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Applying Brain Based Learning Modules for Learning Acceleration of 6th Grade Science Students

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Abstract

This pre-test post-test control group experimental study was conducted to identify difference in the performance of three BBL (Brain Based Learning) types of strategies; practical simulation, problem solving and cooperative learning on early elementary graders. The modules were developed by the researchers to find the effectiveness of BBL strategies over traditional chalk and talk method. The study involved three pairs of control and experimental groups randomly of sixth graders having N=30 each and total 180 students from district Lahore public schools. The students received intervention for four months for 4 chapters of 6th grade General Science subject. All students were pre and post tested by a 40 item multiple choice concept based achievement test. The pre and post test scores of all control and experimental groups were compared to find out the achievement difference of students through comparing their gain score (post-test – pre-test) after intervention. The study revealed that all the three BBL modules were effective because the intervention groups showed greater gain score parallel to their control groups.

Keywords: Brain-based intervention, Learning acceleration, Cooperative learning, Practical Simulation, Problem Solving

Introduction

The process of teaching and learning includes many variables. These variables affect the learner directly or indirectly. The theory of Brain Based Learning (BBL) is based on the structure and functions of the brain. Its approaches focus on how brain learns. The cognitivist understand the nature of brain and focus on how knowledge is acquired (Kolon, 2008). The application of Brain Based Learning activities in classroom help to increase concept building and understand the learning in different and new ways (Cain, 1991; Tambunan, 2019). A recent study by Walid, Kusumah and Mukti (2019) reported that BBL affects pre-exposure scenario, readiness, acceptance and acquisition of concept, its explanation, processing and retention of learners. Moreover, it elaborates process of concept formation through integrated functional approach. Previously, Gozuyesil (2014) and Perone et al. (2019) noted that brain-based learning is a comprehensive way of learning involving multiple senses. Whereas, Tafti (2017) investigated that BBL involves higher order thinking skills and enhances retention of concepts. With the involvement of multiple senses, students are well engaged and immersed in developing concept. Their mental, physical, emotional and social engagement imprints deep impact on learning and its relational aspects.

Objective of the Study

The following objectives were focused for the current study:

1. To prepare BBL intervention modules with cooperative learning, problem solving, and practical simulations as per sixth grade PCTB General Science book.
2. To find out the effect of practical simulation on the achievement acceleration of sixth grade General Science students.
3. To identify the effect of problem solving strategies on the gain score of sixth grade General Science students.

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4. To investigate the effect of cooperative learning on the gain score of sixth grade General Science students.
5. To explore the gain scores difference of three experimental groups taught with problem solving, practical simulation and cooperative learning.

Hypotheses

The study tested the following hypotheses

$H_{o1=}$ The gain score of students' academic achievement taught with traditional method and having practical simulation has no significant difference.

$H_{o2=}$ The gain score of students' academic achievement taught with traditional method and taught with problem solving has no significant difference.

$H_{o3=}$ The gain score of students' academic achievement taught with traditional method and having cooperative learning has no significant difference.

$H_{o4=}$ The gain score of students' academic achievement taught with three different modules; simulation, problem solving & cooperative learning has no significant difference.

Review of Related Literature

A hot discussion among educationists is continued for acceleration of learning and discovering brain functions that are involved to build, retain and sharpen the concept formation. Several recent studies like; Jean (2019), Solihatin and Syahrial (2019) and Satria (2020) conducted for subjects of Science, Math and Language, have provided empirical evidence that brain based models worked successfully for construction of concepts and helped operationalizing higher order thinking skills. These researches further identified that learning is a structured process that involves memory features and the environment provided to the student. The focus of Brain Based learning is how students learn actively rather than sitting passively in the classroom. Likewise, BBL suggests diverse concepts of assessment that instead of measuring test scores and home tasks, teachers should assess students' skills, performance, power of analysis, judgment and several other real life practices (Varghese, 2016).

The Brain Based learning discourages stressful learning environment and supports the relaxed and stress-free learning context (Subadi, 2013), because students can explore and be creative if they are in a fresh and stress-free learning environment. Therefore, a well-designed Brain Based learning helps to create interesting and effective learning environment to make learning long lasting (Siercks, 2012).

Schools and educators use a variety of strategies, programs and techniques during regular classes or outside the classroom to enhance the learning of students. This system of lifelong learning is also effective for learning acceleration (Eleftheriou et al, 2019) because it involves learning in diverse contexts and develop associational skills. Learning can be accelerated in a brain friendly learning environment and the role of teacher is a facilitator and guide in this environment (Gu, Lillicrap, Ilya & Sergey, 2016).

The current study used three brain-based learning strategies:

1. Cooperative learning (Tran, Nguyen, Van De, Soryaly & Doan, 2019).
2. Practical simulation (Nulden & Scheepers, 2020).
3. Problem-solving (Tambunan, 2019).

Cooperative Learning

Cooperative learning is an organized teaching strategy which arranges the activities of classroom according the social learning experiences of an individual. Students learn collaboratively and complete their task in groups, so it is collaborative in nature rather than competitive (Johnson & Johnson, 1998). Jigsaw, inside-outside circle, think pair share and reciprocal teaching are some common cooperative learning strategies. These strategies can be successful for any level, topic and course (Hedeen, 2003).

Students are responsible for their learning in cooperative learning. They interact with each other in a friendly learning environment and accomplish their goals. (Hsiung, 2012). But, it is challenging to implement the cooperative learning in classrooms because it requires control, consumes time and makes students busy. It is also helpful for less confident students and slow learners (Slavin, 2003). Cooperative learning improves the academic achievement of students and enhance their communication skills if implemented correctly. But, some teachers are afraid to adopt it

because it requires time and the role of teacher is an active instructor to facilitate the students (Prince, 2006).

Problem-Solving

Problem solving is known as a student centered technique. Students learn by solving a problem with the help of guidelines given by the tutor. It enhances acquisition of knowledge, communication and group collaboration (Maidmen et al, 2004). The development of problem solving skill in students is a need of today. Students may face many problems in their day to day life that's why it is known as a major quality parameter. Problem solving skills enable students to become successful future citizens who can meet the challenges effectively (Abd-El-Khalick, 2000). It is considered a new perspective to apply problem solving as a learning strategy in classrooms. The correct and effective use of problem solving skill for teaching science concepts encourages students to learn rationally (Kirtikar, 2013). The purpose of problem solving method makes learning meaningful instead of providing only facts and information. Teacher provides freedom and autonomy to students and help them to ensure joy and freedom in science learning (Tandogan, 2007).

Based on the research, the syntax model of problem solving for learning of science at elementary level consists of the introduction, identification of problem, observation, collection of data, organisation of data, data analysis/ generalisation, and conclusion (Gozuyesil, 2014).

Practical Simulations

Practical simulation is also known as student centered approach and considered as a constructive learning strategy. Students learn with simulations in a realistic environment (Deng, 2012). In this strategy, teacher creates a scenario in the form of role play, activity and game and puts the student in that situation to achieve learning outcomes. Teacher controls the parameters of the scenario and creativity and learning of students decides the success of the simulation (Lean, 2006).

Critical thinking and deep engagement is required to apply the practical simulations in classrooms because students have to perform an activity rather than listen to a lecture. Practical simulations known as realistic teaching strategy, it requires time and resources. (Alonzi, 2000). Students adopt the situation and learns the concept but assessment with this method may be difficult. (Sauvé, 2010).

Students interact with other classmates and participate actively in activity. They understand the situation, learn rules and regulations and adopt the situation (Porter, 2004).

Problem solving, practical simulation and cooperative learning known as student centred approaches and traditional/conventional methods considered as teacher centered. Critical thinking, decision making and problem solving skills do not develop in the traditional method. Students learn with memorization and recitation and teacher expects that students learn because teacher ask them to learn (Kirtikar, 2013).

The goal of three domains of strategies of brain-based learning is to teach the students effectively.

Methodology

The study involved a pre-test, post-test control group experimental design with three pairs of control and experimental groups (Mills & Gay, 2019) with N=30 for each group. The three different experimental groups were treated with three different BBL strategies including cooperative learning, problem solving and practical simulation method. All the control groups were taught with traditional chalk and talk method. The study continued for duration of 4 months. The three experimental groups were selected from diverse public schools randomly.

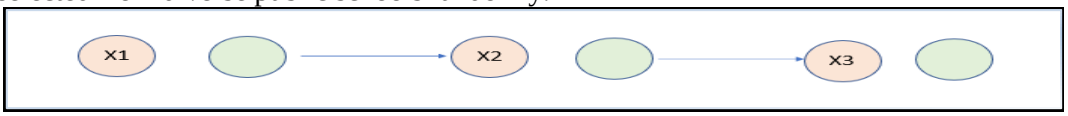

Figure 1: Experimental design of the study, where X1, X2 and X3 show three treatments.

Population of the Study

All early elementary students of grade sixth studying in public schools of province Punjab were the population of the study.

Sampling Technique

The three public schools were selected randomly from the district Lahore. From each selected school, the students of grade sixth, studying General Science subject, were randomly selected from 4 to six

sections of selected schools. Each experimental and control group had N=30 students. Thus, total 180 students were engaged for the experimental study. The students were further randomly distributed to control and experimental groups in each school.

Table:

Distribution of sample students

Schools	Control Group	Experimental Group	Total Sample
Students from school I	30	30	60
Students from school II	30	30	60
Students from school III	30	30	60
Total Sample	90	90	180

Instrument of the Study

Three modules incorporating three types of BBL strategies; problem solving, practical simulation and cooperative learning were prepared by the researcher for required intervention. The modules were developed from the Punjab Curriculum and Text Book Board's General Science Book for Grade 6th. The strategies were developed for the first 4 chapters to be taught in 4 months of the academic session. Thus, the pre and post-test were concept-based multiple choice tests having 40 items; ten items from each chapter. The item analysis of the developed items was conducted and the difficulty level was ranged from .47 to .88. The items were validated by the subject specialists of the concerned schools. Table of specification was used to decide weightage of the concepts given in the book. The pre-test was taken from all control and experimental groups in the beginning of the session and the post test was taken at the end of the fourth month intervention.

Analysis

The descriptive and inferential analysis was conducted to find out the difference in the academic achievement of all control and experimental groups of students separately. Currently the gain score (Wang & Chyi-In, 2004) comparisons are presented below that were compared using independent sample *t-test.* "*Independent sample t-test is used for a research design that has a separate sample for each treatment condition (or for each population), an independent-measure research design or a between-subjects design*" (Gravetter & Wallnau's, 1979, p. 310). Further, the difference among three BBL strategies was found using *ANOVA* as*, "*Analysis of variance (ANOVA) is a hypothesis-testing procedure that is used to evaluate mean difference between two or more treatments or groups" (Gelman, 2005).

Table 1:

Gain score comparison of intervention and control group at Public School 1 by t-test (practical simulation)

		Levene's test for Equality of variances F	Sig.	t-test for Equality of means t	df	Sig. (2 tailed)
Public school 1	Equal variances assumed	.005	.946	9.596	58	.000
	Equal variances not assumed			9.596	57.966	.000

The table no.1 reveals that there is a significant difference in the performance increase of control and intervention groups at rural school with t (58) = 9.596, p=.000< .05. The students taught through practical simulation module acquired greater academic achievement increase from their previous performance as compared to their control group contestants. It was found that the practical simulation strategies helped students to grasp the concept vividly and caused in depth learning. The first null hypothesis that "the gain score of students' academic achievement taught with traditional method and through practical simulation is not significantly different" was rejected.

Table 2:

Gain Score Comparison of Intervention and Control Group at Public School II by T-Test (Problem Solving)

		Levene's test for Equality of variances		t-test for Equality of means		
		F	Sig.	t	df	Sig. (2 tailed)
Public school 2	Equal variances assumed	.258	.613	8.777	58	.000
	Equal variances not assumed			8.777	57.987	.000

The table no.2 depicts that there is a significant difference in the gain score of control and intervention groups at suburban school with t (58) =8. 777, p=.000< .05. The students taught with problem solving module attained greater gain score as compared to their control group contestants. It was found that the problem solving strategies were effective for students to master the concept. The second hypothesis that "there is no significant difference in the gain score of academic achievement of students taught with traditional method and having problem solving instruction" was rejected.

Table 3:

Gain Score Comparison of Intervention and Control Group at Public School III by t-test (Cooperative Learning)

		Levene's test for Equality of variances		t-test for Equality of means		
		F	Sig.	t	df	Sig. (2 tailed)
Public school III	Equal variances assumed	5.745	.020	15.868	58	.000
	Equal variances not assumed			15.868	50.845	.000

The table no.3 indicates that there is a significant difference in the gain score of control and intervention groups at school III with t (58) = 15.868, p= .000 <.05. The students instructed through cooperative learning module achieved greater gain score as compared to their control group. It was found that the cooperative learning strategies were effective for students to master the concept. The third hypothesis that "there is no significant difference in the gain score of academic achievement of students taught with traditional method and having cooperative learning instruction was rejected."

Table 4:

Gain Score Comparison of Intervention Groups t Public Schools I, II and III by ANOVA (Practical Simulation, Problem Solving & Cooperative Learning)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.400	2	6.700	.614	.544
Within Groups	949.500	87	10.914		
Total	962.900	89			

In table no. 4, the one-way ANOVA identified that there is no significant difference among the gain score of three intervention groups at three schools with (F (2, 87) = .614, p = .544). The finding revealed that all the three BBL strategies; practical simulation, problem solving and cooperative learning were approximately equally effective for accelerating learning performance of early elementary graders in all three contexts. This result also supported the 4th null hypothesis of the study that, "There is no significant difference in the gain score of academic achievement of students taught with three modules; simulation, problem solving & cooperative learning."

Discussion and Conclusion

The study has implications for using well designed BBL strategies for students accelerated academic achievement. As discussed by Jazariyah (2017), the brain based learning was found effective for

enhancing learning achievement, the current study has supported these findings. The present study is in line with Connell (2018) results who identified global aspects of BBL and suggested for conducive environment of students where they have a challenging but encouraging situation for resolving their subject related problems. The present study produced an atmosphere of collaboration and interdependence for students to have favorable atmosphere for getting learning help from teachers and peers.

As teaching at elementary level involves active engagement of students' senses (Tambunan, 2019), the current study used all strategies like; games, role play, puzzles, jigsaw discussions, question answer sessions, problem cards, debates, projects, writing journals, pair & share and several other strategies demanding full attention and participation of students. Empirically it was found that all intervention groups had greater gain scores than that of control groups. Further, the study in hand has tried to identify engaging factors of BBL strategies over traditional chalk and talk method practiced in our public schools. The study, thus, supported Jean (2019), Solihatin & Syahrial (2019) and Satria (2020) studies which reported increase in learning acceleration of science, math and language students due to adopting BBL.

The present study supported Tafti (2017), Abd-El-Khalick (2000) and Hsiung (2012) who investigated that learning is a structured function and it demands structured activities keeping in view the phases of learning and complexity of subjects. However, the researchers could not find sufficient empirical data of achievement differences occurred through teaching with different BBL strategies in Pakistani context except the current study. It was noted that all the three intervention groups performed equally higher as compared to their control groups. The study infers that usually the teachers ignore using established BBL strategies for teaching at public schools. Though there are several direct or indirect implications of the study, following recommendations are presented for enhancing students' learning speed and quality:

- The BBL strategies involving practical simulation, problem solving and cooperative learning need to be incorporated in all subjects' curriculum guidelines.
- Class size need to be reduced for raising the quality of learning as BBL activities need individual attention
- Working in heterogenous groups help students to share abilities and increase social skills
- Teachers need to be trained for preparation of BBL teaching material and class management
- Examination system needs to be flexible for multiple ways of assessment
- Assessment needs to be concept based rather than being content based
- Skill and competency development should be preferred over acquiring factual knowledge

Conclusion

The study provides empirical evidence from different contexts that BBL has positive and substantial effect on the learning acceleration of early grade students. If students are involved, mentally, emotionally and socially in learning activities, different parts of their brain will work collaboratively, and they will have comprehensive gist of the concept presented. Continuation of learning activities in real life enhances assimilation or relative abilities of learners and they are better able to solve problems in changed situations. Before the neurologists proceed for inserting a chip in human brain, the children need to be put in natural, challenging and non-threatening environment to have better opportunity of making a real concept of different phenomenon. Well designed, well-practiced and well managed BBL strategies help student to overcome their deficiencies, take interest in learning and finally apply and judge the concept justifiably. BBL cumulatively help students achieve higher order thinking skills and make them critical thinkers.

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