

## CHAPTER 10: BRAIN-BASED LEARNING

Assoc. Prof. Dr. Bahadır Erişti  
Anadolu University, Faculty of Education

Assist. Prof. Dr. Celal Akdeniz  
Süleyman Demirel University, Faculty of Education

(Translated by Muharrem İhsan Şirin)

### INTRODUCTION

A considerable amount of studies on human beings or related to human nature focus on human behaviours. How human beings know, how they acquire behaviours, how and according to what they behave in which situations, the reason of the differences between behaviours, factors that affect human behaviours are some of the subjects that are studied through these studies.

As is known, people acquire all their abilities throughout their lives after birth except for a few innate behaviours that are species-specific. This information is very significant because it emphasizes the fact that people have a capacity that can be improved. A person can learn what a behavior means or how it is formed through his/her direct or indirect experiences, on the other hand, this person can display the said behaviour(s) whenever it is possible and the person wishes to do so. In short, except for the innate behaviours, the answer of a substantial amount of human behaviours is hidden in the concept of *learning*<sup>1</sup>.

Learning is relatively permanent products of experiences that come out as a result of the interaction between individual and environment<sup>2</sup>. A part of a person's all learnings occur incidentally while an important part of it occurs in a specially structured learning environment in a planned and programmed manner. The concept of learning which is of vital importance in terms of explaining human behaviours is one of the important subject areas whose questions are tried to be answered in the body of literature such as how and through which processes learning occurs. In the historical process, there have arisen many theories that are still acceptable despite of some criticism. Learning theories that are interested in learning and ways of learning in order to understand and explain learning process explain learning as a process in which behaviour changes, is shaped or controlled. These theories may be classified under different headings according to some criteria. On the other hand, although these theories have some common views, they also have different points of view, which have been developed considering biological, psychological, physiological, neurological structure of human. Some of these theories are stated below.

In behaviorist learning approach, measurability and observability of human behaviours are considered important while unobservable and immeasurable human behaviours are ignored to the extent that they are disregarded completely<sup>3</sup>. In behaviorist approach, learning is explained as a process in which a stimulus and a response are matched, and a response given to a stimulus is reinforced. Behaviorist theory results from the idea that learning occurs mostly through repetition, motivation and reinforcement. According to this approach, there are basically two types of learning. In classical conditioning, which is the first of them, a neutral stimulus is matched with an unconditioned stimulus. On the other hand, operant conditioning is behaviour is reinforced and so is more likely to repeat.

As some situations about learning could not be explained with the principles of behaviorist theory, researchers headed towards re-defining human learning and as a result of this situation, cognitive learning theories started to gain importance. Cognitive approach, which claims that learning cannot be explained through the connection of stimulus-response, claims that learning is determined by the mental processes of learner, and states that student is not a passive receiver of external stimuli, but is

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

an individual who internalizes them and thus actively shape behaviour. Cognitive learning theories examine mental processes of human while making sense of the world. According to this theory, learning is the change of mental structure of an individual, and it is emphasized that with this change, behaviours of a person are also changed or a person acquires new behaviours. Cognitive theorists are also interested in internal structures of individual as well as observable behaviours while explaining learning<sup>4</sup>.

Another approach, which researches learning, is constructivism. This theory claims that knowledge is produced by learner's value judgements and experiences. Those who defend constructivism explain learning as finding and structuring knowledge by means of associating them with previous experiences and knowledge<sup>5-6</sup>. According to constructivism, learning is an internal process that takes place in a person's mind. A person is not passive receiver of external stimuli, but is an individual who internalizes them and thus actively shape behaviour. Constructivism is a learning approach that states that learners learn something by means of using and structuring their own experiences instead of receiving knowledge in an organized form as given to them<sup>7</sup>. Learning is a process in which students construct their own knowledge in their mind related to a certain object, event, phenomenon or concept or at least, in which students interpret the truth grounding on their previous experiences<sup>8</sup>. We can say that views of constructivist theory and cognitive theory are similar to each other to a great extent.

Brain-based learning, which deals with the concept of learning in a neuro-physiological context, accepts and explains the process of learning as a bio-chemical or electro-chemical change. According to this approach, the process, which is called, learning, is a process of establishing a connection between brain cells and an intercellular connection, and a new connection is established between brain cells with each new learning<sup>9</sup> (Jensen, 2000).

In this chapter of the book, brain and its fundamental features, what kind of a relationship there is between brain and learning, brain-based learning theory, how this theory deals with learning, its foresight about the formation of learning, its suggestions about maintaining quality in learning, its superiority and sides that are open to improvement and such other qualities are addressed and explained.

### **Brain and Its Fundamental Features**

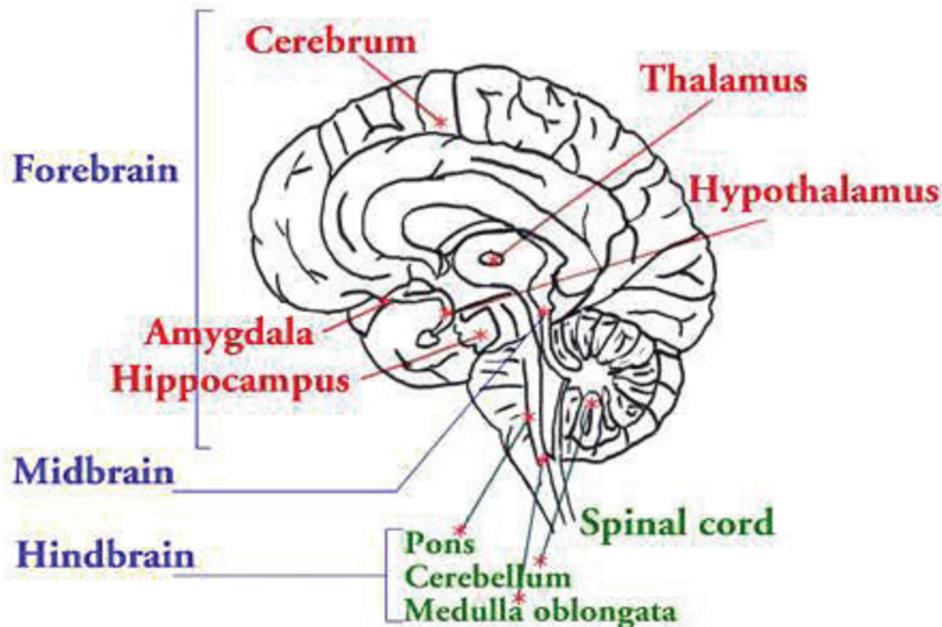
Reviewing basic information related to human brain will make it easier to understand brain-based learning better. Structure and processing of brain, intercellular relations, brain hemispheres and lobes (parts), processes at which each part is good at and structural qualities of brain hemispheres are some of these features.

Brain is the organ which is connected to the other organs of the body, constitutes the center of nervous system, weights about 1400 grams, holds almost %25 of the blood in the body and consumes energy the most. Brain is composed of three layers that are related to each other which are called forebrain, midbrain and hindbrain. As is seen in graph 1 and 2, cerebrum that constitutes the real mass of the brain comprises a big part of brain including the two hemispheres. Corpus callosum maintains data transfer between right and left hemispheres with more than 250 millions of cells. This part is also the place where thinking, memory and speaking are coordinated. Brain stem is at the top of spinal cord and connects lower and middle brains<sup>10</sup>. Brain stem instructs heart and lungs, and thus coordinates two vital systems which are circulation and respiration. Apart from these, balancing body temperature is also the task of brain stem. Cerebellum is located at the back border of brain stem; it directs balance, motion, coordination and other kinetic processes<sup>11-12</sup>.

Hippocampus, which is located in midbrain, coordinates the memory systems of thalamus and amygdala<sup>13</sup>. Thalamus is responsible for collecting information coming from sense organs and distributing this information to the related parts of the brain; amygdala is responsible for establishing connection between feelings; just like hard-disc in a computer, hippocampus is responsible for re-

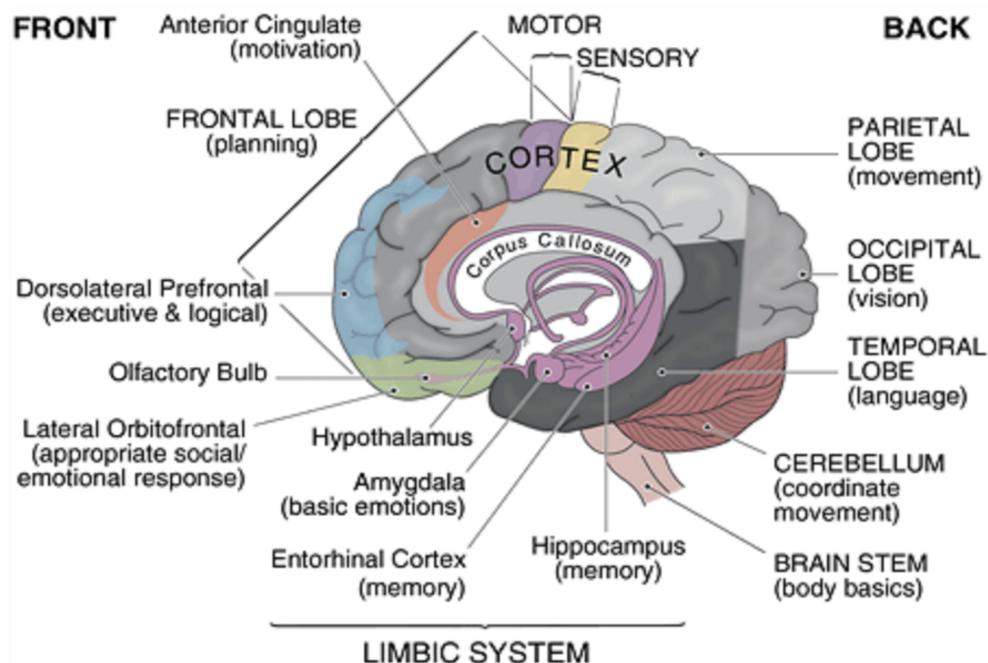
## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

coding data transferred from other structures to short term memory and then given to it and thus maintaining the durability of the information<sup>14-15</sup>.



Graph 1: parts of forebrain, midbrain and hindbrain

Source: taken from the address of <http://www.educarer.com/brain.html>

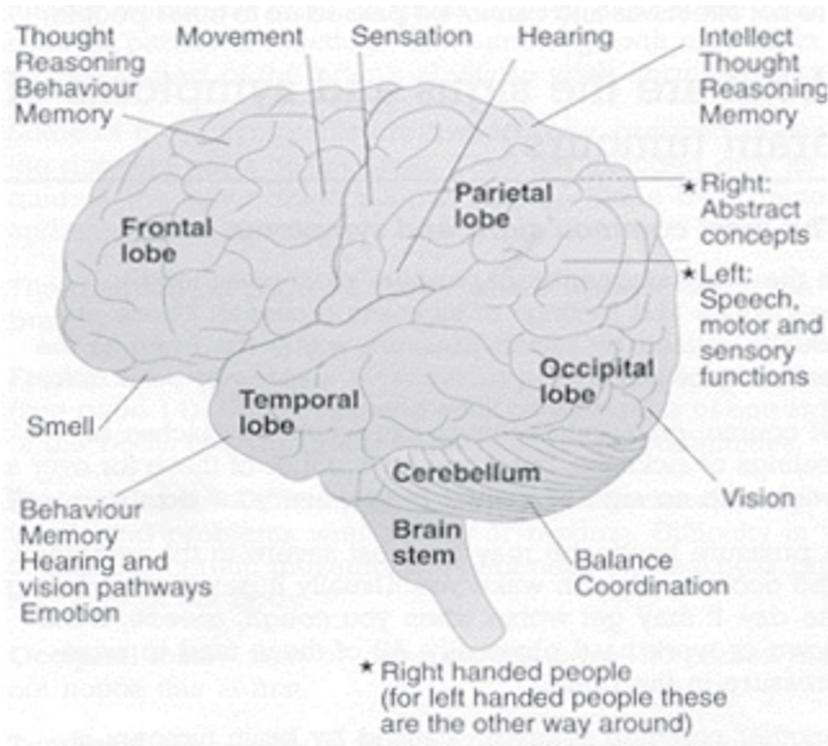


Graph 2: The structure of the brain

Source: [http://www.brainwaves.com/images/brain-basic\\_and\\_limbic.gif](http://www.brainwaves.com/images/brain-basic_and_limbic.gif)

Brain is a structure that is composed of a number of parallel processors that carry out a lot of processes at the same time. Hemispheres and lobes of the brain can be busy with different tasks at the same time. However, each lobe has its specific structure, tasks and processes. So, if a part of brain is damaged, processes carried out in that part may also end.

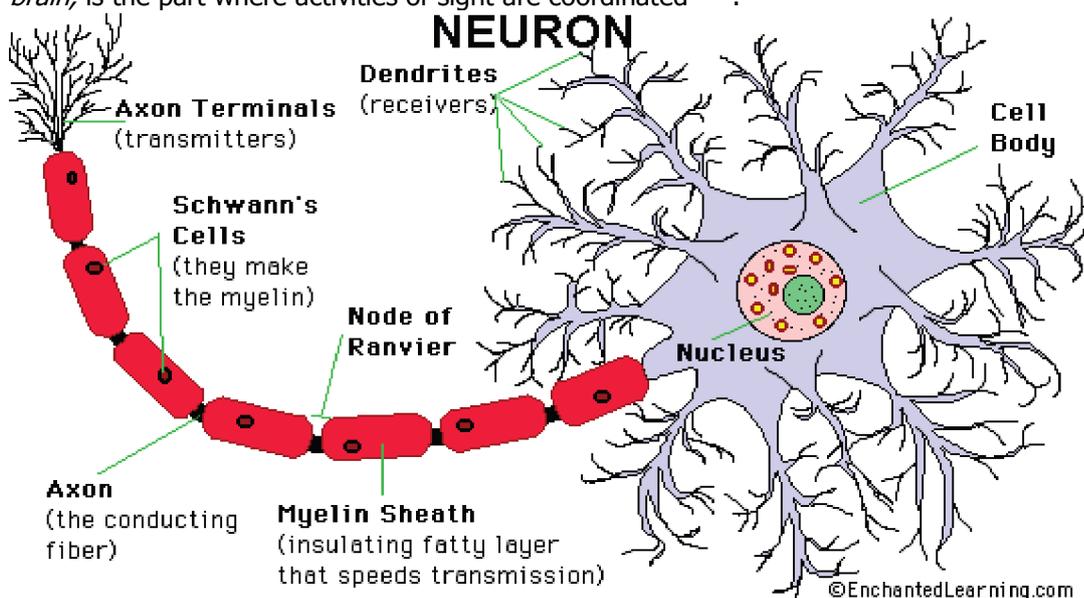
# LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS



Graph 3: Parts of the brain

Source: <http://www.cancerbacup.org.uk/info/brain/brain-3.htm>

*Frontal lobe* that is located in the front part of brain is the part where planning, creativeness, thinking, problem solving and decision-making are carried out, and speaking processes are coordinated<sup>16</sup>. *Temporal lobe* which is located in the middle of the brain when viewed from the side and which has parts in right and left flocculus is the part where listening, speaking, making sense are carried out and hearing processes are coordinated. Another part of the brain, *parietal lobe* is located in the upper side of the brain and it is the part where sense and movements are coordinated<sup>17</sup>. This part is thought to be related to arithmetic and language skills. *Occipital lobe*, which is located at the backside of the brain, is the part where activities of sight are coordinated<sup>18-19</sup>.



Graph 4: The structure of brain cell

Source: [www.enhancedlearning.com](http://www.enhancedlearning.com)

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

As is mentioned at the beginning of this chapter, brain-based learning theory defines learning as establishing connection between brain cells. In this context, brain cells (neurons) which are the basic structures where learning occurs make learning possible by means of establishing connections (dendrite) with other cells. It is predicted that an adult brain has almost 100 billion neurons. Intercellular relations, axon terminals and their fibers are developed to carry certain messages.

As is seen in graph 4, a cell is composed of three parts, which are dendrite, nucleus and axon. Electrical currents coming to neurons, cell body and dendrites influence neurons. While some of the electrical current stimulates neuron, some other causes a change of behaviour in neuron. When neuron is sufficiently stimulated, it gives response by means of sending electrical signs from axons. Electrical messages reach other neurons through axons and thus they are also stimulated and get ready to give response. In this way, there occurs data transfer (neuron activity) between a numbers of neurons. *Dendrites* are structures developed to maintain connections between a neuron and the others and between nerves. On the other hand, *axons* are structures that maintain data transfer between neurons through electrical currents by means of transferring from one cell to the other<sup>20-21</sup>. Axons are covered with myelin sheath that is composed of fat and protein structures in order to be protected from irregular electricity fluctuations coming from external factors and to increase the speed of data flow, as is the case in electric cables. If myelin sheath is damaged, this may slow down data flow up to 400 times<sup>22</sup>. When myelin sheath is damaged, a person's physical responses slow down and there may be losses of function in other parts of the body that are related to neurons. One of the structures, which should be emphasized about this, is synapsis. Synapses are end points where connections between nerves and data transfer between neurons are carried out. Data transfer in the electrical signals between neurons increase the number of synapses, and the more synapses increase in number, the more learning there will be<sup>23</sup>. In other words, the more signals there are, the more data transfer there will be; the more data transfer there is, the more learning there will be. If neurons are not enough in number or if there is less data transfer between neurons depending on age, synapses will also decrease in number and there will be difficulty in learning. High number of synapses is influential on data transfer being quicker and multi-dimensional; therefore it is one of the determining factors about the increase in the capacity and power of cognitive process<sup>24</sup>. After some explanations about the structure and qualities of human brain, the relationship between brain and learning is explained in detail below.

### Brain and Learning

Depending on the findings of the studies about neurological and physiological structure of human brain, brain-based learning theory claims the idea that learning activity takes place by means of new connections (dendrites and synapses) established as a result of data transfer between neurons<sup>25</sup>. According to this approach, learning is a brain function and is a biological process developed mostly through an individual's intentional behaviours and sometimes through stimuli coming from external factors independent from individuals, themselves. Dendrites continually scan data out of neurons and try to find new data sources<sup>26</sup>. When there arise situations that allow data exchange, data exchange between neurons occurs and a basis is founded to let the formation of new dendrites and synapses connections. When data exchange between neurons reach a certain level, this affects other neurons in the environment and thus a close interaction comes out between neuron groups<sup>27</sup>. If the physiological structure of the brain is suitable as well, the processes of establishing new connections for data exchange and of creating new meanings (meaning quest) are included in a cycle<sup>28</sup>.

Although brain is the basic factor in learning, learning is also affected by environmental factors, psychosocial qualities of the individual and chemical structure of the organism; and these interactions reflect on the process of learning. As scientific studies about brain processes increase, more information is gathered about how brain can be used in learning process in the most effective way. According to studies, just one brain cell can establish connections with 50,000 other brain cells. When the number of cells in the brain is considered, the number and amount of connections reach to an unbelievable level<sup>29-30</sup>. There are almost 100 billion cells in human brain. On the other hand, it is claimed that total number of connections between cells can reach 100 trillion. According to a view, the cells in human brain can make connections as many as the number of leaves on all the trees of a

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

forest that covers half of America. It is thought that the total length of cell fibers in an adult human brain is more than 100.000 kilometers<sup>31-32</sup>.

According to Hebb (1980) who is famous for his studies on brain, if learning occurs in brain and if brain is a live structure, the related part of brain must experience a change through learning when compared to the state previous to learning. Hebb mentions two concepts about these changes, which are cell assembly and phase sequences. *Cell Assembly*: Each event or object faced by the individual activates a group of cells that are related to each other. The number and size of cell assembly changes according to object or event. For example; the number of cells activated in relation to pen is less than the number of cells activated in relation to car, because a car has more details than a pen and each detail requires more connections to be established between cells. *Phase Sequences*: It is explained as the series of cell assemblies that are related to each other. It is also defined as the state that cell assemblies form various combinations and influence each other. In these cell assemblies, one can be trigger or cause of others. For example; the smell of a perfume may remind us of our mother. The smell of a perfume, which our mother uses, is recorded in the related cell assembly in our brain together with information about our mother. When we perceive the same smell, this smell will remind us of information about our mother<sup>33</sup>.

According to Hebb (1980), it is natural to have differences between age periods in terms of learning. Learning comprises cell assembly process in babyhood and childhood. Piaget mentions formation of schema in this period. During adulthood, phase sequence is re-arranged. Because of this reason, learning during childhood can be said to be the base of the learning in adulthood<sup>34</sup>.

According to brain-based learning approach, the focus point of learning is brain. In this context, it is useful to explain some concepts such as awareness, conscious, automatization (unconscious behaviour), feeling, sense and attention which are all known to originate from brain and which can be called the factors of learning process.

According to Churchland and Forber (1995), state of consciousness requires state of effective awareness about real-time events. From this point of view, it can be said that state of consciousness may comprise various states of awareness. Sensual awareness (state of using all senses against real-time events in a way to comprise stimulus-response relations), generalized awareness (state of awareness related to factors such as comfort, anxiety, state of body), metacognitive awareness (state of awareness created by the individual in mind or whose real source cannot be explained with concrete data) and conscious remembering (state of awareness that expresses the state of being careful against similar situations because of previous experiences). According to states of experiences, more than one type of awareness stated above can be experienced in a time unit<sup>35</sup>.

It is a fact that each individual's brain is different from others' brains in terms of processing, accumulation, reactions, and frequency of intercellular connections. In other words, each brain is original and makes its owner unique in this way. It should be kept in mind that in learning process each individual has different brain, and their inner worlds, experiences, cognitive and metacognitive abilities, styles of awareness about events and durations of reactions are different. From this point of view, it is important to keep in mind that cognitive structures possessed by individuals will have different reflections on teaching process, teaching should be diversified as much as possible, sense and feelings which are thought to have close relations with conscious and awareness should also be included in teaching process.

Gazzaniga (1995), Hirst (1995), Churchland and Forber (1995) focus on expertised brain hemispheres as source of consciousness and awareness. Gazzaniga, Churchland and Forber divide hemispheres according to conscious or unconscious behaviours first of all. While left hemisphere is mostly conscious, acts with sensations, is source of sudden reactions, can carry out few tasks in a time unit and has a tendency to abstract processes; right hemisphere is stated to display unconscious or automatized processes and reactions (there are different explanations by different researchers in this subject), be influenced by real life conditions through sense and feelings<sup>36-37-38</sup>. In addition to this

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

view, Hirst (1995) and Restak (2000) express that brain hemispheres should not be used independently from each other, instead common activities that require them to work together should be preferred<sup>39-40</sup>. In teaching process, a learning synergy that will require right and left hemispheres of learners to be used can be created and level of learning can be improved to a great extent<sup>41-42</sup>. For example; it is possible to realize qualified and permanent learning by means of a teaching environment with abstract and logical processes<sup>47-48</sup> that will let previous learning experiences have positive impact on new learnings, that will stimulate left brain<sup>43-44</sup> as well as by including right brain into the process through creating an environment of trust that will lead learners to have positive senses and feelings, and through physical stimuli such as sufficient heat, light, oxygen, cleanness<sup>45-46</sup>. Studies about brain state that brain hemispheres specialize in different processes and they get dominance over the other at certain time intervals. Jensen (1998) and Hirst (1995) express that brain realizes high and low intensity processes at 90-110 minutes in a day, and that right or left brain may be dominant over the other during these time intervals. From this point of view, in learning process, it can be said that it is important in terms of the quality of learning to include activities that will make right hemisphere more functional such as intuition, insight, creativeness, holistic thinking and editing, process-oriented evaluations (portfolio, observation, etc.) as well as activities that make left hemisphere functional.

Another concept that should be handled in this subject is attention. Jensen (1995) states that quality time of attention for a person is about 10 minutes, however, he also states that processes of attention such as starting, continuing and ending can be lengthened through various stimuli<sup>49</sup>. For example; in primary schools, a period of lecturing that lasts for about 10-15 minutes should be followed by a break of two or five minutes, because this break will give learners time to process and internalize what they have learnt. Likewise, this is also true with different time periods for higher levels of education. For example; a lecture of 15-20 minutes with high school or undergraduate students should be followed by a break of 1-2 minutes.

Van de Graf (1998) and Jensen (1998) emphasize that brain wave propagations of different frequencies while carrying out various processes and having individuals live similar experiences through some devices may contribute to the increase in the quality of learning<sup>50-51</sup>. Brain waves different propagations for different processes it carries out. These waves can be divided into four according to frequency. The activities below can be given as an example of brain waves and related processes according to their frequencies: *Beta waves* are repeated 13-25 times in a second and they are waved in the frontal lobe of the brain. They come out as a reaction to visual and cognitive activities. In teaching process; discussions, exercises, contest and complex Project Works can cause such waves. *Alpha waves* are repeated 10-12 times in a second and they are waved in the parietal and occipital lobes of brain. They cause relaxed stimulation. In teaching process; reading, writing, watching and problem solving cause such waves. *Teta waves* are repeated 5-8 times in a second and they are waved in temporal and occipital lobes of brain. They refer to the best time to process information. *Delta waves* are repeated 1-5 times in a second and they can be waved all throughout cerebral cortex. They come out during deep sleeping.

There are some examples of qualities of brain hemispheres related to cognitive processes and learning, and also to strengths<sup>52</sup>.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Table 1: Qualities and strengths of brain hemispheres

Left Brain	Right Brain
It is realistic, logical.	It is intuitional.
It is verbal and numeral dominant.	It has visual and spatial tendencies.
It is planned and structural.	It is spontaneous and natural.
It solves problems through analysis.	It solves problems through synthesis.
It controls feelings.	It lets feelings free.
It ends up with objective judgements.	It ends up with subjective judgements.
It remembers names.	It remembers faces.
It sees details.	It sees the whole.
It likes hierarchically structured interaction.	It likes participative informal interaction.
It tends to think realistically.	It considers feelings while thinking.
It is analytical and logical.	It is creative, reactional and abstract thinker.
It focuses on vertical angle.	It focuses on horizontal angle.
It thinks convergently.	It thinks divergently.
Deduction.	Induction.
It is time-oriented.	It is environment-oriented.
It prefers writing and speaking.	It prefers drawing, using objects and imagining.
It controls right side of the body.	It controls left side of the body.
It deals with one task in a time unit.	It tends to focus on different tasks simultaneously in a time unit.
It tries to find differences.	It tries to find similarities.

Adapted from Jensen, 1998.

### Researchers in the Field of Brain-Based Learning and Their Contributions

When the related body of literature is examined, it is possible to come across some researchers contributing to the improvement of brain-based learning.

A lot of researches have been carried out about brain, learning processes of brain and adaptation of brain's learning processes to teaching. Some of these researches have developed principles, rules and suggestions about how brain learns and about how to relate brain's learning style to teaching.

R. N. Caine and G. Caine have come up with some explanations through 12 principles they have developed about brain's tendency to learn and how to reflect these tendencies on education. Explanations about these 12 principles developed by Caine and Caine are included under the heading of "principles of brain-based learning."

E. Jensen is one of the leading researchers in the field of brain-based learning. Jensen (1998) mentions nine principles that should be considered important in his study revealing the qualities of brain-based learning. These principles and their indicators about learning process are<sup>53</sup>: *Reading*; reading plan. *Enriching*; problem solving, critical thinking, preparing projects, arranging complex activities, and getting feedback of other learners. *Attention*; traditional and new, preferences of learners, individual activities, physical and emotional studies. *Anxiety/Stress*; free time, open guidance, techniques of diminishing stress, developing skills. *Motivation*; setting goals, being affected in a positive way, teaching emotion management, getting/giving feedback. *Emotional conflict*; role model, congratulating, discussing, presenting physical rituals, carrying out introspection. *Motion*; playing a role, activities of comprehensive expansion, playing dodgeball. *Quest for meaning*; basic learning activities, learning through cooperation, teaching patterns, grouping, playing role, setting high level social goals, developing complex projects. *Memory*; meaning structures, working structure models, operational learning and quick response activities.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Given (2002) mentions about five systems of brain based learning and explain signals of these systems in learning process as expressions of effectiveness. Five systems of brain based learning and their signals are<sup>54</sup>: *Emotional learning*; teachers should act mentors that diminish stress in teaching environment. *Social learning*; learners should feel confident and should be encouraged to congratulate each other. *Cognitive learning*; teachers should act as facilitators in order for learners to solve real life problems. *Physical learning*; learners should be in close contact with teaching materials. In this process, teachers should act in a way that they let students manipulate materials and then turn them into their previous states again. *Reflective learning*; students should be responsible for their behaviours and their own learnings, they should develop self-control skills. In this process, teachers, as a guide, should help students to teach each other and exchange their experiences.

P. Wolfe (2001) mentions about four basic principles and signals of these principles about reflection brain based approach on teaching process. These principles and their signals are<sup>55</sup>: *Brain has different experiences in different environments*; visual, audio and emotional factors should be kept in mind in teaching process. *The system of memory forgets quickly*; students should be maintained to use strategies that help organizing what they have learnt in the teaching process. *We have got long-term and operational memory types*; activities should be organized so that they help learning to be kept in long-term memory. *Emotions are catalizators of learning*; emotional provocateurs should be watched carefully in teaching process. An environment where students feel safe should be established.

In his study that puts forth the dimensions of brain-based learning and the signals of these dimensions in teaching process, Hardiman (2001) states how teachers and students should act in teaching process. These learning dimensions and their signals are<sup>56</sup>: *Positive behaviours*; teachers should display model behaviours; activities that will ensure students to acquire positive attitudes should be organized. *Acquiring and internalizing knowledge*; students should be allowed to use visuals, to realize tasks again and again, to manipulate written texts, to organize their own learnings. *Using knowledge meaningfully*; students should be ensured to use pieces of information effectively and thus to make them permanent in memory. Students should be allowed to display what they know through drama, visual and audio activities, and presentations. *Habits and mind*; students should be allowed to organize and evaluate themselves.

J. King (1997), who carried out studies about brain based learning, states that brain based learning theory is basically dependent on the theory of using posters, accelerated learning, theory of triple brain and their cognitive functions, theories of classified memory, the role of limbic system and feelings on cognition, uniqueness of individual learnings. According to King; explaining how brain works and how to establish connection between brain and learning will give important clues about which methods, techniques, models, strategies, materials to use and in which way to use in teaching process for quality learnings<sup>57</sup>.

In his theory of proster learning, Hart (1992) claims that the best way to learn new things is to establish connection between previous learnings and new learnings. According to him, materials to be used in teaching process will be useless unless they involve preliminary information and establish a connection between preliminary information and new things to be learnt<sup>58</sup>.

In his theory of triune brain theory, McLean (1978) claims that brain can be divided into three basic structures, and these structures are reptile complex that consists of brain stem which is accepted to be source of instinctive behaviours, mammalian complex that regulates feelings and that consists of limbic system, neocortex complex that ensures high level of thinking and learning. According to McLean, in case of anxiety, an individual will tend to use mammalian (emotional) and reptile (instinctive) brains instead of neocortex in order to survive<sup>59</sup>. In this case, it can be said that an anxious individual will have difficulty in using his/her skills of high level of thinking and interpretation. From this point of view, brain based learning emphasized the teaching environment should be eliminated from worrisome elements. Some researchers do not agree with this idea and claim that anxiety is a necessity in learning to a limited extent.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

In the related body of literature, it can be said that researchers draw attention to the points stated below<sup>60-61-62-63-64-65-66-67-68-69-70</sup>.

- Brain needs sufficient nutrition, water and rest in order to realize the best learning.
- Feelings can weaken or strengthen learning.
- Learners should be active in the process.
- New learnings are built on previous learnings.
- Brain is composed of various structures and each brain is original in itself.
- Learning is a social activity and is a form of reaction that brain gives to the interaction with others.
- Stress diminishes the capacity of learning and even some types of high level stress can cause death of brain cells. Anxiety can dampen learning.
- Brain stores data in more than one place.
- Brain processes the gathered data beyond the awareness of learners.
- Reflection is an important part of learning and processing information.
- Brain has got two memory systems; short-term memory that stores unprocessed instant data and long term memory that processes data and stores for a later use when necessary.
- Brain can acquire information both through a holistic view and in a detailed manner.

### Brain Based Learning

*"Brain based learning is a new science that shapes learning process."*

Eric Jensen, 2000.

Today, researches carried out about brain can explain the basic structure and operation of brain as well as how it learns to a great extent. Many researches carried out about especially physiological aspect of learning explain how learning occurs, what kind of physiological and chemical changes in learning process, which dimensions of brain are effective in learning process to which extent, how brain should be supported in order to strengthen learning.

While brain based learning has come to the point of explaining learning depending on researches on brain, it is also an approach that is going on developing today in terms of educational programs, teaching environment, teaching time and evaluation<sup>71-72-72</sup>. Brain based learning can be defined as an approach that is built on the operation of human brain and that establishes a connection between learning and structure, functions and operations of brain. This approach emphasized the necessity of heading towards new models and methods considering people's preferences.

According to Caine and Caine (2002); brain based learning is an approach that is based on the structure and function of human brain. In this approach, key concept is to maintain learning opportunities that are consistent with brain's function as a result of its nature. Brain based learning comprises the idea that the principles of how brain operates should be accepted and teaching activities should be planned and organized depending on these principles in order to create meaningful learnings. Making sense in brain is much more important than receiving knowledge. Brain creates meanings in line with patterns, connections and feelings. According to brain based learning approach, learners not only see the connections about subjects on which they study but also create a meaningful learning by means of establishing connection between previous information and new information<sup>74</sup>.

According to Jensen (1998), brain based learning can be defined as a systematic of questioning that focuses on ways and methods about involving brain in learning process. Jensen also defines brain-based learning as an interdisciplinary answer given to the question of "How can brain learn best?"<sup>75</sup>

The basic foundation of brain based learning approach is the idea that brain is the basic organ in learning. In this aspect, factors that affect brain's operations in a positive way should be supported and strengthened while factors that affect brain in a negative way should be eliminated in order to create quality learnings. In this context, it is very important to know the structure and operation of brain.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

To sum up the information given until here; in brain based learning approach, learning is handled as a biochemical and electrochemical change. According to this approach, in learning process, intercellular connections (axon fibers) are built in brain cells (neurons). Each cell establishes new connections with other cells and thus realizes learning and other vital activities of life. Brain based learning focuses on how brain perceives, operates, interpretes, establishes connection, stores (such as establishing connection, coding, structuring matrixes) and remembers messages in learning process. According to brain based learning approach, learning not only occurs cognitively but also involves cognitive, sensual and kinetic whole. For example; a student who displays kinetic behaviours can operate his mind cognitively. From this point of view, it can be said that brain can carry out more than one tasks at the same time.

According to brain based learning approach, there are some factors that ensure learning to be meaningful and permanent. These factors are relaxed alertness, orchestrated immersion and active processing<sup>76</sup>:

*Relaxed alertness* emphasized that when a person is in an environment where he feels relaxed and calm, learning will be influenced by this environment positively. On the contrary; when brain perceives states of tiredness and threat, learning is suppressed. In this aspect, a safe environment should be ensured for people in order to realize high level and quality learnings. Sense of security that accepts risks at appropriate levels is a part of the state of being relaxed.

*Orchestrated immersion* expresses that learners focus on learning content to which they are exposed. When a certain level of integrity and inter correlativity is ensured, learners will use memory systems in order to explore content and reach learning goals.

*Active processing* emphasized that a learning brain is an active brain. Teachers should carry out an intentional and conscious study together with learners so that the information to be learnt will be integrated and internalized coherently in terms of meaningful and conceptual ways by the learner.

### Principles of Brain Based Learning

Researches on brain can have impact on many fields about learning. Some of them are developing educational programs, approaches of training teachers, teaching design, teaching strategies, and assessment applications<sup>77</sup>.

Caine and Caine (1998; 2000) state that some principles should be kept in mind in order to realize a brain based and effective learning, and to have qualified learners. These principles are stated below<sup>78-79</sup>:

*The brain is a parallel processor.* Human brain carries out many activities simultaneously. In other words, a number of operations (feeling, thinking, imagination, disposition, etc.) go on at the same time in human brain. Educational methods and techniques that will create learning synergy by means of having right and left hemispheres interact with each other should be involved in order to reach the goals set in the teaching process, and to enrich the learnings of students that have different cognitive structures and whose different parts of intelligence are powerful.

*Learning engages the entire physiology.* Brain is an organ that works according to its own principles of physiological operations, and that interacts and communicated with all the organs of the organism. Learning occurs in a natural way just like respiration. Today, fund of knowledge about the topic shows that learning can occur more easily through having brain influenced in a positive way. Eating habits of students, their level of stress and anxiety, manners of breathing healthily, whether their sitting manner is ergonomic or not and many other physiological states should be considered in teaching process. It should be kept in mind that learning occurs in proportion to the level of development of organism and so brain, and that there may be a lot of individual differences affecting learning, and learners should be compared in that way.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

*The search for meaning is innate.* Making sense of experiences and acting in line with this occurs naturally. While brain looks for and answers new stimuli through dendrites, it also registers these stimuli automatically on the other hand. Making sense is a process that is continuous, that cannot be stopped but that can be directed. The process of making sense is mostly intentional whereas it may also occur while asleep. For effective learnings, it is important for the brain to carry out easy and difficult tasks consecutively, to look for solutions for the problems that are new, unexplored or waiting for solution. For this purpose, activities that will encourage students to be curious and then to do research can be preferred in teaching process. Teaching contents should be attractive, meaningful and rich in terms of presenting alternatives.

*The search for meaning occurs through patterning.* Patterning means organizing and classifying information meaningfully. Brain is just like an artist or scholar who makes use of his intuition and creativity while patterning. While brain accepts information patterns that are meaningful for it, it denies the ones that are not meaningful. In this aspect, it is important to establish relations between pieces of information while ensuring information to be integrated. Patterning and making sense go on all throughout life. Activities such as problem solving and critical thinking that requires brain to operate actively are approaches that are influential in patterning meaningfully.

*Emotions are critical to patterning.* Emotions and cognition are inseparable structures. When emotions make it easier to store and remember information, they are very important for memory. Besides, many emotions cannot be revived or put out easily. Impact of an experience can come out much later than the event that causes this impact. From this point of view, it should be kept in mind that learning is influenced by the individual's emotions such as expectations, tendencies, prejudices, self-respect, etc. Emotions of learners should be considered important in constructing teaching process since emotional gains in a learning process have the capacity to have negative or positive impact on later learnings. Teaching process should be ensured to be supportive and in a way that learner will feel safe and need for respect is met.

*The brain processes wholes and parts simultaneously.* Although there are differences between right and left hemispheres in terms of their functions, there is certain integrity between two hemispheres. On the other hand, two hemispheres also have common tasks. While one hemisphere divides information into parts, the other integrates information and thus makes perception easier. While right hemisphere of the brain processes examples about the subject on which thinking is carried out, left hemisphere is responsible for processing much more general concepts and classes. Learning is an accumulative process. When parts and wholes are preferred over other in teaching process, it is possible to have difficulties in learning. While right hemisphere takes the whole picture, left hemisphere focuses on parts and details composing the whole.

*Learning involves both focused attention and peripheral perception.* While brain basically receives the information on which attention focuses on, it also receives information and signs apart from that one. Those sense organs receive things that are included within the area of perception and that we do not pay attention intentionally is a sign of the sensitiveness of brain's sensual mechanisms. Teaching environments should be organized so that learners can focus on learning context, and it should be kept in mind that physical conditions such as teaching materials, heat, light, noise, colour are also influential on learning directly and indirectly.

*Learning involves both conscious and unconscious processes.* Learning consists of conscious and unconscious processes. We learn much more than what we understand consciously. This situation is an indicator that unconscious process works continually. A number of stimuli received from around goes into brain and gets into interaction without the learner's awareness. Information arriving at the brain influences motivation and decisions. For example; if a student does not come across appropriate teacher's behaviours while learning Maths, he also learns to hate maths or teaching. It should be kept in mind that if verbal expressions are supported by body language such as gestures, mimes, eye contact, this will also influence learning indirectly and will be effective in keeping students' attention

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

alive and active. In teaching process, activities should be organized in a way that they increase learners' experiences and give opportunity to make sense of their experiences sufficiently. A teaching environment where teaching materials are meaningful and valuable for learners will ensure learners to be active in learning process.

*We have two types of memory.* These are spatial and mechanical learning systems. It is not necessary to review some behaviour we have acquired. Because we have got a natural spatial memory system that makes it possible to store experiences for a short time. This system, which works non-stop, has a quite comprehensive capacity. While mental processes develop in time, our memory system also develops. It is not necessary to do rehearsal in order to remember with whom we play game the day before. In mechanical learning systems series, the brain constructs skills and knowledge acquired in an isolated environment organized for a special purpose differently. This memory is a system constructed to store information. Rehearsal is insufficient in making sense and transferring learning into next ones. It is important in order to strengthen learning to retrieve knowledge in the memory through various activities, and to have knowledge be re-shaped in new situations.

*We understand and remember best when facts and skills are embedded in natural, spatial memory.* Experienced-based learnings are the best ways to use spatial memory. Activities that allow students to learn by doing and experiencing directly should be used in order to activate spatial memory. Activities that require multi-dimensional interaction and various emotions such as experiments, shows, trips, and metaphors should be used in order to turn students into active shapers of learning process.

*Learning is enhanced by challenge and inhibited by threat.* Brain's performance decreases in case of a fear or anxiety. On the contrary, will of learning increases to a high level when the brain is forced appropriately (motivated to make an effort). The basic reason of the decrease in the performance is the sense of desperateness. In this case, perceptual area narrows down, flexibility decreases, and automatically, primitive and routine behaviours come out. Hippocampus, which is a part of limbic system, is the most sensitive part of the brain to stress. Some channels that go into some parts of the brain work less than expected capacity because of excessive sensitiveness of hippocampus in case of fear. Situations such as fear, anxiety, and stress prevent interaction at the expected level between brain parts. When the feelings of fear, anxiety, and stress are intense, hippocampus, which works just like a hard disk tend to cooperate with other parts of the brain less frequently, and thus, the quality of learning is influenced badly by this situation. A teaching environment, which encourages learners, which provides positive inspirations and instructions, is very important in learning to occur.

*Each brain is unique.* Although all people have the same system in terms of being an organism that is a species, individual differences cannot be denied. Moreover, learnings possessed by individuals also change the structure of the brain; therefore, the more learning there is, the more specific the individual will be. It will influence the quality of learning process positively to have a learning process that attracts attention of each of the learner, that addresses different parts of intelligence, especially the fields at which they are good, that includes visual, audio, tactile, emotional alternatives. Teaching activities should be valuable, meaningful, executable, and finishable for students. Thus, each learner can construct his/her own learning process, can enrich his/her learnings and thus have the opportunity to increase his/her fund of knowledge.

### **Process of Brain Based Teaching-Learning**

*Brain is affected by all the states in the environment, so factors that can affect students' positively/negatively should be watched carefully in teaching environments. Positive factors should be strengthened while negative ones should be eliminated.*

Eric Jensen, 2008.

Some of the basic features of brain based learning are that it does not ignore other theories that explain learning, it allows students and teachers to make a choice about the process in teaching environments, it supports contingent thinking, it has a holistic system approach<sup>80</sup>. Among traditional teaching strategies, brain based learning also comes to the forefront because it gives importance to

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

qualities of student, it emphasized rich learning environments lacking anxiety, it supports and strengthens inner motivation, it diversifies teaching according to age and level, it prescribes that all sub-systems of an individual work together<sup>81</sup>.

Brain based learning approach sets forth brain compliant learning environments. Brain compliant environments consider individual differences in teaching activities from this point of view that each student has a unique brain. The main idea of brain based learning approach related to teaching process is that the basic organ in realizing learning is brain, learning occurs in the brain, and so it is necessary to strengthen factors that contribute in a positive way to the learning of brain and to eliminate and minimize the factors that have negative effect.

According to Caine and Caine (1998 and 2002), it is necessary to know positive and negative factors in order to strengthen the positive ones and eliminate negative ones. The basic principles that are thought to influence the operation of the brain are stated below<sup>82-83</sup>:

- The organic / chemical structure of the brain
- Emotions
- Music
- Sleep
- Physical vitality
- Exercise
- Nutrition
- Genetic factors
- Lifestyle
- Stress / anxiety
- Motivation
- Social / physical / educational environment
- Health

Some other factors on which brain based learning approach puts emphasis for the sake of increasing the quality of teaching process include memory, capacity of intelligence, parts of intelligence, attention, reward, punishment as well as teaching strategies and assessment activities that will be used considering the individual differences of the learners.

*Memory:* Memory, which plays an important role in teaching and learning process, determines what we will learn from our experiences. Brain based learning prescribes that memory should be used actively in learning process. Human eye catches images just like a camera, but we send the ones that attract our attention to the brain as data. In other words, we choose and see what we wish to. In this process, our attention is influenced by our emotions. Teachers should foresee which type of memory needs being used in which teaching activity<sup>84</sup>. There are five different types of memory according to the quality of what they do. *Semantic memory* processes rules, principles, concepts; *episodic memory* records about past times and places. *Procedural memory* processes what is done and when it is done; *automatic memory* processes mathematical operations, responses, sudden answers; *emotional memory* processes interests, feelings, phenomena such as good and bad, success and failure<sup>85-86</sup>.

*Stress, fear and anxiety:* Brain based learning claims that all the systems possessed by an individual work together about learning. The impact of brain on learning process depends on the extent to which brain is influenced by environmental and biological conditions. Memory and remembering, music, stress, anxiety, feelings, mental patterns, ideas, learning experiences, nutrition, etc. are included in the factors that affect brain. Stress, fear and anxiety are very influential on brain's learning. In case of fear and anxiety, behaviour is controlled by limbic system and r-complex down to the neuro-context and the individual displays primitive behaviours. It is necessary to have a low level of anxiety in order for the learning to be realized. Responses given by sympathetic and parasympathetic nerve systems in case of relaxation and resting changes when the organism has stress. Stress has negative effect on the operations of the organism; brain is influenced by the operations of the organism and thus affects learning<sup>87</sup>.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

*Attention:* Another factor that is influential in brain's learning is attention. Brain should be used as actively as possible in order to enhance attention and awareness. It is necessary to inform the students about the subject and goals before starting the learning activities and they should be given enough time to get ready. Students should be ensured to be responsible for their own learnings and they should be provided with the opportunity to determine their strengths and weaknesses. A positive emotional environment should be organized in class and at school; necessary arrangements in line with students' preferences and students should be encouraged to have a change. Cooperation should be supported and students should be given the opportunity to improve themselves in order to set standards related to themselves and their goals and to spend their free time well. Precautions against risks should be taken, students should be directed to alternative activities, different activities should be organized such as educational trips, visual projects, independent game time<sup>88-89</sup>.

*Rewards and punishment:* It is important to use rewards and punishment carefully in teaching process. Punishment should not be used as much as possible, or it should be in a way that is not the same as the known ones and that will not cause an emotional depression. On the other hand, rewards should be given in line with certain educational goals and included in various activities<sup>90</sup>.

Studies carried out by Jensen (1998) show that rewards that are given directly decrease the inner motivation, diminishes the will and value of learning, gives wrong messages and directs students towards a game of adventure lacking a winner. Instead of this, it is necessary to increase the feedback given to students in teaching environment, to provide students with the opportunity to make satisfying explorations, to support students to use the right to prefer and control related to their own studies and thus to encourage them to reach innovations in this way<sup>91</sup>.

*Educational programs:* Brain compliant learning requires brain compliant educational programs and brain compliant teaching activities. Brain compliant programs provide students with the opportunity to know and improve them. The basic features of brain compliant educational programs are stated below<sup>92</sup> (Jensen, 1998):

- It includes plans and lessons that are open for improvement and flexible.
- It includes general and specific cultural elements in the lesson.
- It supports the use of interdisciplinary materials.
- The relation between teacher and student is at a high level.
- It considers gender differences important.
- It prescribes social and emotional literacy.
- It provides the opportunity to improve the skills of learning how to learn.
- It includes daily physical activities.
- It includes metacognitive strategies.

Brain based learning prescribes that teaching programs should be developed considering the individual needs of learners. It is important to arrange multiple learning activities possessing visual, audio, kinetic and emotional dimensions so that individual and group learning is maintained in order to ensure students to participate in learning experiences actively. From this point of view, we can say that while arranging brain based teaching environments, multiple intelligence theory which claims that each individual has different learning qualities and each tends to learn through different ways and at different speeds, which offers teaching activities that will facilitate learners' learnings, ensure students to know themselves and gain self-confidence and develop high level thinking skills should be made use of.

While designing teaching process, the question that should be kept in mind should be "How can my students learn best?" rather than "How can I teach best?" Activities that can provide contentful, multi-dimensional and emotional experiences should be used for students possessing different learning styles in order to help students to be able to create meaningful learnings, strengthen their scientific understanding, store data in their memories effectively and retrieve them when necessary<sup>93-94</sup>.

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Teaching activities follow a line of process. It is a well-known fact that activities used in teaching process are carried out through programs that have a certain framework. Because of this reason, although students have the capacity to achieve much more, they cannot succeed due to the limited content included in programs. From this basic point of view, brain based learning claims the idea that processes that affect brain and individual differences should be kept in mind while setting educational goals and arranging learning environments. It is possible through arranging learning environments in a brain compliant manner for the human brain to realize learning efforts effectively and productively. Learning can be improved by means of arranging environments having stimuli that support brain and the quality of learning, and eliminating factors that affect brain in a negative way. Some of the activities and behaviours that can be suggested for teaching environments are stated below<sup>95</sup>:

- An atmosphere that gives courage and confidence should be arranged.
- Students should not be expected to meet high standards.
- Brain compliant assessment techniques should be used.
- Individual differences should be considered.
- Students should be provided with the opportunity to specialize in different subject areas.
- Group activities and cooperation should be supported.

Researches carried out about the operations of the brain show that human brain has a huge capacity to learn, however, most of the learning activities in the brain are realized unconsciously. Brain carries out a number of operations without the individual's awareness, but the limited capacity of focusing attention prevents us to be aware of all these going on<sup>96-97</sup>.

Jensen (2004) states that a teaching program that will be developed in line with brain based learning theory should have some qualities such as social fluency, individual development, scientific research, information literacy, and artistic expression. The key concepts related to the given qualities are stated below<sup>98</sup>:

- *Social fluency*; emotional intelligence, appreciating differences, language skills, spiritual identity, suitable family manners, team works and conflict resolution.
- *Individual development*; stress management, physical relaxation, cognitive awareness and reflection, sense and goal of understanding, nutrition, habits of health and eating, heading towards the goal and success, skills of learning how to learn, personal and moral responsibility.
- *Scientific research*; environmental studies, future and global studies, studies on maths, physics, biology and chemistry.
- *Information literacy*; skills of reading and writing, searching and looking for, cognitive processing, skills of speaking and presenting, skills of technology.
- *Artistic expression*; music, story writing, dance, theatre, sports, hobbies and arts, design, visuality.

*Teaching strategies*: Brain based learning prescribes the use of various strategic alternatives as much as possible in teaching process. Some of the teaching strategies that can be used in teaching process are stated below<sup>99-100</sup>:

- Defining differences and similarities
- Note taking and summarizing
- Reinforcing individual and group works, ensuring awareness
- Homeworks and applications
- Cooperative learning
- Making premises and testing
- Asking question and high-level organizing
- Active learning

Various strategies are made use of in brain based teaching process. Each strategy is used to ensure the brain to work and learn effectively. For example, some of the teaching strategies that can be used by the teachers in question-answer activities in teaching process are<sup>101</sup>: *Time of waiting*: after teacher asks students a question, students are given a time to wait for about 3-5 seconds and then students

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

are expected to give their responses and answers. This activity aims at developing behaviours of remembering in a short time. After the first responses coming from the students, a second short time is given to them to reflect their ideas. Students' answers are not met with a reaction or response, students think over their own answers. In this way, the brain is expected to carry out some operations such as searching, establishing relations and organizing. *Time of reflective pause*: a time of pause is given for about 3-5 seconds after the question asked by the student before, during or after comment. Then, students are given time to transfer their ideas to each other. Activity goes on until students reach a big piece of information. Activity goes on for more 1 or 2 minutes in order to give students time to set their ideas more clearly, to do an overall thinking from the beginning to the end, to re-arrange their questions. Reflection is a behaviour through which long term memory is fed. *Time of work waiting*: It is an activity that is carried out by individuals or groups quietly and quickly for about 30 seconds to 2 minutes. Learners interact with each other by means of asking questions to each other. They carry out discussions and definitions related to information, skills and concepts. Partners in each group ask questions to each other and answer the questions, and thus they go on carrying out the activity in this way.

*Assessment*: In an environment where brain based learning theory is used, assessment is accepted to be a study of identifying states. In a process of brain based assessment, assessment techniques that are often used include performance tasks, portfolio, conference, report cards, memory tests, multiple-choice tests, true-false tests, fill in the blank, observation, interview, books designed by students, drawings, projects, products, presentations, creative drama, mind maps<sup>102</sup>.

### Brain Based Learning and Principles of Effective Implementation

It will be very useful to arrange brain compliant classes, make use of mental models and brain compliant strategies, use brain compliant assessment processes and turn the school into a learning community in order to use the brain effectively and productively in teaching process. For this purpose; it is necessary to prepare brain compliant teaching programs by means of considering environmental factors that affect brain.

Suggestions made by Pridge (2002) as well as Politano and Paquin (2000) provide teachers with important clues about constructing brain based teaching process. According to Pridge (2002); while strengthening brain based teaching activities and increasing the quality of teaching process, it is important to carry out the activities stated below in order to prepare learners for learning, arrange learning environments, maintaining attention, storing and retrieving information<sup>103</sup>:

#### *Preparing students for activities and learning*

- Giving information to students about how their brains work
- Setting the goals of learning together with students
- Teaching students the right styles of sleeping
- Telling students the impact of nutrition on behaviours and success
- Raising students' awareness of the impact of water on their organisms, especially their brains
- Ensuring students to be aware of their learning preferences

#### *Arranging learning environment*

- Establishing a positive learning atmosphere
- Using music in activities
- Using positive visual reminders
- Creating an interactive learning environment

#### *Increasing and keeping student's attention*

- Establishing a connection between emotional reminders and learning
- Allowing the behaviour of laughing in learning process
- Allowing students' mobility in activities
- Avoiding factors that can create internal and external anxiety

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

### *Increasing memory and remembering*

- Emphasizing the importance of emotions on learning
- Establishing a learning dilemma sensitive to learning
- Considering students' individual differences about learning
- Including creative repetitions
- Remembering the most important first and last phenomena about the topic
- Using specific remembering techniques

Politano and Paquin (2000) offers some examples that can be classified under the headings such as individuality, assessment, emotions, meaning, multiple ways, unity of body and brain, memory, nutrition, cycle and rhythm, overcoming fears in order to enhance the quality of brain based learning applications in teaching process and the effects of these applications. Some of the examples about the given areas are stated below<sup>104</sup>: *individuality* means providing learners with alternatives, providing the opportunity to establish a connection between preliminary information and new learnings, knowing the learning styles, feelings and strengths of learners. *Assessment* means ensuring students to give feedback at right time and to give feedback to each other, providing learners with the opportunity to reflect them, helping students to turn their mistakes into learning opportunities. *Emotions* mean encouraging learners to express their feelings, accepting games and fun as a part of learning, using positive expressions towards learners. *Meaning* is about using holistic learning, knowing individual appropriateness and emotional content, providing students with sufficient time to study, providing student with enough time to reflect what they have learnt and to transfer what they have learnt into their own developmental processes. *Multiple ways* includes implementations aiming at considering multiple intelligence, producing ways of multiple teaching designs, providing opportunities for various presentations, enriching teaching environment with visual and audio materials. *Unity of body and brain* is about ensuring effective learning and organizing activities such as trips, games, shows through which students will have the opportunity to move enough. *Memory* is composed of implementations about using organizational promoters (information, concept and mind maps) and providing students with rich learning experiences through using environment as much as possible. *Nutrition* includes informing students about nutrition and helping them to choose useful food, and having water and sugar, which are the basic needs of brain in the learning environment. *Cycle and rhythm* means arranging activities through which student will de-energize, knowing and managing students' excitements, ritual, leading the proper use of innovations. *Coping with fears* includes activities aiming at managing stress, motivating learners by means of creating a democratic atmosphere in learning environment and strengthening learners' inner motivations.

### REFERENCES

1. Erişti, B. (2011). Beyin temelli öğrenme ve yapılandırıcılık. Eğitim psikolojisi (Ed: G. Can). Eskişehir: Anadolu Üniversitesi Açıköğretim Fakültesi Publication.
2. Şimşek, A. (2009). Öğretim tasarımı. Ankara: Nobel.
3. Ormrod, J.E. (1990). Human learning. Columbus: Merrill Publishing Company.
4. Senemoğlu, N. (2010). Gelişim, öğrenme ve öğretim: kuramdan uygulamaya. (16. Basım). Ankara: Pegem Akademi.
5. Lambert, L. (1995). The constructivist leader. Columbia: Teachers College Press, ColumbiaUniversity.
6. Kafai, Y. and Resnick, M. (1996). Constructionism in practice: Designing, thinking, and learning in a digital world. New Jersey: Lawrence Erlbaum Associates, Inc.
7. Eggen, P. and Kauchak, D. (1999). Educational psychology. New Jersey: Prentice - Hall.
8. Deryakulu, D. (2000). Yapıcı öğrenme. Sınıfta demokrasi. (Ed: A. Şimşek) içinde (53-77). Ankara: Eğitim-Sen.
9. Jensen, E. (2000). Brain-based learning: A reality check. Educational Leadership, 57 (7), 76-80.254 Öğrenme ve Öğretme
10. Jensen, E. (2000). Mentioned Source
11. D'Arcangelo, M. (1998). The brains behind the brain. Educational Leadership, 56 (3), 20-

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

- 25.
12. Brandt, R.S. (1999). Educators need to know about the human brain. *Phi Delta Kappan*, 81, 235-238.
13. Bloom, F.E. and Lazerson, A. (1988). *Brain, mind and behavior* (2nd Edition). NY: WH Freeman and Company.
14. Van de Graaff , K.M. (1998). *Human anatomy*. (5th Edition). Boston: McGraw-Hill.
15. Politano, C.P. and Paquin, J. (2000). *Brain-based learning with class*. Canada: Penguins Publishers.
16. Brandt, R.S. (1999). Mentioned Source
17. Van de Graaff , K.M. (1998). Mentioned Source
18. Jensen, E. (2000). Mentioned Source
19. Politano, C.P. and Paquin, J. (2000). Mentioned Source
20. Bruer, J.T. (1998). Brain science, brain fiction. *Educational Leadership*, 56 (3), 14-18.
21. Bruer, J.T. (1999). Neural connections: Some you use, some you lose. *Phi Delta Kappan*, 81, 264-277.
22. Sprenger, M. (2002). *Learning and memory: Th e brain in action*. Alexandria, VA: ASCD.
23. Jensen, E. (2000). Mentioned Source
24. Diamond, M. and Hopson, J. (1999). *Magis trees of the mind: How to nurture your child's intelligence, creativity and healthy emotions from birth through adolescence*. New York: PenguinPutnam, Inc.
25. Perry, B. (2000). How the brain learns best. *Instructor*, 110 (4), 34-35.
26. Sprenger, M. (2002). Mentioned Source
27. Jensen, E. (2000). Mentioned Source
28. Greenleaf, R. K. (2003). Motion and emotion. *Principal Leadership*. 3 (9), 14-19.
29. Perry, B. (2000). Mentioned Source
30. Sprenger, M. (2002). Mentioned Source
31. Denton, M. (1986). *Evolution: A theory in crisis*. Adler & Adler.
32. D'Arcangelo, M. (1998). Mentioned Source
33. Hebb, D.O. (1980). *Essay on mind*. New Jersey: Lawrance Erlbaum Associates, Inc.
34. Hebb, D.O. (1980). Mentioned Source Beyin Temelli Öğrenme 255
35. Churchland, P.S. and Farber, I.B. (1995). Consciousness and the neurosciences: Philiosophicaland theoretical issues. In M.S. Gazzaniga (Ed.). *Th e Cognitive Neurosciences*, (pp.1295–1306). Cambridge MA: MIT Press.
36. Gazzaniga, M. S. (1995). Consciousness and the cerebral hemispheres. In M.S. Gazzaniga (Ed.). *Th e cognitive neurosciences*. (pp. 1391–1400). Cambridge MA: MIT Press.
37. Hirst, W. (1995). Cognitive aspects of consciousness. In M.S. Gazzaniga (Ed.). *Th e cognitiveneurosciences* (pp. 1307-1319). Cambridge MA: MIT Press.
38. Churchland, P.S. and Farber, I.B. (1995). Mentioned Source
39. Restak, R. (2000). *Mysteries of the mind*. Washington: National Geographic Society.
40. Hirst, W. (1995). Mentioned Source
41. Jensen, E. (1998). *Teaching with the brain in mind*. Alexandria, VA: Association for Supervisionand Curriculum Development.
42. Jensen, E. (2004). *Teaching with the brain in mind*. (2nd Edition). Alexandria, VA: ASCD.
43. Greenleaf, R.K. (2000). *Brain based learning: Building excitement for learning*. 12.11.2012tarihinde [www.greenleaflearning.com] adresinden alınmıştır.
44. Greenleaf, R. K. (2003). Mentioned Source
45. Bruer, J.T. (1998). Mentioned Source
46. Bruer, J.T. (1999). Mentioned Source
47. Caine, G. and Caine, R.N. (1998). Building the bridge between the neurosciences and education:Cautions and possibilities. *NASSP Bulletin*, 82 (598), 1-8.
48. Caine, R.N. and Caine, G. (2002). *Beyin temelli öğrenme* (Çeviren: G. Ülgen). Ankara: Nobel.
49. Jensen, E. (1995). *Th e learning brain*. Del Mar, CA: Turning Point Publishing.
50. Van de Graaff , K.M. (1998).
51. Jensen, E. (2000). Mentioned Source
52. Jensen, E. (1998). Mentioned Source
53. Jensen, E. (1998). Mentioned Source

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

54. Given, B. (2002). Teaching to the brain's natural learning system. Alexandria, VA: ASCD.
55. Wolfe, P. (2001). Brain matters: Translating research into classroom practice. Alexandria, VA: ASCD.
56. Hardiman, M. (2003). Connecting Brain Research with Effective Teaching: The Brain Targeted Teaching Model. Lanham, MD: Rowman & Littlefield.
57. King, J. M. (1997). Brain-function research: Guideposts for brain-compatible teaching and learning. The Journal of General Education, 46 (4), 276-289. 256 Öğrenme ve Öğretme
58. Hart, L.A. (1992). Human brain, human learning. Kent, WA: Book for Educators.
59. MacLean, P.D. (1978). A Mind of Three Minds: Educating the Triune Brain. In 77th Yearbook of the National Society for the Study of Education, Chicago: University of Chicago Press.
60. Hart, L.A. (1992). Mentioned Source
61. Sylwester, R. (1995). A celebration of neurons. Alexandria, VA: Association for Supervision and Curriculum Development.
62. Sylwester, R. (2000). A biological brain in a cultural classroom: Applying biological research to classroom management. Thousand Oaks, CA: Corwin Press, Inc.
63. Sapolsky, R.M. (1996). Why stress is bad for your brain. Science, 273, 749-750.
64. Kotulak, R. (1996). Inside the brain. Kansas City: Andrews & McMeel.
65. Caine, G. and Caine, R.N. (1997). Education on the edge of possibility. Alexandria, VA: Association for Supervision and Curriculum Development.
66. Davis, J. (1997). Mapping the mind: The secrets of the human brain and how it works. Secaucus, NJ: Carol Publishing Group.
67. King, J. M. (1997). Mentioned Source
68. Cardellichio, T. and Field, W. (1997). Seven strategies that encourage neural branching. Educational Leadership, 54, 33-38.
69. Smilkstein, R.P. (1998). Tools for writing: Using the natural human learning process. Fort Worth: Harcourt Brace College Publishers.
70. Diamond, M. and Hopson, J. (1999). Mentioned Source
71. Sousa, A.D. (2000). How the brain learns. (2nd Edition). Thousand Oaks, California: Corwin Press, Inc.
72. Caine, G. and Caine, R.N. (2000). Building the bridge from research to classroom. Educational Leadership, 58 (3), 59 – 61.
73. Dwyer, M.B. (2002). Training strategies for the twenty first century: Using recent research on learning to enhance training. [<http://www.tandf.co.uk/journals>]
74. Caine, R.N. and Caine, G. (2002). Mentioned Source
75. Jensen, E. (1998). Mentioned Source
76. Caine, G. and Caine, R.N. (1998). Mentioned Source
77. Jensen, E. (1998). Mentioned Source
78. Caine, G. and Caine, R.N. (1998). Mentioned Source
79. Caine, G. and Caine, R.N. (2000). Mentioned Source
80. Jensen, E. (1998). Mentioned Source
81. Jensen, E. (2004). Mentioned Source
82. Caine, G. and Caine, R.N. (1998). Mentioned Source
83. Caine, R.N. and Caine, G. (2002). Mentioned Source
84. Sprenger, M. (2002). Mentioned Source
85. Jensen, E. (2004). Mentioned Source
86. Caine, R.N. and Caine, G. (2002). Mentioned Source
87. Jensen, E. (2004). Mentioned Source
88. Jensen, E. (2004). Mentioned Source
89. Caine, R.N. and Caine, G. (2002). Mentioned Source
90. Caine, R.N. and Caine, G. (2002). Mentioned Source
91. Jensen, E. (1998). Mentioned Source
92. Jensen, E. (1998). Mentioned Source
93. Politano, C.P. and Paquin, J. (2000). Mentioned Source
94. Caine, R.N. and Caine, G. (2002). Mentioned Source
95. Caine, R.N. and Caine, G. (2002). Mentioned Source

## LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

96. Jensen, E. (1998). Mentioned Source
97. Caine, R.N. and Caine, G. (2002). Mentioned Source
98. Jensen, E. (2004). Mentioned Source
99. Marzano, R.J., Pickering D.J. and Pollock J.E. (2001). Classroom instruction that works. Alexandria, VA: ASCD.
100. Jensen, E. (2004). Mentioned Source
101. Jensen, E. (2004). Mentioned Source
102. Caine, R.N. and Caine, G. (2002). Mentioned Source
103. Pridge, D.J. (2002). Promote brain based learning and teaching. *Intervention in School and Clinic*, 37 (4), 221-237.
104. Politano, C.P. and Paquin, J. (2000). Mentioned Source