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Effect of Brain-based Learning on Academic Achievement of VII Graders in Mathematics

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Abstract

Brain based learning is generally considered as the educational technique derived from the research in neurology and cognitive sciences to maximize learning in a safe yet challenging manner. The main aim of this study was to explore the effect of brain based learning methods on students' academic achievement in mathematics at elementary level. Pre-test Post-test control group design was used. Experimental group was taught through brain based learning and control group was taught by conventional methods. The findings of the study indicated that experimental group performed significantly higher as compared to control group. Present study also revealed that teaching through brain based learning method needs more time as compared to conventional method. Individual performance of the students of experimental group improved more significantly as compared to control group.

Keywords: Brain-based learning, academic achievement

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Introduction

In current years, the usage of imaging methods, tests of neuropsychology, studies of electrophysiology have produced opportunities for researchers in the functional and structural studies of the human brain which have presented hints resulting in large modifications in the area of education. In education, teaching without knowing the functioning of the brain is just like designing a glove without awareness of the structure and movement of the hand(Awolola, 2011).We can explore pathways of maximum learning after having complete understanding of the brain (Carolyn, 1997; Gozuyesil & Dikici, 2014).

This method relates learning with the brain and its way of working, and declares that improved performance of the brain and its features have a positive impact on learning. So, learning generally enhances the development of the brain. The studies of neuroscience, examine the linkage among brain, the neural organization with our cognitive behaviors and learning. Brain-based learning is progressively more defined and promoted with the findings of neuroscience and advanced technologies (Hansen & Monk, 2002).

Brain based learning is a combination of different concepts such as cooperative learning, experiential learning, multiple intelligences, mastery learning, learning styles, right brain theory peer tutoring, left brain theory and triune theory of the brain. These are well-suited for the existing methods of teaching in various fields like natural sciences, languages and social sciences. This method applies in a brain friendly and unthreatening classroom environment for maximum learning and also to minimize the conventional method which promotes only rote-learning (Rehman, 2011).

Caine and Caine (1991) developed some Brain Based Learning principles to optimize maximum learning;

1. The brain is a parallel processor.
2. Total physiology is employed by learning.
3. The exploration for understanding is inherent.
4. Understanding is developed through patterning.
5. For Patterning sentiments are significant.
6. Simultaneously wholes and parts processes by the brain.
7. Learning can engage perception and attention.
8. Learning includes both conscious and unconscious processes.
9. Rote learning required two types of memory.
10. Spatial memory is helpful in understanding and remembering best.
11. Challenges improved learning while threat repressed it.

Above mentioned principals are affectionately implemented in U.S.A, Japan, Europe, Turkey and Australia in 1990s and onward. These provide learning through inductive reasoning (generalization based on observations), deductive reasoning (conclusion on the basis of generalization) and problem solving reasoning (intellectual procedure of searching and shaping a problem) (Rehman, 2011). The inductive, deductive and problem solving reasoning are applied in various fields of learning like languages, social sciences, natural sciences, medical field and especially in mathematics for teachers in considering the student's learning abilities.

Currently, brain based learning connects the field of neuroscience with teaching and learning of mathematics. Imaging techniques have permitted scientists to find out which regions of the brain are working when brain is involved in mathematics. This strategy has provided researchers and educators an innovative part of the learning puzzle. This technique develops logic of an idea or concept and also offered presentation of this concept in a more logical manner (Sprenger, 2002). The learners could develop various concepts of mathematics when teacher creates activities of teaching and learning which are brain-compatible. Nowadays it is possible to contrast theories of learning in mathematics to neurological investigation of physical working of the brain while learning mathematics (Risley, 2009).

Mathematics requires a lot of mental abilities for understanding of its various concepts comparative to other disciplines. So, mathematics is still believed as the most complicated and challenging subject across several countries (Klinek, 2009).The discussion reveals that brain based learning is a practical approach for teaching and learning of mathematic. But unfortunately brain based teaching method is not implemented in mathematics classrooms(Johnson, 2003).Same is the case in Pakistan, where threatening environment, authoritative attitude of teachers and learning by cramming are brain-aggressive means and promote only rote-learning (Ali, Hukammad, Shahzad, & Khan, 2010). According to Annual status of Education report Pakistan (ASER, 2012) conducted study to find out the student achievement in mathematics and languages. The findings of this research indicate that the vast majority of pupils have not even accomplished what is required of a grade II to VII. Average performance of students in mathematics is 48 percent.

In Pakistan, teaching methodology beside many factors is considered to be the foremost factor contributing to student's performance (Farooq & Shah, 2008). Mathematics is taught under unsatisfactory conditions by conventional methods. In other words the methodology which is currently used in our classroom not achieved the desire goals of mathematics. So, students could not develop their mathematical skills and their performance is also poor in this field (Khan, 2012). But in many countries like U.S.A,

Japan, and Australia different teaching strategies are applied in the classrooms. This methodology develops learning abilities as well as deeper understanding of the learners as compare to the leading chalk and talk method (Rehman, 2011).

Therefore the rationale behind conducting this research was to compare outcomes of conventional methods and brain based learning method on student's academic achievement and to discover the empirical evidences for the effectiveness of this approach in Pakistani context along with the practicality of applying this method in our classrooms.

The main objective of the study was to compare the effect of brain based learning and conventional method on student's achievement of experimental and control group. More over ability wise comparison of the student's achievement in the subject of mathematics in experimental group was planned.

Research Methodology

The study was experimental and designed to investigate the effect of brain based teaching method on student's achievement. Pretest and Posttest control group design was used to measure the achievement before and after treatment. The following is the design of the study.

R G_1	O_1	X1	O_2
R G_2	O_3	X2	O_3

One of the public schools, where researcher could conduct research was selected. There were three sections of 7^{th} graders in the school having 175 students. All of them were pretested. These were classified into desired subgroups of three levels of ability (i.e. high, average and low). A group of175 students was classified into subgroups which comprised105 average ability students, 44 low ability and 26 high ability students. Twenty (20) students were randomly selected from each of the ability subgroups; a total of 60 students (30 in each group) were selected. Thirty students were then randomly assigned to one of the two methods of instruction.

Instrumentation

Achievement test was used in this study as a research tool because the aim of the research was to investigate the effect of brain based learning (BBL) method on academic achievement. The items for the test were taken from "California Standardized Test for Mathematics" after fulfilling the following steps:

1 Firstly matched the standards of National curriculum of Pakistan2006 with the standards of California standardized test (Table 1).Items for these content areas were selected by keeping in view the Bloom's taxonomy.

2 Table of specification was constructed (Table 2).

Table 1

Comparison of Curriculum Standards

Standards no	Standards of Pakistani Curriculum	Standards of California Standardized test
1	Numbers and Operations	The Number Sense Strand
2	Algebra	The Algebra and Functions Strand
3	Measurements and Geometry	The measurement and Geometry Strand
4	Information Handling	The Statistics, Data analysis and probability Strand
5	Reasoning and Logical Thinking	Reasoning Strand

Table 1 gives the matched standards of National curriculum of Pakistan developed and implemented in 2006 with the standards of California standardized test.

Table 2

Table of specification

Content	knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total Items	Total %
Chapter #2 (Financial Arithmetic)	-	2	2	-	-	-	4	20%
Chapter #3 (Algebraic Expression)	1	4	-	-	-	-	5	25%
Chapter #4 (Linear Equation)	-	2	2	-	-	-	4	20%
Chapter #5 (Fundamentals of Geometry)	-	3	-	-	-	1	4	20%
Total	1	13	4	-	-	2	20	-
% of items	5%	65%	20%	0%	0%	10%	100%	

The above table of specification gives the distribution of items keeping in view the Bloom's taxonomy. Maximum items were selected from comprehension level of the taxonomy followed by items of application level.

A pilot test was conducted on 200 students. ITMAN and Conquest techniques were used for analysis of data. The items were selected by keeping in view the criteria of Classical Theory (CT) and Item Response Theory (IRT)

IRT	**CT**
Range Value of b = -3 ─ +3	D-Index 0.3 – 0.8
Range of Means Square = 0.8─1.2	D-Index 0.2 – 0.8
Range of outfits means square = 0.8─1.2	Point Bi-serial less than 0.8

Procedure of the study

There were two parts of data collection. Part one comprised of data collected through pretest and posttest. Second part dealt with the scores that researcher collected through weekly assessments of both groups. Experimental studies in education often suffer a failure to make the treatment sufficiently different to each other. So, it is important that researcher would find a meaningful difference between two treatments. That is why it was planned that two approaches of instructions have clear cut differences.

Teaching to Experimental Group

Selected six principles of BBL were applied by the teacher in the classroom. The detail is presented in the table below.

Table 3
Implementation of Principles in the Classroom

Principles of Brain Based Learning	Implementation in the Classroom
Principle1: The brain is a parallel processor.	• Solving figures • Recognizing mistakes and correct them • Finding similar and dissimilar concepts of mathematics.
Principle2: Learning engages the whole physiology.	• Demonstrating balanced diet plan • Motivating students to take water bottles with them and drink plenty of water • Also providing guidelines about good health to them • Telling joking and welcoming suggestions and criticism • Solving brain energizers.

Principle3: The search for meaning is innate.	• Introducing innovations in teaching content • Relating earlier knowledge of students to the new concept
Principle4: The search for meaning comes through patterning.	• Motivating students towards self-exploration • Make sure that students remain active and speak in the classroom • Appreciating student's task • Unfolding riddles • Solving real-life problems • Group discussions • Assessment of work through feedback, self-evaluation and peer evaluation etc.
Principle6: At the same time each brain perceives and generates parts and wholes.	• Break down difficulties, mathematical problems into small parts • Combine these parts into a single unit • inductive and deductive thinking etc.
Principle12: Every brain is unique.	• Individual assignments • Home assignments

Teaching to Control Group

Control group was taught through conventional method. Teacher gave instructions to the students to open their text books at the start of the periods. Teacher solved the problems and exercise questions on the white board and asked students to copy these questions. The home work was assigned to them based on text book exercises and regularly checked by teachers.

Results

$H_{01,}$ Pretest scores of experimental and control groups are not significantly different before treatment.

Table 4

Comparison of Pretest scores of Group I and Group II before treatment

Groups	N	Mean	SD	*t*- value	*df*	*p*
Group I	30	11.70	4.001	.198	58	.843
Group II	30	11.50	3.803			

Table 4 clearly depicts that p is .843 > 0.05 which specifies that Pretest scores of group I and group II were not significantly different. So, data supported the null hypothesis stating Pretest scores of experimental and control groups are not significantly different. It means groups are equivalent before treatment.

$H_{02,}$ Posttest scores of experimental and control groups are not significantly different after treatment.

Table 5

Comparison of Post-test scores of Group I and Group II after treatment

Groups	N	Mean	SD	*t*- value	*df*	*p*
Group I	30	23.80	6.472	7.701	58	.000*
Group II	30	12.97	4.181			

*$p < 0.05$

Table 5 clearly depicts that p is .000 < 0.05 which indicates that group I and group II are significantly different. So, the null hypothesis stating that Post-test scores of experimental and control groups are not significantly different is rejected. This shows that treatment has effect on the achievement of the students.

Trend in Academic Achievement of Experimental and Control Groups

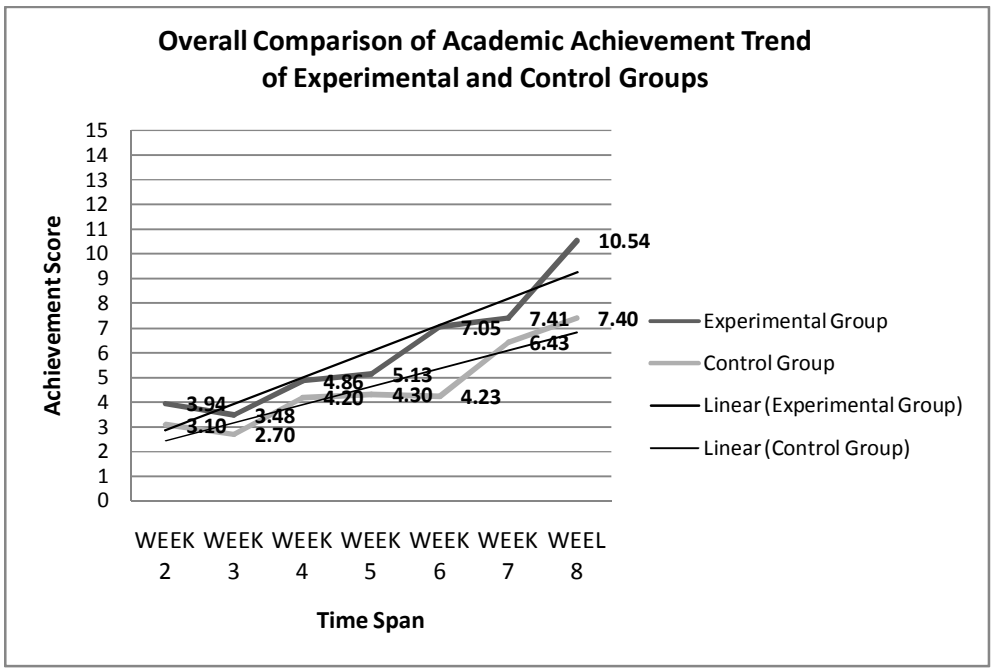

Figure 1 Overall Trend in Academic Achievement of Experimental and Control Groups

Above graph shows that the scores of experimental and control groupimproved with the passage of time but group II improvement is greater than group I. In the six weeks this difference becomes much greater. The improvement in control group can be explained in two ways. Firstly their awareness to be a part of experiment and secondly, a continuous assessment and feedback improved their performance.

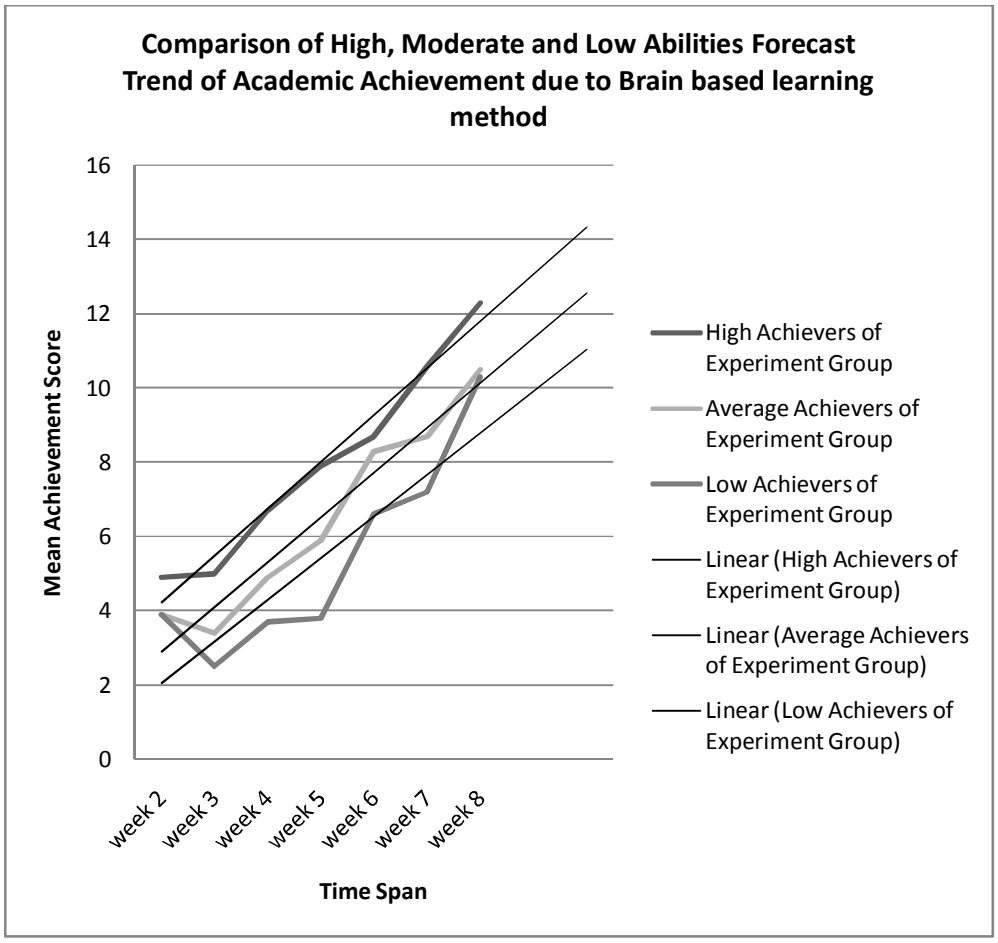

Figure 2 Trend in Academic Achievement of High, Moderate and Low Abilities Groups

The graph shows that brain based learning method is effective for all students but it affects high ability students more as compared to low ability students. Size of effect of technique on students' achievement is corresponding to their ability.

Findings

1. There was no significant difference (t = .198, p= .843)between pretest scores of experimental and control groups.
2. A significant difference was found (t = 7.701, p= .000) between post test score of experimental (M= 23.80) and control group (M=12.97).
3. The scores of experimental and control group improved with the passage of time but improvement of experimental group was much greater than control group.
4. Brain based learning method was effective for all students but it affected high ability students more than low ability students.

Conclusion and Discussion

This study was planned to investigate the effect of BBL method on the academic achievement of students. The main objective of the study was to compare the BBL with conventional method. The results of present study concludes that BBL show better results than conventional method. Finding of present study supports the findings of other studies (Duman, 2010a, 2010b; Gozuyesil & Dikici, 2014; Ozden & Gultekin, 2008)that BBL is helpful in improving the student's academic achievement.

Besides improving academic scores, BBL also enhances the working of the brain (Bruer, 1997; Klinek, 2009; McGuckin & Ladhani, 2010). Above mentioned studies also describe that working of brain is improved when taught through principles of BBL. These principles contain many teaching and learning activities. The findings of these studies support the finding of present study that working of the brain can be improved by applying principles of BBL. There were twelve principles of BBL method. But due to time constraint six principles were applied. Those six principles were selected which contain cognitive exercises of teaching learning session during experiment.

Students have different ability levels in the normal classroom. In present study the students were divided into their ability levels during experiment. The findings help to conclude that BBL method is more beneficial for students who have different ability levels such as high, moderate and low but high ability students acquire a lead as compared to low ability students. The results display differences between ability levels of both groups. Similarly Rehman, Malik, Hussain, Iqbal, and Rauf (2012)conducted an experimental study on secondary level students having different achievement levels. They found significant difference between achievement levels of both groups. Ali et al. (2010) andHerson(2006)findings also show that students of mixed abilities gradually increase their performances through BBL method. Either they were from high, moderate and low ability.

The BBL method show better results than conventional method when evaluated weekly. These findings were similar to the findings of Davis (2004),Gülpinar (2005),Akyurek and Afacan (2013)who applied BBL method on different levels and on different subjects such as science and technology classes. After conducting experimental studies they concluded that weekly scores of students improved with the passage of time.

Findings also show that the learning mathematics skills of students might also develop in a better way by applying BBL principles than other methods. These findings were supported by study of Johnson (2003),Risley (2009) and Sousa (2008). They revealed that mathematics could be taught and learned with its pure meaning and understandings with BBL.

An important outcome of this study was that this technique takes more time than other methods for applying in normal classroom and it was also useful for learning some concepts but difficult to teach whole content through this process. To establish generalizability of the results, more research of a similar kind was recommended.

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