (1997) describes this as “learning by osmosis”, which means to learn by
immersing oneself in the experience involving attention and emotional engagement
and the context of experience. Caine has also mentioned that patterning also involves
the information in the context, as the context helps to give/ create meaning and
develop a memory for that. The researches on implicit memory and mirror neurons
(Schacter, 1996; Rizzolatti & Craighero, 2004) have shown that the children pick up
behaviours, preferences, beliefs or dislikes by engaging in life experiences.

Implications: Learners should be emotionally engaged in learning and must be
exposed to techniques like breathing, observation, etc. to acquire the skill of
concentrating and maintain attention. The context should also be included during
teaching learning process which can include aroma, colour, feel, temperature, sound
of classrooms, posters, seating arrangement, etc. as context helps learners to
understand and remember the information for longer duration (Fuller, 2012) as these
indirectly give a background to the experiences.

8. Learning always involves conscious and unconscious processes.

The brain is involved in learning both at and below the level of awareness. When
learning is without the involvement of conscious processing, it is called cognitive
unconscious. Cognitive unconscious is the processing of perception, memory,learning, thought, and language without being aware of it (Kihlstrom, 2007). The
unconscious cognition plays role in cognitive activity. The association of the
unconscious mind leads to the creation of implicit attitudes, which have profound
effect on the decision making ability (Greenwald, McGhee, Schwartz, 1998). For
creative insight, time should be given for unconscious ‘incubation’. Cognitive
unconscious also governs the executive functions of the brain, including planning,
decision making and metacognition (reflecting on own processes by focusing on own
strength and weaknesses).

Implications: The learners should be made aware of the processes that prime
unconscious incubation. The time and space should be provided to the learners to
develop insight about any newly learned information. Learners should be provided
with the environment where they can freely ask questions, make their own decisions
having effect on real life situations, reflect on the decisions made and learn from the
consequences of their actions.

9. There are at least two approaches to memory: contextual and rote.

Various memory systems have been recognized (Schacter, 1996) which interact with
each other (Fuster, 2003) and form complex networks (Greene, 2010). One of the
memory systems, sometimes referred as rote memory, is used to register and save
experiences, facts, skills and daily activities. The other memory system naturally
registers, creates meaning and saves ongoing experiences. Caine says that when rote
memory interacts with ordinary experience, it becomes meaningful, easy to
understand and remember.

Implications: Learners should be provided with the kind of experiences that can be
naturally remembered. Create environment where students can make thorough
observation and analysis so they can have in-depth understanding with the help of
ongoing and effective questioning. Memorization should be used for rehearsal and
practice only when required.

10. Learning is developmental.

Development involves two different dimensions. One is development of identity and
general capacities, which follows almost similar pattern in all individuals, such as
shift in thinking from specific to complex and concrete to abstract. Similar to all
physiological development, the brain development also occurs in stages. Another
dimension of development is advancement in mastery, from amateur to experienced
(Ericsson, Charness, Feltovich & Hoffman, 2006), as all learning is built on previous
experiences and this accumulation of learning brings change in physiology of brain. This is a cyclic process where new experiences keep changing the structure of brain and this process continues throughout the life, where continuously insight emerges and skills and capacities develop.

Implications: Learners should be provided with experiences considering the individual differences in maturation, development and previous experiences. Learners should be provided with the situations and chances to reflect on their learning and to deal with the criticism to develop understanding and insight over time.

11. Learning is enhanced by challenges and inhibited by threat.

Various researches in the field of neuroscience (LeDoux, 1996), creativity theory (Deci & Ryan, 1987), stress theory (Sapolsky, 1998; Lazarus, 1999) and perceptual psychology (Combs, 1999) concluded that cognitive and affective functions of the brain can be disrupted by threat and accompanied with feeling of vulnerability. As soon the survival response comes into play the processing brain is impaired and individuals lose their ability for higher order processing and originality. Caine explained "when we encounter high stress in learning, there is a psycho-physiological response to the threat, accompanied by a feeling of helplessness or fatigue. This type of response keeps people from using their higher order, more complex thinking, and creativity." This survival response was called “low road” by LeDoux (1996) and “threat rigidity” by Olsen and Sexton (2009). The survival response is initiated by factors like being devastated, losing control, experiencing extreme stress and uselessness. It has been observed by Wills (2007) that under stress, the amygdala becomes metabolically overactive and the rest of brain cortex does not show any activation during the normal functional magnetic resonance imaging or positron emission tomography scanning, showing the brain reverts to ‘fight or flight’ response when it perceives threat thus becoming less flexible. It impairs the ability of learners to classify what is significant and what is not significant. The ability of the brain for short term and forming long term memories are repressed.

During stress the adrenal glands secretes cortisol, whose high level causes death of brain cells in the hippocampus, affecting explicit memory formation. Stress also decreases serotonin levels, which controls emotions and behaviours, thus increasing the violent and aggressive behaviours (Jensen, 1998). Whereas, when threat free and
challenging environment is provided, the motivation increases due to increase in dopamine level (Fuller, 2012) as dopamine is critical for some aspects of motivational function (Salamone & Correa, 2012) and functions to motivate the learners to achieve (Berridge & Robinson, 2002).

Implications: Since the stress in classroom is detrimental for the learners, Caine and Caine (1994), Jensen (1995), Sousa (1995) lay emphasis on providing the learners with a safe and secure learning environment to make learning more effective. Healthy relationship needs to be developed between the learners and the teacher so that learners feel safe to ask questions, share their ideas, and try out various activities without fear of being judged or humiliated. Activities which are meaningful to the learners should be taken up and learners should be allowed to pursue their own interest within the context of the activities by providing them adequate resources and control over time and ways to complete the activities, as this provides challenge to the learners.

12. Each brain is uniquely organized.

The oddity that exists is that every individual is similar and different at the same time. Everyone follows similar pattern for growth and development yet the individual differences exist. Every individual has similar expressions of DNA yet have unique genetic composition. These individual differences can be identified by multiple intelligence (Gardner, 1993), Myers-Briggs personality typology, Caine’s identity profile and many like various learning styles, reading styles, sensory preferences and more. And these uniquenesses of individuals become more complex when various customs, cultural, ethic, social, economic, gender differences come into play, making the connections in the brain more unique.

Implications: Learners should be provided with the learning opportunities where all are treated equally; also their individual uniqueness, abilities, talents, strengths and weakness are dealt with. Learning styles of learners should be identified and experiences should be given as per those. Also learners need to be made aware of differences due to cultures, ethnicity, gender, customs, etc.
Understanding these principles and modifying the classrooms and teaching strategies as per the needs of every child is what we aim at for the better learning of every learner. The principles of brain based learning are in congruence with the aim of inclusion to include and cater to every child in the classroom. Inclusive education demands each learner is unique with his own unique personality, aspiration, capabilities, limitations, learning styles added upon with their own experiences social and cultural hence leading to individual differences and brain based learning allows us to understand how each child differs and how are they similar to each other and helps the teacher to provide the best to a child so the best in the child can be brought out, fulfilling the aim of inclusive education.

**Interactive Teaching Elements of Brain Based Learning**

Sousa (2004), Ryan and Abbot (1999), Caine and Caine (1990) and Jensen (1998) the exponents of brain based learning gave three instructional techniques of the strategy based on the principles of brain based learning. The three interactive teaching elements of brain based learning are as follows:

(i) **Relaxed Alertness**, is providing the learners with low levels of threat and highly challenging environment which keeps the brain alert but relaxed. When fear is eliminated from the environment the learner feels secure thus bringing the brain to the optimal state of learning (Jensen, 1998; Caine & Caine, 1995) making learner ready to face the challenges and improving their confidence, motivation and comfort to deal with situation. This helps the learner to think differently and establish association between old and new knowledge (Pool, 1997).

Relaxed alertness demands to create the comfortable situation involving social and emotional competence. In threat free environment when learners come together they develop listening skills, ability to persuade, feeling of association and acceptance, and this in turn acts as emotional support which allows students to use the optimal potential.

The opportunities for relaxed alertness can be created by:

- Pre -exposure to new subject matter and context
• Providing adequate time for learning
• Providing regular and unbiased feedback
• Designing differentiated challenging situations as per the abilities of learners by manipulating the time, resources and learning environment
• Motivating social associations by utilizing collaborative learning
• Creating secure classrooms by accepting zero tolerance policy for teasing, humiliation, put downs etc.

(ii) **Orchestrated Immersion** is when learner is completely immersed in learning experience learning (Jensen, 1998; Caine & Caine, 1995). It involves creating threat free environment where all senses (sight, hearing, smell, touch and taste) are utilized to acquire learning. The received information through the senses makes the learning more meaningful and realistic if they are able to relate the new knowledge with the previous knowledge, thus increasing the retention of information among learners. The brain needs the involvement of hand, heart and head and repetition to make the learning more permanent. This not only eliminates fear from learners, but also maintains a highly challenging environment. The varied and complex experiences during complete immersion allows learner to make patterns and association in brain helping to form more permanent learning (Materna, 2000).

The opportunities for orchestrated immersion can be created by:
• Providing occasions to the learners to get involved with learning experiences
• Allowing students to make connection between new knowledge and previous knowledge and experiences of the learner
• Allowing opportunities to frame and ask questions, doubts and sharing opinions
• Ensuring students express themselves through various approaches like pictures, drawings, poetry, story, etc.
• Encouraging the feedback from others

(iii) **Active processing** is the consolidation and internalization of useful experiences by learner by actively processing the information (Jensen, 1998a; Caine &
Caine, 1991, 20002, 2003). For increasing patterning to optimal and gaining more experiences and possibilities, the brain needs to consciously process the information (Cram & Germinario, 2000). The active processing of information emphasizes the meaningful learning over memorization. When the brain processes the information, it tries to construct meaningful patterns or associations from the previous experiences (Materna, 2000) thus the learning becoming long lasting before the brain could take up new information and store it for use in future. Only complete immersion does not help in learning but the learner should be provided with the critical feedback and be allowed to think and question what they experience.

Evaluation is an important part of active processing of information (Caine & Caine, 1995). The five factors of evaluating brain based learning are context, emotions, physical environment, process and organization. These factors of evaluation involve cognitive, psychomotor and affective functions as well as past, present and future. To achieve these goals in evaluation, the process should be free from any kind of threat but at the same time should be motivating for learners (Stevens & Goldberg, 2001).

The opportunities for active processing of information can be created by:

- Providing learning experiences that involve maximum number of senses
- Intentional practice and rehearsal
- Linking the learning experiences with the previous learning
- Different modes of questioning
- Analysis and evaluation of data and sources
- Encouraging reflective thinking

**Interactive Teaching Elements of Brain Based Learning and Corresponding Principles**

The interactive teaching elements and principles of brain based learning are deeply interrelated. Based on the understanding of principles and teaching elements of brain based learning researcher has tried to organise different principles with interactive teaching element of brain based learning as presented below. It was also felt by the
researcher that placement of few principles can be under more than one elements, so the categorization of these principles under these elements is considered flexible.

1) Relaxed alertness
   a) The brain/mind is social
   b) Emotions are critical to patterning
   c) Learning is enhanced by challenge and inhibited by threat

2) Orchestrated immersion
   a) All learning engages the whole physiology
   b) The search for meaning is innate.
   c) The search for meaning occurs through patterning
   d) The brain/mind processes parts and wholes simultaneously

3) Active processing
   a) Learning involves both focused attention and peripheral perceptions
   b) Learning always involves conscious and unconscious processes
   c) There are at least two approaches to memory: contextual and rote
   d) Learning is developmental
   e) Each brain is uniquely organized.

Elements, Principles and Strategies of Brain Based Learning

The elements and principles of brain based learning can be applied in the classrooms by identifying the teaching strategies that help the brain to learn naturally. These elements and principles can be utilized in classroom during teaching learning process by using appropriate resources and various instructional methods that can improve learning. The elements and principles of brain based learning are listed in table 1.1 with resources and instructional method that can be used in classroom. Though the effort has been made by researcher to enlist elements, principles and strategies, the list of strategies is non-exhaustive. Understanding of elements and principles of brain based learning help in selection of appropriate resources and methods for teaching to make learning effective. The researcher has presented significant aspect of brain based learning; elements, principles and strategies.
Table 1.1. Principles and Elements of Brain Based Learning and Strategies

<table>
<thead>
<tr>
<th>Elements</th>
<th>Principle</th>
<th>Strategies</th>
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<tbody>
<tr>
<td>Relaxed alertness</td>
<td>All learning engages the whole physiology</td>
<td>Individualized learning, Zero tolerance policy for teasing, humiliation, put downs, etc.</td>
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<tr>
<td></td>
<td>The brain/mind is social.</td>
<td>Collaborative learning, Cooperative learning, Think-pair-share, Experience sharing, Freedom of expression, Problem based learning, Demonstrations, Experiments, Observations, Questioning, Brainstorming, Feedback, Reflective writing, KWLH charts, Practice, Memorization, Audio visual aids, Videos, Storytelling, Role plays, Art and drawing, Games, Movement, Humour, Mediation, Relaxation, Music, Analogies, Puzzles, Quiz, Seating arrangement, Break for water</td>
</tr>
<tr>
<td>Orchestrated</td>
<td>The search for meaning is innate.</td>
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<tr>
<td>immersion</td>
<td>The search for meaning occurs through patterning.</td>
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<td>processing</td>
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<td>There are at least two approaches to memory: contextual and rote.</td>
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<td></td>
<td>Each brain is uniquely organized</td>
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The brain based learning can be best described as engagement, strategies and principles. Learners need to be engaged in classroom using various strategies and resources based on principles of brain based learning. Emotional engagement, physical involvement, breaks, threat free environment, social interconnectedness, etc. must be included in a classroom to enhance learning. The researches in neuroscience and education have proven that use of strategies based on brain based learning effects the brain and causes release of certain neurotransmitters like noradrenaline, dopamine, cortisol etc. cause rewiring or strengthening of neural connection or neural pruning effecting learning.

The present research utilises the instructional strategies developed on 12 principles of brain based learning as given by Caine and Caine (1991) in light of interactive
teaching elements (Caine and Caine, 1990; Jensen, 1998; Ryan & Abbot, 1999; Sousa, 2004). The effectiveness of the strategies has been inferred from achievement test scores. The next section elaborates on concept and meaning of achievement.

1.2 ACHIEVEMENT

Achievement is the foundation of almost every aspect of education. The programmes for improving education, schemes for educational accountability and the findings of most educational studies focus on achievement as an important construct. The term achievement implies the accomplishment of learning goals. Although learning can occur in a wide variety of contexts, but in an educational set up the learning goals relate with the teaching learning environment. The interaction of teacher and learners during classroom process is focused to assist learners acquire knowledge and develop understanding and skills (Guskey, 2013).

Achievement is a multifaceted construct and involves different kinds of learning in various subject areas. Therefore it becomes necessary to define achievement clearly in terms of instructional objectives and activities that students are expected to achieve.

Achievement is defined by learning goals categorised in three domains: cognitive, affective and psychomotor. Cognitive domain (Bloom, Englehart, Furst, Hill & Krathwohl, 1956) forms the basis for most of academic achievement during the formal education system. The cognitive domain describes the concepts and skills that are required through planned instructional activities so students can acquire them. Cognitive goals provide the basis of academic curriculum. Some cognitive goals apply across multiple content areas but many are subject area specific. The cognitive goals vary in intellectual complexity ranging from simple goals that require only recall of factual information, to more complex goals that require reasoning and higher mental processes, like applications, analysing relationships, or drawing inferences. The cognitive learning goals spreads over a wide range of sub domains and topics in each subject area therefore achievement within a subject area also varies. The instructional objectives and activities thus need to be planned in such a way that they improve the achievement of the students (Guskey, 2013).

Affective domain of learning goals refers to learners’ attitudes, interests, feelings, belief and dispositions (Krathwohl, Bloom & Masia, 1964). It includes feelings and beliefs of learners relating to the subject, teachers, school, learning and themselves. It
also involves factors such as learner’s motivation, attitudes, perceptions and ethics. It had been found that affective domain can significantly affect the students’ learning by enhancing, inhibiting or even preventing it (Hattie & Anderman, 2013) and it had been emphasized more in elementary grades (Guskey & Bailey, 2010). There has to be clear instructional objective for growth of affective domain of students as it relates with emotions and feelings which draws attention and channels strong residual memory (Wilson, 2018).

Psychomotor domain of learning goals for achievement typically requires student performances or demonstration of specific skills (Simpson, 1966). It is a progressive level of behaviours from observation to mastery of physical skills. Development of these skills needs drill that is assessed in speed, precision, distance, procedures or methods in execution (Clark, 1999).

In achievement, the three domains are interrelated and some researchers consider affective and psychomotor goals to be “enabling” traits or behaviours that facilitate student achievement of cognitive outcomes (McMillan, 2001). Learners with interest in the content, confidence in their ability to learn and who actively engage in instructional activities tend to perform well on associated cognitive tasks. There are researchers with the view that cognitive results elicit affective and psychomotor responses. Learners who achieve success on cognitive activities have inclination towards content, experience more improved belief in self and are more expected to be involved in consecutive related learning experiences (Creemers & Kyriakides, 2010). Therefore, the measures of student achievement in these three domains tend to be moderately related, and those relations appear to be reciprocal. Achievement is a multidimensional construct that dwells on different domain of learning that can be assessed through various methods depending on the objectives of the assessment.

Thus, achievement can be described as a result, successfulness, extent, ability or development in attainment of experiences. Achievement is reflected by the level of skill or knowledge acquired by an individual due to training. An individual’s skill, range and depth of the knowledge acquired or proficiency in learning or behaviour indicates level of achievement. The term achievement can be described as improvement that a student or group of students gain as a result of their learning experiences during teaching learning process. Achievement is based on documented change in performance, and requires two, parallel or linked measures of student
learning; one administered at the beginning of an instructional sequence and another at the end. It is assessment of learners’ academic capabilities in associated content areas, and the skills that necessary to survive in school and real world (Hattie & Anderman, 2013). Measures of achievement provide the basis for “growth trajectories” in education and “value added” models of accountability (Martineau, 2010; Harris, 2009). Achievement is the success or proficiency gained during the educational career in the subjects assessed by the school authorities with standardized or teacher made achievement test. For assessing achievement the domain of learning goals, the way it is determined, its detailed information and purpose should be considered as these factors affect the interpretations of student achievement results (Hattie & Anderman, 2013).

Garrison, Kingston, and McDonald (1955-1964) characterize achievement as the advancement learners make toward the objectives and goals of the curriculum. It is individual's capacity or the degree of his/her insight in a specific content area.

According to Crow and Crow (1956), “Achievement means the extent to which a learner is profiting from instruction in a given area of learning.”

According to Stephens (1956) it is not that other elements of educational goals are to be neglected but academic achievement is the unique responsibility of all educational institutions that have been set up by the society for promoting all round development of the learner in academics.

Traw (1960) defines academic achievement as “the attained ability or degree of competence in school tasks usually measured by standardized tests and expressed in age or grade units based norms derived from a wide sampling of pupil performance”.

Smith and Hudgins (1964) stated that “achievement is to do one’s best, to be successful, to accomplish tasks requiring skill and effort and to be recognized by authority”.

Travers (1970) says that achievement is the result of what an individual has learned from some educational experiences.

Good (1973) in the Dictionary of Education referred to academic achievement as “Knowledge attained or skills developed in the school subjects usually designated by test scores or marks assigned by the teacher”.

23
DeCecco and Crawford (1977) expresses that achievement is the expectancy of finding satisfaction in mastering challenging and difficult performances.

According to Yelon, Weinstein and Weener (1977) achievement is the successfulness of individual.

Tinambuuan (1988) has described achievement as the student’s command on certain body of knowledge or competence in certain skills.

According to Cunningham (2012) to quantify and measure student achievement is not easy. The achievement of students is measured in terms of their performance in various academic areas and measured by achievement tests.

Collins Dictionary (2018) defines achievement as “something which someone has succeeded in doing, especially after a lot of effort”.

According to Dictionary.com achievement is “something accomplished, especially by superior ability, special effort, great courage, etc. It is an act of achieving; attainment or accomplishment”.

Merriam-Webster dictionary defines achievement as “a result gained by effort”.

According to English Oxford living dictionaries “achievement is a thing done successfully with effort, skill, or courage.”

Cambridge Dictionary (2018) defines achievement as “something that a person, company, etc. has done or finished successfully. It is the act of achieving something or of achieving things generally”.

Macmillan dictionary (2018) describes achievement as the fact of achieving something or the fact of achieving or succeeding at things in general, by being determined or working hard.

In the present research achievement refers to the learning of students for the part of syllabus taught by the researcher using conventional teaching strategy and brain based instructional strategies during the period of intervention and assessed as scores on achievement test in science.

Several studies have pointed to relationship of achievement with self esteem of learners. The concept and meaning of self esteem is explained in the following section.
1.3 SELF ESTEEM

Maslow’s hierarchy of needs has given place to self esteem. The esteem needs form the fourth level of Maslow’s pyramid, with physiological needs at the base of pyramid at first level, followed by safety needs and then need for love and belongingness, which is the third level. The fifth level above the esteem needs is the self-actualization needs (McLeod, 2017).

A need is that which is necessary for successful functioning of the individual like food and water, we not only want them rather would die as one needs them to survive. Esteem needs are not however the needs without which one might die but these are necessary for an individual as without these the functioning may decline (Branden, 1995). Maslow described that for an individual to attain self-actualisation and have growth, their need for inner-respect and esteem from others must be met (Ackerman & Brown, 2018).

Maslow (1987) mentioned that every individual needs high appraisal for oneself, for self-respect or for self esteem and also for the esteem of others. Though a component of self esteem is there in esteem needs but Maslow was of opinion that esteem of others was more important for development and need fulfilment than self esteem (Ackerman & Brown, 2018) and thus he divided the esteem needs into esteem need for self and esteem need for others. The esteem needs for self include courage, accomplishments, competence, proficiency, expertise, belief in self, liberty and freedom. Esteem needs for other include desire of reputation, prestige, position, fame, glory, power, acceptance, attention, importance, influence, dignity or appreciation (Maslow, 1987). The esteem needs and self esteem are definitely related but esteem needs of Maslow are concentrated upon outside appraisal in form of appreciation, approval, achievement, acceptance, fame and reputation (McLeod, 2017). The researchers however are not in congruence on whether to give more preference to esteem needs for self or esteem needs for other but contentment of self esteem needs develops self-confidence, value for self, potential, courage and competence in an individual and generate a feeling of being useful and imperative. When individual’s self esteem need is defied, one may develop feelings of inadequacy, vulnerability, fragility and incompetence (Maslow, 1987). Branden (1995) wrote that individuals with high esteem do get troubled up by the problems but they quickly regain their courage and confidence to deal with the problems. He called it ‘positive self esteem’
that “affects the immune system of consciousness, providing resistance, strength, and a capacity for regeneration” (Braden, 1995). Thus “self esteem is not a substitute for a roof over one's head or food in one's stomach, but it increases the likelihood that one will find a way to meet such needs” (Braden, 1995).

**Schools of Thoughts on Self Esteem**

The varied definitions of self esteem have given many dimensions to this widely used construct. Mruk (2006) in his book “Self-Esteem Research, Theory, and Practice” wrote about the significance of self esteem and three major schools of thoughts on self esteem that include competence, worthiness and a twofold approach.

Carr (2011) mentioned that the self esteem was first defined by William James in 1890 in the first American textbook on psychology in 1890. James said comparison of what we are and how we want to be develops a feeling of self-worth which defines self esteem. This led to understanding of self esteem as competence. In terms of competence, self esteem is seen as relationship between success and aspirations. Crocker and Park (2003) explained self esteem as competence in terms that to achieve success and avoid failure, there is cost evaluation in terms of taking risks or using aggression. But since it does not take into consideration what a person thinks or feels about oneself and the values they hold, which led to defining self esteem as worthiness.

Self esteem as worthiness utilised the social science perspective of Rosenberg (1965). This relates to certain feelings and experience of individual that lead to the formation of attitude. The behaviour of individual was not considered while defining self esteem as worthiness. Self esteem as worthiness is widely used to measure self esteem in empirical researches (Mruk, 2013).

The third approach of self esteem combined competence and worthiness and their relationship with each other (Baumeister, 2003). It is also known as a two-factor or multidimensional approach. Mruk (2006) pointed out that the two-factor approach was not used in research and he criticized self esteem as one dimensional approach, as self esteem is not unrelated construct. Covington (2001) adopted the two-factor approach of self esteem and translated it into an educational setting. In educational setting using two-factor approach defines self esteem by learners’ perception about
their own abilities or inabilities to meet the academic challenges set by other students (Covington, 2001).

**Types and Sources of Self Esteem**

Mruk (2006) in his book “Self-Esteem Research, Theory, and Practice” described types of self esteem based in the two factor approach including the relationship between competence and worthiness. To understand the types of self esteem the two factors, i.e. competence and worthiness are kept in dynamic relationship with each other resulting in four quadrants. Quantitative and qualitative differences exist in each quadrant depicting types of self esteem.

Depending on the quadrant self esteem is classified as low self esteem and high self esteem. The work from various researchers have shown there are individuals who project to have high self esteem but they actually do not have high self esteem (Deci & Ryan, 1995; Greenier, Kernis & Waschull, 1995; Jordan et al., 2003; Kernis, 2003; Tafarodi, Tam & Milne, 2001). This kind of self esteem had been known as conflicting, pretencious, defensive, unstable, paradoxical and vulnerable self esteem. This type of self esteem could be due to presence and use of one of the two factors in order to compensate for the absence of the other factor, thus giving rise to worthiness-based self esteem and competence based self esteem.

![Self-Esteem Meaning Matrix with Basic Types of Self-Esteem](image-url)

(Source: Mruk, 2006, p. 152)

**Figure 1.3. Self-Esteem Meaning Matrix with Basic Types of Self-Esteem**
Low Self Esteem

As per the two-factor theory, low self esteem includes both an absence of ability and an absence of worthiness. Low self esteem includes having both an absence of ability and an absence of worthiness. Low self esteem is generally connected with alert, hesitancy, absence of initiative, conflict avoidance, frailty, nervousness, discouragement and so on.

High Self-Esteem

Individuals with high self esteem show a positive level of both competence and worthiness. Individuals with high level of worthiness, like themselves, are open to new encounters, feel accepted and acceptable, etc. The two sets of qualities show a connection between self esteem and satisfaction, initiative, receptivity, spontaneity, a secure identity and general absence of psychopathy.

Worthiness-Based Self Esteem

In worthiness-based self esteem the individuals have high sense of worthiness but lack competence. To compensate lack of competence many other mechanisms are used like decreasing defeat, opposing flaws, being with those who accept one or presuming that one has high self-esteem as s/he may feel good about oneself.

Competence Based Self Esteem

In competence based self esteem the individuals have high sense of competence but lack worthiness. They try to make up for lack of worthiness by targeting the capabilities, especially in the areas that are imperative to them. These individual pay attention to outward rather than inward as competence implies demonstration of capacity or accomplishments. Also, this help to escape the realization of lack of worth of oneself.

Coopersmith (1967) was the first one who studied and found four sources of self esteem. These four sources were: power (the ability to influence or control others), significance (being valued by others as shown by their acceptance), virtue (the adherence to moral standards), and competence (a successful performance in regard to a goal).

Epstein (1979) indicated that if accomplishments are included in self esteem then failure is a part of it too. Based on this he gave four sources of self esteem: acceptance
versus dismissal, virtue versus guilt; power versus weakness and accomplishments versus failures.

Branden (1995) in his book “The Six Pillars of Self-Esteem” wrote about six practices that can increase or decrease the self-esteem of an individual. He called these the six pillars of self esteem and these are:

1. **The Practice of Living Consciously**

   It means living in the present moment with awareness of our inside and outside, without ignoring anything that we do not like. It is being aware of one’s own emotion, with complete attention on present and without any distress of yesterday or tomorrow.

2. **The Practice of Self-Acceptance**

   It is the unconditional acceptance of self. It is being empathetic toward oneself even if one does not appreciate own feelings or decisions as these do not change regard for the self.

3. **The Practice of Self-Responsibility**

   After acceptance of self, it is to admit that individual is in-charge of all his choices and actions and no one except himself can do anything about it. One is responsible for his own decision and actions and should not make any one else accountable for his own choices and his happiness.

4. **The Practice of Self-Assertiveness**

   Practicing self-assertiveness is expressing and fulfilling own needs and interest in a proper way. One should accept that it is acceptable to have needs and interest and other should know about them as well in an appropriate manner.

5. **The Practice of Living Purposefully**

   It deals with the objectives of one’s life. Every individual if is living with a purpose definitely have certain objectives in life and set s/he plans to achieve those. Every individual needs to be aware of these goals and should always try to achieve them.

6. **The Practice of Personal Integrity**

   Integrity is firm belief that conduct is proper and is in consonance with the set norms. It is about the consonance or the integrity in words and actions.
Self esteem is used extensively in general language of communication and in psychology. Chronologically the term has evolved a period of time and is used interchangeably with self confidence, self-evaluation and self concept, etc. (Mruk, 2006) that has made it difficult to define.

Self esteem is described in terms of three general levels. First is global self esteem or general self esteem. It is a stable quality within an individual and is an evaluation of his own worth. Second is specific self esteem, also known as situational self esteem. It is assessment of individual in his/her own capabilities in certain specific situation. Third is task self esteem. It includes particular activities in specific situations (Brown, 2007).

In words of Blascovich and Tomaka (1991) self esteem is “individual’s sense of his or her value or worth or the extent to which a person values, approves of, appreciates, prizes or likes him or herself”.

Self esteem is regarded as an evaluative component of the self-concept. It is a wider representation of the self including cognitive, behavioural, evaluative or affective aspect of self (Blascovich & Tomaka, 1991). In broader sense self esteem is related with worth or value of self in a more comprehensive sense and in a confined or specific sense it refers to self esteem in a particular domain. Self esteem is believed to be a trait and therefore it is considered to be stable quality of an individual. It is a widely used construct in psychology and hence relates with almost every psychological construct like personality, behaviour or cognition. Self esteem had been studied for understanding the nuances of the self esteem construct and also for its adaptive and self-protective functions (Blascovich & Tomaka, 1991).

Self esteem is the process of evaluating own performance, capabilities and attributes in accordance with the personal standards and values that an individual has incorporated in self from the community and the individuals important in one’s life. This assessment of self leads to actions that are in consonance with knowledge about one self (Moody 1984).

According to James (1890) “the position which a person holds in the world contingent on his success or failure that determines self esteem” (1995 O’toole).

Allport (1961) said that self esteem “is the feeling of pride that results when the child accomplishes things or the child’s success in mastering tasks”.

30
Rogers (1961) mentioned that self esteem is that feeling of pride and excitation that comes along with accomplishment. It can be enhanced through our day to day interactions with significant others such as peers, parents and teachers.

Rosenberg (1965) said that self esteem is the attitude a person have towards himself. He defined self esteem as a “favourable or unfavourable attitude towards the self”.

Coopersmith (1967) described “by self esteem we refer to the evaluation which an individual makes and customarily maintains with regard to himself; it expresses an attitude of approval or disapproval, and indicates the extent to which an individual believes himself to be capable, significant, successful and worthy.” Therefore, self esteem is an evaluation of self-worth exhibited through perspective of a person towards oneself.

Mussen, Conger and Kagan (1974) defined self esteem as the value and belief in oneself and as expressed through his attitude towards himself. It is a personal experience that one conveys to others verbally or through manifestation of his actions or behaviours.

Robertson (1978) expresses self esteem as a person’s assessment of self with his verbal and overt behaviour being the best estimate of that personal evaluation.

Gardner (1991) defined self esteem as how an individual feels and values oneself reflecting individual’s evaluation of self-worth.

Branden (1995) stated self esteem as “the disposition to experience oneself as competent to cope with the basic challenges of life and as worthy of happiness.”

Burnett (1994) reported that self-esteem and global self-concept were identical concepts and both of these are associated with confidence in self as an individual.

Lawrence (1996) said that self esteem is “what the person feels about the discrepancy between what one is and what one would like to become”. He says that self-concept is a comprehensive concept that includes self-image, ideal self and self esteem.

Ansarie Jaberi et al. (1999) defined self esteem is confidence in own abilities in thinking and to cope with life’s challenge.

Adler and Stewart (2004) said self esteem alludes to individual’s general feeling of his or her value or worth. It can be expressed as a way to assess how much a person “values, approves of, appreciates, prizes, or likes him or herself”.

31
Huitt (2004) defined self esteem as the affective aspect of self, which refers to one’s feeling of self-worth.

Powell (2005) in his book “Self esteem” defined self esteem as the way we feel and think about ourselves, how we look at our abilities, our relationships and our future. Reasoned (2005) asserted self esteem as the experience of being able to meet challenges of life.

Rubio (2007) expressed self esteem as a psychological and social fact where an individual assesses own self and own proficiency on the basis of certain values that emerge from various emotional conditions and in different situations.

In words of Baumeister (2008), self esteem is how favourably one evaluates himself or herself.

According to Mruk (2006) “self esteem is the lived status of one’s competence at dealing with the challenges of living in a worthy way over time.”

In the present research self esteem is a favourable or unfavourable attitude of a person towards himself and the way in which he views himself. It is assessed as scores on Rosenberg’s self esteem scale.

### 1.4 CLASSROOM ENVIRONMENT

Environment plays an inevitable part in learning. Classroom environment includes the classroom conditions that facilitate teaching learning process. It refers to those forces in the learner’s environment which have capacity to contribute to educational development of the learner. The classroom provides the situation where interaction of knowledge takes place between teachers and learners, and learning takes place. The learning environment includes interactions with teachers, students, principals and learning activities. The concept of classroom environment indicates the aim to create and nurture a positive context and encourages learning. But the fact is classroom environment varies from unfriendly or pernicious to welcoming and supportive and that can change every day and over the school years. Hoy and Miskel (1987) believe that classroom environment includes a set of internal attributes that differentiate one school from another and impact the behaviour of the individual in it.

Lewin (1936) believed behaviour of human is explained by the complex interaction between the person and the environment in which he/she is interacting with others.
Mathematically the human behaviour (B) is denoted as a function of person (P) and the environment (E), i.e. \( B = f(P, E) \). He also recommended that the human behaviour is an outcome of influence of the person and the environment. He expressed that mutual interaction between the individual and the environment affect the human behaviour. Hence, the performance or the behaviour of the learner is governed by the individual and his environment. Psychological perceptions of classroom environment have significant influence on students’ accomplishment, performance and self concept and also other important educational outcomes. It is the place where learners get the experiences required to accomplish their ultimate goals and aims for the life ahead. Learning environment requires to be positive so as to involve learners to develop reasoning and creative mind. The classroom environment is therefore a common playground hosting all these personalities at the same time. The classroom environment includes teacher support, resources for teaching, task orientation, study habits, engagement, empathy, friction, withdrawal, etc.

Classroom environment can be defined as the interaction that takes place in classroom between teacher and pupil and among pupils. It includes the physical environment and the classroom rules and procedure. It is necessary to provide positive, safe, nurturing and intellectually stimulating environment so the learners can achieve optimum level of learning.

Environments themselves may be divided into 6 kinds, two relevant to each general section.

a) (i) Communication environment: where students are engaged in discussions by establishing objectives, problems, context, information and criteria for achievement

(ii) Information transmission environment: where students are engaged in discussion by acquiring knowledge.

b) (i) Problem-solving environment: where students work on projects and problems.

(ii) Training environment: where students practice various assignments to enhance their skills and knowledge.

c) (i) Evaluate performance environment: where students perform for others.

(ii) Recitation and testing environment: where students show their capability to solve problems or answer questions.
Classroom environment or climate includes social, emotional and the physical aspects of the classroom. The classroom social environment is a multidimensional build that involves scholastic and social elements. Scholastic elements concentrate on learning and achievement, while social element accentuates association of teachers and learners and emotional support from teachers. Classroom provides the environment where during the learning process one to one interaction takes place leading to social interaction and building interpersonal relationship between teacher and learners and among the learners. Perkin (1951) concluded that quality relationship that a teacher and student share is an important component of classroom environment. In a positive classroom environment students feel they are important and are encouraged to develop healthy relationship with others. The teacher in a positive classroom environment is passionate about teaching and expects learners to be highly motivated for learning and showing that behaviour. Effective educators make a learning situation which is welcoming and cheerful and in which students feel secure. Learners feel safe for taking risks and commit mistakes without threat of being judged and ridiculed.

Apart from social and emotional environment, physical environment also influences this environment. These may involve physical components, for example, art on walls of classroom, desks arrangement and other learning aids. Likewise, there are non-physical components, for example, the classroom rules and learners’ concentration and consequently his learning in the class. Physical environment implies the room’s physical characteristics and attributes. Physical environment of the classroom is a blend of different things like temperature, lighting, size of room, layout and organisation, ventilation, walls, floor, seat, mats, whiteboard, PCs, alongside the primary components, the learners and the teacher. The classroom environment also incorporates such components as classroom management, discipline methods, properly planned lessons and the making of a safe and secure environment for the learners.

Classroom environment includes all elements of classroom life (Wang, Haertel and Walberg, 1993). The physical arrangement of furniture, accessibility of learning aids, duration of class period (Chapin & Eastman, 1996), levels of difficulties in tasks, type and pace of instructions by teachers (Wang et al., 1993), predictability of environment (Anderson, Steveens, Prawat & Nickerson, 1987) and the importance of interpersonal relations (Gottfredson & Gottfredson, 1989) impact classroom environment. Positive
classroom environment provides protective and secure environment and sufficient chances for investigation and experimentation.

**Factors Defining Classroom Environment**

According to Steward et al. (1997) classroom environment can be divided into four factors: (i) physical environment, (ii) time/ instructional management, (iii) behaviour management and (iv) teacher effectiveness.

Physical environment is “creating an orderly setting to establish an environment conducive to learning” It includes "designating areas for specific activities, selecting and arranging furniture, arranging seating to facilitate learning, decorating areas for specific purposes, and organizing materials and areas for easy access” (Steward et al. 1997).

Time/ instructional management is required to conduct classroom activities smoothly. Teachers need to develop and observe the schedule of classroom as well as for each student. "It is helpful to plan a routine to open each day or period so that students know exactly what to do and a closing routine to tie together the school day or period in a pleasant, orderly manner” (Stewart et al., 1997) . Creating and executing such schedules helps teacher to manage time properly and enable them to utilise more time for teaching.

Behaviour management includes behaviour management and classroom management that influence learning (Marzano & Marzano, 2003). For managing classroom properly the teacher should develop certain rules and regulations in order to communicate expectations. Stewart et al. (1997) argued "behaviour management and classroom control are central to stimulating learning”.

Teacher effectiveness is an important factor effecting classroom environment. “For over thirty years, the behaviours of teachers have been studied to determine the relationship to learner achievement” (Cano, 2001). Marzano and Marzanon (2003) have found that “teachers' actions in the classrooms have twice the impact on student achievement as do school policies regarding curriculum, assessment, staff collegiality and community involvement”.

Key concepts related to understanding classroom climate include (a) social system organization, (b) social attitudes, (c) staff and student morale, (d) power, control, guidance, support, and evaluation structures, (e) curricular and instructional practices,
(g) communicated expectations, (g) efficacy, (h) accountability demands, (i) cohesion, (j) competition, (k) the "Fit" between key learner and classroom variables, (l) system maintenance, growth, and change, (m) orderliness and (n) safety. Rudolph Moos (1979) groups such concepts into three dimensions for classifying human environments and has used them to develop measures of school and classroom climate. Moos's three dimensions are: relationship, personal development and system maintenance and change.

- Relationship includes the quality of individual’s relationship with the environment and the degree of involvement with environment and the support and assistance given to one another.

- Personal development is the way along which the growth and enhancement of an individual takes place.

- System maintenance and change include the expectations, control and change in environment in an orderly and responsive manner.

Argyris (1958) stated that dimensions of classroom environment and the learner interaction involve "ordering and conceptualizing a buzzing confusion of simultaneously existing, multi-level, mutually interacting variables".

According to Hall (1970) classroom environment includes element interactions, resources, desire to change, freedom of students, critical feedback to students, contribution of teacher and the related tasks.

Falsario, Muyongand and Neuvaespana (2014) identified two dimensions of classroom environment namely physical and social environment. According to them physical classroom climate is the organisation of infrastructure including chairs, desks, furniture, fixtures, colour, light, ventilation, etc. and the social environment refers to the authority and control demonstrated by the teacher and the participation and interaction among the learners.

The most effective learning environments combine advantage of each type. Participation in discussions, various activities and presentation of the things done for evaluation are all essential to learning. Traditional schooling has emphasized reading and lecture, problem solving, drill and practice, homework and recitation and testing as learning environments. In the shift from traditional learning environments to more
In a constructivist learning environment, there has been a parallel shift to incorporate some of the characteristics of work environments, such as shared cognition, tool manipulation, and contextualized reasoning (Resnick, 1987).

<table>
<thead>
<tr>
<th>Positive characteristics</th>
<th>Negative characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement</td>
<td>Disengagement</td>
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<tr>
<td>Satisfaction</td>
<td>Frustration</td>
</tr>
<tr>
<td>Self worth, Social satisfaction,</td>
<td>Difficulty</td>
</tr>
<tr>
<td>Competence, (Academic achievement)</td>
<td>Psychosomatic hindrance</td>
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<tr>
<td>Intimacy</td>
<td>Alienation</td>
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<tr>
<td>Independence</td>
<td>Cliqueness</td>
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<td>Enthusiasm</td>
<td>Apathy</td>
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<tr>
<td>Home work</td>
<td>Formality</td>
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<tr>
<td>Teaching methods</td>
<td>Direction diversity</td>
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<tr>
<td>Acceptance</td>
<td>Reproving</td>
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<tr>
<td>Problem structuring</td>
<td>Disparaging</td>
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<td>Cohesiveness</td>
<td>Control</td>
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<td>Task orientation</td>
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<td>Teacher support</td>
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<td>Study habits</td>
<td></td>
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<td>Cognition</td>
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Source: Kaur (2013)

**Figure 1.4. Characteristics of Classroom Environment**

Good (1973) defined the classroom environment includes the physical, social and psychological dimensions. According to him climate includes heat, light, differences among individuals, the teachers’ personality and teacher-student relationship. Dave (1963) explained educational environment “as the conditions, processes and psychological stimuli which affect the educational achievement of the child”. Tagiuri and Litwin (1968) defined classroom climate as the context, environment, culture, feel, tone or the inner standards of an institution, particularly as experienced by its members and perceived by visitors to the school. According to Litwin and Stringer (1968) climate “is the perceived subjective effects of a formal system … attitudes, beliefs, values and motivation of people”.

Forehead and Gilmar (1964) asserted classroom environment as set of attributes that explains and impacts the behaviour of individuals in the school. In view of Chamberline (1971) classroom environment is a subtle spirit that prevails in a school,
both in the minds of the teachers and learners and in behaviour that might never be precisely explained or analysed, but which an expert observer experiences when he visits a school. Hodgetts and Altman (1979) stated classroom environment as “a set of properties of the work environment perceived by individuals who work there and which serve as a major force in influencing their job behaviour”.

Walberg (1976) explained classroom environment as encompassing perception of students and teachers of all dimensions of the educational environment that influence learning. These learning environments include interpersonal relationships amongst students, student-teacher relationships, disposition and facilities of the classroom, liking of students for the subject and teaching methods. Bhatnagar (1977) observed “the unique quality of the environment largely depends upon scientific ways the pupils are treated in the school and classroom”. In words of Myers and Fouts (1992) the classroom environment is "the unique interactive combination of teacher behaviours, curriculum expectations and student-to-student interactions which develops in the classroom setting. The measure of classroom environment is the individual student's perception of these interactions". Farris (1999) stated “Classroom environment includes time management, students’ involvement, student engagement and classroom communication.” Moore (1988) defined the classroom environment as the design that describes the complex psychosocial classroom climate as perceived by learners. Miller and Cunningham (n.d.) expressed that classroom environment comprises various educational concepts including physical and psychological environment through social contexts and various pedagogical components related to the attributes and behaviours. Brighton, Hertberg, Moon, Tomlinson and Callahan (2005) stated “Classroom environment is the process of organizing and conducting a class, so that is result in maximum students learning, preventing distractions and disturbances.”

Moos (1979) talked about the ‘personality of the environment. He mentioned that the way an individual personality can be defined, similarly it is possible to define the environment. Like individuals, the social environment can be cordial and supporting or strict and restraint. Pierce (1994) stated that classroom environment is the physical, emotional and aesthetic attributes of the classroom that is required to improve attitudes towards learning. Creemers (1994) defined classroom environment as the nucleus where other influences on the learning of students and their educational
results are found. These include classmates, peer groups and also teachers and textbooks. Ashton (2001) expressed that classroom is the place where learners become aware of their own self and the society.

In the present research concept of classroom environment included perception of students towards the physical infrastructure, interpersonal relationship with teacher and among students, teaching and evaluation methods used in learning process and discipline in the class. It is assessed as scores on scale for perception of classroom environment (Kaur & Sharma, 2013) categorised as favourable or unfavourable.

1.5 RATIONALE OF THE STUDY

Science as a subject forms an inseparable part of education system and has utilitarian value in the day-to-day life. Owing to the importance of science being an integral part of our life instead of being taught in isolation it should be taught with an interdisciplinary approach which not only makes it more meaningful and interesting for the learners but also makes it easy to understand for the learners with differing learning styles (Mangan, 1998). As per the recommendations of Indian Education Commission (1964-66) science education and research play a pivotal role in the development of the economy of a nation. Subjects such as science and mathematics must be an indispensable part of education till the culmination of schooling for each and every child. In NCF (2005) science has been defined as “a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition”. But, the poor results in science as a subject raise a lot of questions regarding the present education system in our country and how exactly science education is being imparted in our schools. In report by Trends in International Mathematics and Science Study in 2003 India ranked 46 among 51 countries on assessment of knowledge of students in mathematics and science (Anirudh Sethi Report, 2011). The ASER report for the year 2007 showed that only 35.3% students in age group of 11-14 years could comprehend and solve problems based on class 2nd text. Another report that raised concerns regarding the science education in India was the report issued by Program for International Student Assessment (PISA) in 2009. As per this report India ranked second last among the 73 countries that participated, leaving behind only Kyrgyzstan.
PISA assessment scores on science education in terms of scientific literacy, which means “An individual’s scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual and cultural environments and willingness to engage in science-related issues and with the ideas of science, as a reflective citizen” (Walker, 2011). However, the students lack in these areas leaving India at 72nd position among 73 countries. After 2009 India withdrew from PISA due to ‘bad results’ owing to a socio-cultural disconnect (Venkatachalam, 2017), though PISA claims that the assessment designed is culture free wherein items or even units are discarded form the initial drafts of the assessment tool, after feedback related to the operation of these items in various cultural as well as national contexts is taken into account (OCED, 2006, 2009, 2012). Later, the results reflected in ASER 2016 report claimed that 27% of students studying in class 8th could not read text of class 2nd and 57% students could not solve problems of simple division of class 4th level. It was seen that the poor levels of reading and writing ability negatively impacted understanding in other curricular as well as non-curricular areas as well. In such circumstances it is difficult to expect students to perform well in subjects such as science, which needs both, knowledge of language as well as mathematics. India has planned to participate in PISA once again in the year 2021 and the sample for the assessment will be taken from all schools of Chandigarh (Chopra, 2018). But the main concern for all those associated with school education system is that has the teaching learning process changed in any ways that its impact would be visible on any such international level assessment.

NCF (2005) advocates that at elementary level the learner should be taught science through real life experiences by providing hands on experiences through experiments and explorative activities. Actively participating in group tasks, brainstorming on issues, collecting and organizing data and thereafter displaying it, must be an integral part of the teaching learning processes. It should be understood that the brain is always looking for meaning and it learns best when it can relate things in a natural way. Teaching science using brain based learning could be very fruitful as each and every child could learn and understand science by doing and not by merely
memorizing it (Mangan, 1998). It becomes difficult to understand learning if we do not understand functioning of brain.

Brain based learning focuses on differences among individuals, using various teaching strategies, and optimizing the natural processing of brain (Gülpınar, 2005; Tileston, 2005; Zadina, 2004). The brain naturally searches for meaningfulness, associations in pattern, importance and applicability (Greenleaf, 2003) from the environment. It has been revealed through various researches that human mind show changes according to the environment (Diamond and Hopson 1998). It has been suggested by Diamond and Hopson (1998) that allowing learners to participate actively, providing emotional support, health and nutrition diet, threat free environment, interpersonal interactions and promoting mental, physical, aesthetic, social and emotional skills provides a positive environment to the learners which effect development and functioning of brain and hence learning. Brain based classrooms, also referred to as “brain friendly places”, are the learning places where brain can function optimally and performance can be seen in terms of teaching learning process. These brain friendly classrooms provide an emotionally supportive environment where learners can have total immersion in the challenging but stress free environment. The learners are believed to be unique in brain friendly classrooms and it is felt that the basis for new knowledge lies in the previous knowledge (Fogarty, 2002). In such classrooms, activities those have challenges, novelty, critical and deep thinking and multitasking are adopted and are seen to be favourable for the functioning of the brain. Jensen (2008) observed that if the learning environment is not stimulating, the connections and their strength in brain decreases and also the expectations about learning. Therefore, “the art of teaching must be the art of changing the brain” (Zull, 2002). It has been found in various researches that brain based learning effects the learning (Ali, Ghazi, Shahzad & Khan, 2010; Altiti, 2014; Awolola, 2011; Aziz-Ur-Rehman & Bokhari, 2011; Bello, 2007; Duman, 2006; Gozuyesil & Dikiciib, 2014; Noureen, Awan & Fatima, 2017; Olaoluwa & Ayantoye, 2016; Sadrabad, Ghavam & Radmanesh, 2015; Saleh & Subramaniam, 2018; Shabatat & Al-Tarawneh, 2016; Sharma, 2013; Varghese & Pandya, 2016; Yasar, 2017) but not much researches have been done in this field in India (Binulal & Aravind, 2013; Chavhan, 2012; Grover, 2015; Francis, 2014; Kaur, 2013; Panse,
2012; Ramakrishnan, 2015; Sharma, 2013; Thomas & Swamy, 2014), but these studies have proven that brain based learning is effective in improving achievement of learners, life skills, self esteem, academic stress, etc. Hence, the researcher decided to design interventions based on the principles of brain based learning which could effectively promote learning of science.

Self esteem is an important aspect of personality of an individual and explains success, happiness, satisfaction (Bhagat, 2016), failures and frustration (Doodman, Zadeh & Changizi, 2017) and it has been found that positive self esteem effects learning (Acharya, Pal & Sengupta, 2015; Aryana, 2010; Booth & Gerard, 2011; Bankston & Zhou, 2002; Colquhoun & Bourne, 2012; Das & Pattanaik, 2013; Duari, 2012; Fathi-Ashtiani, Khodapanahi & Tarkhorani, 2007; Hall, 2007; Lockett & Harrell, 2003; Marsh, Byrne & Yeung 1999; Meftah, 2002; Pullmann & Allik, 2008; Nwankwo, Obi, & Agu, 2013; Rahmani, 2011; Redenbach, 1991; Rubie, Townsend & Moore, 2004; Schmidt & Padilla, 2003; Vishalakshi & Yeshodhara, 2012; Walter, 2003) but many contradictory studies have also been reported where higher self esteem does not relate with or predict better achievement (Chen & Graham, 2018; Chilca & Manuel, 2017; Cvencek, Fryberg, Covarrubias & Meltzoff, 2018; Dev & Qiqieh, 2016; Khaola, 2014; Lew & Harklau, 2018; Tetzner, Becker & Maaz, 2016; Vialle, Heaven & Ciarrochi, 2015). Self esteem is belief of an individual towards himself giving a sense of self worth, like or dislike oneself (Blascovich & Tomaka, 1991). It develops a sense in individual if he can be successful or not, and what amount of efforts should of put in (Coopersmith, 1967, 1981). If an individual has positive self esteem, one becomes more goal oriented, better problem solver and decision makers, manages emotions properly and have better coping skills (Federal occupational health, n.d.) also they are more confident and motivated. The brain based instructional strategies provides the opportunities to learners considering their potentials and abilities in a threat free environment where they have the freedom to express themselves without fear of being judged and thus helping to develop a positive self esteem towards oneself. The brain based learning have been found to improve the self esteem, self confidence, self efficacy (Canbulat & Kucukkaragoz, 2014; Chavhan, 2012; Davis, 2004; Erlauer, 2003; Pociask & Settles, 2007; Respress & Lufti, 2006; Sharma, 2013) of the learners.
To improve the achievement and self esteem of learners the classroom environment plays an important role. Learning occurs in a positive classroom environment where students feel safe with opportunities for experimentation and exploration without feeling of making mistakes and being judged. The physical environment like infrastructure, light, ventilation, etc. affects the learning of students. Suleman et al. (2014) mentioned that physical environment has an effect on students feeling comfortable in class and thus affecting their learning, as positive classroom environment plays an important role in developing and maintaining interest in learning process, they also mentioned if students feel comfortable in class they become more willing to receive information. Classrooms with effective teaching methods and teaching learning processes positively affect the achievement of the students (Ezike, 2018). The social environment including interaction among students and with teachers play an important role in effecting the learning of students. The classrooms were teachers knows what their students need, respect and value their students, such students are more motivated and develop positive self-esteem (Ames & Miller, 1994). The researchers who have studied self esteem acknowledged that positive classroom environment help to develop and strengthen adequate self perception about themselves (Meskauskiene, 2017). Reinisch (n.d.) said that positive classroom environment “help children feel safe, secure, and valued. As a result, self-esteem increases and students are motivated to engage in the learning process.” The review of literature also shows that positive classroom environment is an important aspect of brain based learning and positively impacts the achievement (Adesoji & Olatunnosun, 2008; Adeyemo, 2012; Anbalagan, 2017; Bellamy, 2016; Bennett, 2001; Dwivedi, 2005; Ekpo, Akpan & EssienImo-Obot, 2009; Ezike, 2018; Gietz & McIntosh, 2014; Iweka, 2017; Javed& Asghar, 2017; Kausar, Kiyani & Suleman, 2017; Kekare, 2015; Kumara, Devi & Mayuri, 2017; Kumari & Rajani, 2017; Lizzio, Wilson & Simons, 2002; Madrazo & Motz, 2005; Mahmood & Gondal, 2017; Mary & Jebaseelan, 2014; Maxwell, Reynolds, Lee, Subasic & Bromhead, 2017; Mehdipour & Balaramulu, 2013; Mucherah & Ambrose-Stahl, 2014; Rahmi & Diem, 2014; Suleman & Hussain, 2014; Sunitha & Khadi, 2007; Swamy, 2013; Tabibian, 2018; Tope, 2013; Umar, 2017; Utne, 2001; Varshney, 2017; Vazalwar & Yadav, 2005; Wilson, Abbott, Joireman & Stroh, 2002) and self esteem of learners also gets
effected by the classroom environment. (Akin & Radford, 2018; Barter-Colcord, n.d.; Brooks, 2018; Bucholz & Sheffler, 2009; Burnett & Howard, 2002; Chionh & Fraser, 2009; Demirdag, 2015; Gunnell, 2012; Kilbride, 2014; Lawer, Isaac, Seth & Nashiru, 2016; Meskauskiene, 2017; Roskam & Nils, 2007; Shore, 2018; Strauss, 2011; Tran, 2012; Trautwein, Ludtke, Koller & Baumert, 2006; Watson, 2017), but certain results have been found in contradiction with achievement (Koroye, 2016; Lawrence & Vimala, 2012; Miah, 2015; Saini, 2010; Sivakumar & Malliga, 2015; Sunitha, 2005;). Therefore, the present study was taken up to find out the effect on achievement and self esteem of learners when they are taught science through instructional strategies that are designed based on the principles of brain based learning in relation to how the learners perceive their classroom environment.

1.6 STATEMENT OF THE PROBLEM

EFFECT OF BRAIN BASED INSTRUCTIONAL STRATEGIES ON ACHIEVEMENT AND SELF ESTEEM IN RELATION TO PERCEPTION OF CLASSROOM ENVIRONMENT AMONG ELEMENTARY SCHOOL SCIENCE STUDENTS

1.7 OPERATIONAL DEFINITIONS

Brain Based Instructional Strategies are the teaching and learning strategies based on principles of brain based learning.

Achievement is scores obtained by students on self constructed achievement test based on the CBSE/NCERT prescribed syllabus of Science for class VII.

Self Esteem is taken as the score obtained by students on self esteem scale (Rosenberg, 1965). It is the value ascribed by individual to himself and the quality of the ways in which he views himself.

Perception of Classroom Environment is assessed as the score obtained by students on scale for perception of classroom environment (Sharma and Kaur, 2013). It is in terms of classroom infrastructure, teacher behaviour and characteristics, student behaviour and characteristics, discipline, teaching and evaluation.
1.8 OBJECTIVES OF THE STUDY

“A research objective is a statement of intent used in quantitative research that specifies goals that the investigator plans to achieve in a study” (Creswell, 2012). In the present study the researcher planned to achieve the following objectives:

1. To compare the effect of instructional treatments on achievement in science of class VII students.
2. To compare the achievement in science of class VII students with differing perception of classroom environment.
3. To compare the effect of instructional treatments on achievement in science of class VII students with differing perception of classroom environment.
4. To compare the effect of instructional treatments on self esteem of class VII students.
5. To compare the self esteem of class VII students with differing perception of classroom environment.
6. To compare the effect of instructional treatments on self esteem of class VII students with differing perception of classroom environment.

1.9 HYPOTHESES

“Hypotheses are statements in quantitative research in which the investigator makes a prediction or a conjecture about the outcome of a relationship among attributes or characteristics” (Creswell, 2012). In the present study null hypothesis were formulated as “it can be tested and found to be false, which then implies there is a relationship between the observed data” (Helmenstine, 2018). The null hypothesis is presumed to be true until statistical evidence nullifies it for an alternative hypothesis (Haldar, 2013). It is important to formulate an alternate hypothesis when a null hypothesis is formulated (Gauthier & Hawley, 2007; Good & Hardin, 2009) as it “suggests that the experimental or independent variable has an effect on the dependent variable” (Helmenstine, 2018). The following hypotheses were formulated for the present study:

Hypotheses related to achievement in science

$H_{01}$) There exists no significant difference in the scores of achievement in science between control and experimental groups of elementary school students.
$H_{A1}$) The elementary school students in experimental group score better on achievement in science than the students in control group.

$H_{02}$) There exists no significant difference in scores of achievement in science between elementary school students with favourable and unfavourable perception of classroom environment.

$H_{A2}$) The elementary school students with favourable perception of classroom environment score better on achievement in science than the students with unfavourable perception of classroom environment.

$H_{03}$) There exists no significant interaction effect between instructional treatments and perception of classroom environment on scores of achievement in science of elementary school students.

$H_{A3}$) There exists significant interaction effect between instructional treatments and perception of classroom environment on scores of achievement in science of elementary school students.

**Hypotheses related to self-esteem**

$H_{04}$) There exists no significant difference in the scores of self esteem between control and experimental groups of elementary school students.

$H_{A4}$) The elementary school students in experimental group score better on self esteem than the students in control group.

$H_{05}$) There exists no significant difference in scores of self esteem between elementary school students with favourable and unfavourable perception of classroom environment.

$H_{A5}$) The elementary school students with favourable perception of classroom environment score better on self esteem than the students with unfavourable perception of classroom environment.

$H_{06}$) There exists no significant interaction effect between instructional treatments and perception of classroom environment on scores of self esteem of elementary school students.

$H_{A6}$) There exists significant interaction effect between instructional treatments and perception of classroom environment on scores of self esteem of elementary school students.
1.10 DELIMITATIONS OF THE STUDY

Delimitation help researcher in feasibility of the study by delimiting variables, sample, method, tools and statistical techniques of the study (Singh, 2006). The present study had following delimitations:

1) The brain based instructional strategies were developed for selected topics of science from prescribed syllabus of class VII of CBSE/NCERT. 30 lesson plans were executed with both control and experimental group.

2) The experiment was limited to about three months of an academic session.

3) The study was confined to only one residential school of Chandigarh.

4) The study was conducted on class VII science students only.