Preferment in Neurosciences Leading To Brain-Based Learning: An Emerging Technology of Learning

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***Abstract*— Advancement in Neurosciences has led to the development of Brain-Based Learning, which can be referred as the emerging Technology of Learning regarding Brain as the biggest processor, which can be processed for whole life for the improvement in level of learning. This paper provides an overview of the anatomy, brain chemistry, neuronal connections, and current neuroscience research that are important in understanding how learning occurs Effectiveness of Brain-Targeted Teaching Units, developed on the various aspects of Brain-based Learning and Neurological researches has been checked out by an experimental try out on 8th Class students of CBSE Board.**

***Index Terms*— Brain-Based Learning, Neuroscience, Brain Targeted Teaching Units**

I. Introduction

With the advancement in Science and Technology, the discipline of Neuroscience is also reaching to the zenith, moving beyond all the leaps and bounds. Study of the Brain also comes in the field of Neurosciences as it deals with the neural networks and connections that lead to Brain functioning. Researchers have explored many different aspects of the brain, including anatomy, circulation, electrical activity, glucose metabolism, and neuronal growth. In-spite of the growth of scientific information, the human brain is, for the most part, still unknown, due to its complexity. Brain is, just similar to a computer's CPU (central processing unit). It is the information processor of the human body. The brain is capable of multitasking, and it "assembles, patterns, composes meaning, and sorts daily life experiences from an extraordinary number of clues" (Jensen, 2000, p. 12). Due to large number of neurons and interneurons working together, enormous neural nets are formed inside brain, from which our daily experience is created

Genetics, development, experience, culture, environment, and emotions, are all the controller of the Brain's activity and it is constantly under stimulation to change (Gardner, 1999). Since the 1980s, significant scientific findings have emerged about how learning occurs. By the 1990s, with the advancement in research and technology have allowed researchers to see inside the brain, and make them able to visualize how the structures in the brain communicate amongst themselves. Common imaging techniques used by researchers include computerized axial tomography, functional magnetic resonance imaging (fMRI), and positron emission tomography (PET). With the advancement in these tools and technology have allowed scientists to learn more about the brain, and findings arising through them have the implications for the world of education, science, and medicine.

With advances in technology and knowledge about the brain, there has been the development of Brain-based learning. Brain-based learning is a new paradigm that has tremendous implications for educators and students. This advancement in Neuroscience researches needs to be translated into brain-based learning strategies that can be used by educators. These Neuroscientific researches provide methods that help educators to develop instructional strategies

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II. The Biology of Learning: Reflecting Brain Anatomy, Chemistry, Structure and Body Connections

According to Jensen (2000), brain-based learning is "learning in accordance with the way the brain is naturally designed to learn". Research about how the brain learns is being conducted across several disciplines, including psychology, neuro-anatomy, genetics, biology, chemistry, sociology, and neurobiology (Jensen, 2000).

In order to understand how the brain learns, it is very much necessary to have a basic understanding of the anatomy and physiology of the brain. Focusing on the anatomical structure of the brain, the largest portion of the brain is called the cerebrum, which is the most highly evolved part of the brain, and is sometimes called the neocortex. Higher order thinking and decision making occurs here. The cerebrum is composed of two hemispheres that are connected by the corpus callosum, which is nothing, but just a neural highway. Information travels along the corpus callosum to each hemisphere so that the whole brain is involved in most activities. Each cerebrum is composed of four lobes: frontal, parietal, temporal, and occipital. Each lobe is responsible for specific activities, and each lobe are interdependent on each other as they keep on communicating from the other lobes, as well as from the lower centers of the brain. Axons, which are the extension of neurons, modify and grow in response to any brain activity, such as learning. Learning puts demands on the brain, and the brain responds by developing new circuits to connect new information to current or past knowledge. According to Fishback (1999), "the creation of neural networks and synapses are what constitutes learning". Human Brain actually maintains an amazing plasticity as the

brain is dynamic and flexible for the whole life. Brain keeps on shaping itself by more and more experiences which results in changing, modification and redeveloping axonal circuit. This fact means nearly any learner can increase their intelligence, without limits, using proper enrichment" (Jensen, 2000). The brain modifies its structure based on incoming information. "The brain changes physiologically as a result of experience and it happen much quicker than originally thought. The environment in which the brain operates determines to a large degree the functional ability of the brain" (Roberts, 2002). Learning is also due to input to the brain, more it receives, more it absorbs, but what matters is the environment in which the brain is receiving any information. For learning to be more effective, it is necessary to make the brain to not only focus on rote memorization, rather receiving sensory information (e.g., aural, visual, and tactile information) which enters the brain along multiple nerve receptors. Sensory input causes axons to react by budding, branching, and reaching out to other neurons, thus, leading to the development of new connections in the brain. These new connections only enhance the level of learning. If the information is novel, the brain needs to develop these budding new pathways. It is when an axon grows and meets up with another neuron than learning occurs. The most important aspect is that these neural circuits continue to grow, even with age.

With the neurological researches, it become evident that learning is defined as changing the structure of the brain. An individual's neural wiring changes, while learning any activity. If an activity is new, the brain will respond slowly and start to develop new connections. As the activity is practiced, the pathways get more efficient, and transmission speed increases. The pathways may become permanent as the skill becomes integral to the brain, and is held in long-term memory. Neuroscience research confirms that practice improves performance. Fishback (1999) reported that all new information is incorporated into existing neural networks. The human brain is always looking to make associations between incoming information and experience. With the emergence of science and technology resulting in various Brain imaging techniques has revealed that the longer certain areas of the brain are stimulated, the better information is remembered. In addition, personal experience intensifies, focus, and concentration. The more elaborate a memory is, the easier it is to access. Repetition is also important, as it causes neural connections to reactivate and increases the chance of retaining the memory (Fishback, 1999).

III. BRAIN BASED LEARNING: MEMORY, UNDERSTANDING, THINKING AND METACOGNITION

Memory is due to complex, multipath neuronal growth. The brain is a multimodal processor that assembles patterns, makes meaning, gone through various daily life and experiences, and then processes these Information. In order for information to get to the hippocampus of the midbrain, which is where long-term memory is believed to be stored, the learner needs to use the information actively to strengthen the new neural circuit. There are two different types of memory: explicit memory and implicit memory. These are further broken down into categories which are semantic and epesodic memory. Semantic and episodic memories are considered explicit memory, or memory that was learned by effort. Implicit memory is memory that is automatically learned. It deals with nonconscious cognitive processing of experiences. Many of the insights and patterns that we grasp are the result of on-going nonconscious processing. According to Jenkins (2000), thinking occurs when the brain accesses "prior representations for understanding", or when the brain tries to create a new model if one does not exist. Thinking occurs when the mind, body, and feelings are all involved. Adult students should be encouraged to use their metacognitive skills to facilitate learning (Hill, 2001). To promote higher-level learning, metacognitive skills, or critical thinking, it is important to create challenging activities that foster students' metacognitive abilities, and help them acquire meaningful knowledge. Students need the time to collaborate, interact, and reflect during the learning process (Ally, 2004).

There are several aspects, which act as the key pointers in the Brain-based Learning, these are as follows:

a) *Making Meaning or Meaningful content*
b) *Pre-exposure and Pattern Making*
c) *Survival Mode*
d) *Emotions*

Detailed descriptions of the following aspects have been given as follows;

1. **Making Meaning or Meaningful Content**-Caine and Caine (1994) asserted that the search for meaning is innate. It cannot be stopped; however, one can channel or focus it (Deveci, 2004). According to Jensen (2000), three factors generate meaning: (a) relevance or connection with existing neural sites, (b) emotions that trigger the brain's chemistry, and (c) the context that triggers pattern making. If information is personal, emotional, and makes sense, it is meaningful. The search for meaning is "survival oriented and basic to the human brain/mind. According to Deveci (2004), learning is more profound, when the learners get to know, what he is learning and why he is learning. Learning should be made meaningful for students (Hill, 2001) so that they can apply and personalize new information. Instructors should design activities for students that are interactive. The new information will assist the student in constructing new knowledge. Having students draw on their previous knowledge, with the instructor acting as a facilitator in a contextual learning setting, allows the student to connect content with context, thus bringing meaning to the learning process.

2. **Pre-exposure and Pattern Making** –Pre-exposure or priming has been shown to be important for learning. The greater the amount of a priming stimulus, the more the brain extracts and "compartmentalizes the information" (Jensen, 2000). This Pre-exposure to new information is the only thing which allows the brain to detect and create patterns of meaning and this brain's capacity to elicit patterns of meaning is one of the key principles of brain-based learning"

(Jensen, 2000). Pattern making depends on the past information or experiences. Jensen (2000) recommended the use of mind-maps, graphic organizers, advance organizers, models, or paintings of course material. The key is to get the learner to relate the information to his or her personal life. It had been researched that until and unless connections are made to students' prior learning, comprehension and meaning may not be to that extent. For any teacher, it is become important for the teacher that before starting a new topic, it is necessary for them to ask students to discuss what they already know about the subject; do role plays or skits; make mind-maps; and brainstorm its potential value.

3. **Survival Mode-** The brain is primarily concerned with survival, not instruction. "The brain will concentrate on instruction that is only perceived as meaningful and only if the brain's primary survival needs have been satisfied" (Jensen, 2000). A strong emotion, such as fear, will initiate the fight-or-flight physiological and mental response, which shuts down the higher centres of the brain. Teachers or Instructors need to ensure that they do not invoke the lower centres, which are involved in the protection from any injury, and therefore learning will not occur. Stimulation is necessary for learning, but too much information can lead to overload. If a stimulus is too strong, the brain will shut down and go into survival mode. And because of this reason only testing and examination can cause some students to go into "survival mode." In this situation, students will not be able to succeed, even if they have learned the material covered in the test. Thus multiple method of assessment can be used by the instructor, which may include presentations, e-portfolios, case studies, and problem-based learning tool.

4. **Emotions** -According to Jensen (2000), emotions are drivers for learning. "All learning involves our body, emotions, attitudes, and physical well being. Brain-based learning advocates that it address these multiple variables more often and more comprehensively". Emotion also has a strong influence on learning, and instructors should incorporate emotion into learning to make it more memorable. The amygdala is responsible for our emotions, and is concerned with survival and emotional interpretation of situations. It is responsible for bringing emotional content into memory, and plays a major role in learning. Using Brain-based technique by the instructors reflects the importance of integrating emotions with learning. It is important to recognize and acknowledge the feelings and emotions that students may have. It is required by the instructor to eliminate stress threats and deadlines and provide personal, meaningful projects and greater individual choices.

IV. EFFECTIVENSS OF BRAIN-TARGETED TEACHING UNITS: AN EMPIRICAL EVIDENCE OF IMPROVED LEARNING

On the basis of all the above literature and Neuro-scientific researches done by various scientist, a model has been developed in the form of Brain-Targeted Teaching Units (Hardimann, 2000), which comprised of all the aspects of Brain-based Learning. There are six basic steps which are involved in the Brain-Targeted Teaching Units, which are as follows;

a) Emotional Environment
b) Physical Environment
c) Learning Design
d) Teaching for Mastery
e) Teaching for Application
f) Evaluation

To check the Effectiveness of the Brain-Targeted Teaching Units, a study was carried out by the authors under following heads;

A. OBJECTIVES OF THE STUDY

The objectives of the present study are laid down as follows;

1. To develop the Brain targeted Teaching Units in Biology for the 8th standard students.

2. To Test the effectiveness of the Brain-targeted teaching Units in Biology for the 8th standard students.

B. HYPOTHESES OF THE STUDY

In order to test the aforesaid objectives of the study the following null hypotheses have been formulated:

1. There will be no significant effect of the Brain targeted teaching Units on the academic achievement of the 8th standard students.

C. DESIGN OF THE STUDY

The researcher has adopted Quasi Experimental design with comparable matched groups categorized as Pre and Post groups for testing the efficacy of the Brain targeted teaching Modules.

D. SAMPLE OF THE STUDY

The Sample selection in the present study has been done in two distinct stages mentioned as under:

Stage 1: Sampling of School:
The researcher has selected an English medium Public school, offering English as a medium of instruction and affiliated to CBSE Board, Delhi.

Stage 2: Selection of Students:
The researcher has randomly selected one section of 8th standard and divides the whole strength of 65 students of the class into two separate groups after equating them. On their academic achievement finally two groups of 32 and 33 students had been formed out of which one group is treated as control group and the other one as experimental group respectively.

E. METHOD OF THE STUDY

Quasi *Experimental method* was adopted by the authors in order to test the effectiveness of the Brain targeted teaching modules in Biology on the academic achievement of the 8th standard students. In a quasi-experimental design, the research substitutes statistical "controls" for the absence of

physical control of the experimental situation. The most common quasi-experimental design i.e. Comparison Group Pre-test/Post-test Design has been mentioned in the table 1.1.

Table 1.1: Exhibiting the Method of the Study

S.N	GROUPS	SAMPLE SIZE	PRE TEST (P-1)	TREATMENT	POST TEST (P-2)
1.	Experimental Group	33	Achievement Test	Brain-Targeted Teaching Units	Achievement Test
2.	Control Group	32		Traditional Lesson Plans	

F. TOOLS EMPLOYED IN THE STUDY

For the present study, following set of tools has been formulated.

1. Self- constructed Achievement test (Pre-test and a Post-test) for measuring Academic Achievement before and after experimentation.

2. Self-constructed Brain Targeted Teaching Units in Biology for 8th standard students.

V. DATA ANALYSIS

Pre Academic achievement test is conducted on the two groups formed i.e. Control group and experimental group. On the pre-test scores, when descriptive statistics Mean, Standard deviation, Skewness and Kurtosis) are applied then the two groups formulated comes to be almost similar as difference in the means of the two groups is 0.29, which is negligible, but skewness and kurtosis values are showing that the population is not normally distributed and thus for better generalization, Non parametric test i.e. Mann Whitney U test is applied for hypotheses testing and better generalization. Here is the table, showing the descriptive statistics of the groups in the Pre-test scores;

Table 1.2*:* Descriptive Statistics of the groups in the Pre-test scores

S.N	Groups	Sample Size (N)	∑ R	U_{obt}	Z Value
1.	Experimental Group	33	1615	1054	6.90*
2.	Control Group	32	530		

When Post-test is administered on both the groups then there found a significant difference between the Mean scores of both control and experimental group which lead to testing of hypothesis. For testing of hypothesis Mann Whitney U Test is applied on the Pre-test & Post- test scores of the control group & experimental group respectively to see the difference. Given below is the table exhibiting Z value of the Pre-test & Post-test scores of the control and experimental group respectively.

Table 1.3: Exhibiting Z value of the Pre-test & Post-test Scores of Control & Experimental group

S.NO	Groups	Sample Size (N)	Pre –test	Post-test	Z Value
			∑ R value		
1.	Experimental Group	33	563	1648	6.957*
2.	Control Group	32	8.46	645.5	2.297*

* P < 0.05, P < 0.01

From the table, it is clear that Z value for the Pre-test and Post-test scores of the control group come to be 2.297, which is significant at 0.05 level.Similarly, in the Pre-test scores and Post-test scores of the experimental group, when Z value is calculated which come 6.957 which is highly significant at 0.01 level of significance. In order to test the formulated null hypothesis that *there will be no significant effect of the developed Brain targeted teaching module on the academic achievement of secondary school students*, comparison of the post test scores of the control and experimental group has been done.

The given table is exhibiting the U & Z Values for the Post-test scores of the experimental and control group.

Table 1.4: Exhibiting U & Z Value for the Post-test Scores of the Control & Experimental group

S.NO	Groups	Sample Size	Mean	SD	Skewness	Kurtosis
1.	Experimental Group	33	8.75	4.33	-0.464	-2.013
2.	Control Group	32	8.46	4.34	-0.453	-3.911

*P < 0.01

Mann Whitney U Test is applied & Z Value comes to be 6.90 which is highly significant at 0.05 as well as 0.01 levels. It clearly proves that the result is highly significant.

VI. FINDINGS

The findings of the present study supported by adequate discussion have been furnished in the following lines.

1. After comparison of Pre-test and Post-test scores of the control group has been done, then Z Value is found significant at 0.05 that means there was a little gain in the academic scores of the students of the control group, which had been taught by traditional method, comprising lecture method followed by simple explanations.
2. Comparing the Pre-test and Post-test scores of the Experimental group, it came that the Z Value was highly significant at both the level, as here gain in the achievement score was much more in comparison to the control group as the learning process in this group comprised of 6 steps in the lesson planning, which is based on new approach i.e. Brain-based Learning.
3. Comparing the Post-test scores of the Control and Experimental groups, highly significant results was found. It proves that the six steps, *Emotional Climate, Physical Environment, Learning Design, Teaching for Mastery, Teaching for Application, Evaluation*, which are present in the Brain targeted teaching units based on the Neurological approach. Due to the process of learning in this group, students connect themselves to the content emotionally, they engaged in active discussion among themselves and with the teacher as well and are able to create stress free zone, enjoy & learn the benefits of working in the cooperative environment the students are able to systematize their knowledge with the help of learning designs and are able to do mastery over the content as well as apply their learning to various other higher applicative situations.

VII. CONCLUSION

It can be concluded that the present approach of Brain-based Learning, which is based on various researches conducted in the field of neurosciences really proves to be highly beneficial in improving the level of learning, which became evident with the increase in the academic achievement of the students. The main aspects which seems to have contributed in improving the level of learning were due to the six major steps, which were involved in formulating the Brain targeted teaching units, viz., It include creating emotional environment which connect students emotionally to the content, creating physical environment which form stress free zone and at the same time eliminating threat and facilitates learning, creating learning designs with the help of advanced organizers which formulate cognitive maps and in turn facilitates learning as it is focused on the aspect of Pattern making, doing mastery of the content with the help of various sources. By applying the knowledge of the Neurological approach to the day to day life activities and other higher cognitive levels as well as performing continuous evaluation so that it can be known, how much the learners have assimilated effectively. Brain-based Learning therefore is emerging as a technology that is reflecting the notion that learning is the expansion of natural knowledge, which an individual possess. Improved level of learning can be seen by the increased Academic achievement of the experimental group. Academic achievement of the control group was also increased, but not to such an extent as it happened in case of the experimental group. It proves that Brain-based Learning in the form of Brain Targeted Teaching Units is really beneficial for the learners. It is totally based on the advancement in the Neurosciences and those neurological principles which increase the working efficiency of the brain and thus facilitates learning.

REFERNCES

[1] Ally, M. "Foundations of educational theory for online learning". In T. Anderson & G. Sanders (Eds.). Theory and practice of online learning. 2004. Athabasca, Canada: Athabasca University. Retrieved from http://cde.athabascau.ca/online_book/index.html

[2] Caine, R. N., & Caine, G. "Understanding a brain-based approach to learning and teaching". 1990. Retrieved from http://poncelet.math.nthu.edu.tw/chuan/note/note/brain-based

[3] Deveci, T. "Developing Teachers.com". 2004 Retrieved from http://www.developingteachers.com/articles_tchtraining/ brain2_tanju.html

[4] Fishback, S. J. "Learning and the brain. Adult learning". 1999. Retrieved from http://learningandbrain.pdf

[5] Forrester, D., & Jantzie, N. "Learning theories". 2004. Retrieved from http://www.acs.ucalgary.ca/~gnjantzi/learning_theories

[6] Gardner, H. E. "Multiple approaches to understanding. In C. M. Reigeluth (Eds.), Instructional-design theories and models: A new paradigm of instructional theory", Volume II, pp.69-89. 1999. Mahwah, NJ: Lawrence Erlbaum.

[7] Hill, L. H. "The brain and consciousness: Sources of information for understanding adult learning. New Directions for Adult and Continuing Education ". 2001. 8, 73-81.

[8] Jensen, E. "Brain-based learning". 2000. San Diego, CA: The Brain Store.

[9] Jenkinsn, D. H., & Land, S. M. "Theoretical foundations of learning environments". 2000. Mahwah, NJ: Erlbaum.

[10] Roberts, J. W. "Beyond learning by doing: The brain compatible approach". 2002. The Journal of Experiential Education, 25(2), 281-285.