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Effect of Brain Based Learning Strategies on Students' Achievement in Science

Jagannath Kunar[1], Dr. Sudarshan Mishra[2]
[1] Department of Education, Raven shaw University, Cuttack, Odisha, India
[3] HOD, Department of Education, Ravenshaw University, Cuttack, Odisha, India

Abstract
The content and intent of this present research study is focused on to determine the effectiveness of brain-based learning on learning achievement in science of higher secondary school students. This study was executed as an experimental method and pretest-posttest control group design. The total population was stratified by the administration of Kolb's learning style inventory. The sample size consisted of 96 (+ 2 Science) first year students who were selected randomly by applying stratified random sampling and were placed in two groups of control and experiment (each group, 48 students). The researcher taught the experimental group through lessons designed on the basis of brain based learning principles for 12 weeks. The achievement test was used for collecting the data. The collected data were analyzed by using the statistical technique i.e. analysis of covariance (ANCOVA) test. The results of ANCOVA analysis test clearly indicated that the brain-based learning has effect on learning achievement in science. According to different researches, Brain-based Learning can be used as an intervention therapy for enhancing learning achievement in science of higher secondary students.

Keywords: brain based learning, self-regulation skill, learning style, intervention

Introduction

Background of the Study

Brain based learning (BBL) is the active engagement of practical strategies based on principles of brain sciences. From a different angle it is a way of thinking about how brain process and organize information. Hence BBL helps to design instructional objectives with diversifying teaching strategies mostly concern with uniqueness of brain & learning styles of diverse learner. Teaching should be as per learning style difference of students (Gardner, 1993).

People often say that everyone can learn. Yet the reality is that everyone does learn provided that the new learning must compatible with brain processes. To make learning compatible it is necessary to engage the learner in learning process, teach them to think, provide room for exploration and reflect upon it, motivate them to use new information to solve problems. Most importantly provide the learner a threat free environment with challenges. All these may not be achieved through conventional method alone. So there is a need to bring change in instructional process. According to Frederick Goodwin, president of the National Institute of Mental Health "it was thought previously, that our brain nerves are unalterable but in fact positive environments can create physical change in growing brain (Hoseini Iraj, 2010) [18]. Brain changes with experience and science gives evidence that how they change in response to experience E. Jensen, (2012).

The human brain has many compartments with multi functions but the present system has pointed out and emphasizing a very small percentage of that. Technically speaking, the present schooling or system of learning emphasizes on a very narrow part of brain, present on the left side of cerebral cortex. The human brain is a complex system that is still used in school as a simple storing and information retrieval device (Hoiland, 2005) [4]. According to Kerry (2010) [19], the school learning concentrates on a narrow part of brain which is placed in left side of cerebral cortex and isolation of specific parts of the brain, has eliminated its systematic cohesion and correlation. From the ancient Gurukul to today's constructivism the teaching method and strategies have been modified and restructured a lot, but very less method emphasized on the brain i.e. the functions of brain and the brain compatibility in regards to new information and learning. Currently many teachers continue to use teacher-centered instruction even though evidence is available to suggest a constructivist approach is more effective (Beauchman, 2005) [3]. The results of this study may have implications for using constructivist instructional method and theories of education.

Objectives of the Study

Objectives are listed as follows

1. To compare mean scores of Achievement in Science of Brain Based Learning and conventional Method Groups by taking Pre- Achievement in Science.
2. To study the effect of Treatment, Gender and their interaction on Achievement in Science by taking Pre-Achievement in Science.

Hypotheses

1. There is no significant difference in mean scores of Achievement in biology of Brain Based Learning and conventional Method Groups by taking Pre-Achievement in biology.
2. There is no significant effect of Treatment, Gender and their interaction on Achievement in biology by taking Pre- Achievement in biology.

Theoretical Framework

The study uses the constructivist theory as foundation. Gardner's multiple intelligence theory is a constructivist theory (Gardner, 2006). According to Jensen, 2008b [12],

Gardner's theory of multiple intelligences is the base of brain based learning whereas behaviorists approach of Skinner and Pavlov are the bases of teacher centered instruction i.e. instruction for control group. The constructivist theoretical perspectives of education is the foundation for brain based instruction (Bush, 2006) [7]. Brain based instruction uses orchestrated immersion as a central components of student learning (Jensen, 2008b) [12]. Orchestrated immersion is using student knowledge as it applies to real life situations (Jensen, 2008b) [12]

Gardner's theory identifies eight different intelligences: linguistic, logical-mathematical, spatial, kinesthetic, musical, interpersonal, intrapersonal, and naturalist (Gardner, 2006). Linguistic intelligence occurs when a person processes words better than other forms of information; the person learns best from reading, lectures, taking notes, and discussions (Gardner, 2006). Logical-mathematical intelligence is the ability to learn best through numerical and logical formats (Gardner, 2006). These types of learner learn best from graphs, problem solving, algorithms, and they excel at abstract thinking (Gardner, 2006). People with spatial intelligence are good at visualizing, as well as solving puzzles and having a keen sense of direction (Gardner, 2006). Kinesthetic intelligence is an ability to learn best by movement or building things (Gardner, 2006). These learners tend to be successful in sports or activities requiring movement. Individuals with the ability to learn best through rhythms or sound have a musical intelligence (Gardner, 2006). Learner who can learn best by working with others in groups possesses interpersonal intelligence (Gardner, 2006). A person with intrapersonal intelligence learns best by having time alone to concentrate and analyze information (Gardner, 2006). The naturalist intelligence is defined as learning best when material is connected to the natural environment, this intelligence was added by Gardner in 1997 (Douglas *et al*. 2008). The multiple intelligence theory suggests a person has a primary intelligence (Gardner, 2006). Brain-based instruction allows the use of multiple intelligences to work seamlessly with orchestrated immersion and active processing. Neuroscience has expanded since then and now brain theory encompasses a more holistic approach (Wilson, 2007) [10]. Brain-based instruction stems from the research of Gardner's multiple intelligence theory, as Gardner used brain-based evidence for his theory of multiple intelligences (Jensen, 2008b) [12].

Brain-based instruction goes beyond the multiple intelligence theory; brain-based instruction includes the physical environment and reactions to learning to aid in increasing learning (Jensen, 2008b) [12]. Brain-based instruction has a focus on orchestrated immersion as one of three components, so students actively engage in learning (Wilmes, Harrington, Kohler-Evans, & Sumpter, 2008) [15]. Orchestrated immersion is the component of brain-based instruction containing Gardner's theory of multiple intelligences, as these activities create the appropriate environment for the multiple intelligences. Apart from orchestrated immersion the two other components of brain-based instruction are relaxed alertness and active processing. Marian Diamond has studied the relaxed alertness component of brain-based instruction (Wilson, 2007) [10]. Armstrong and Jensen have conducted studies more recently on all three components of brain-based instruction (Wilson, 2007) [10]. The controversy surrounding brain-based instruction is how the neurological information currently available translates to use in the classroom (Sternberg, 2008; Willingham, 2008) [14]. The current study uses this content specific theory as the theory relates to the constructivist theory and brain-based instruction. Historically, teacher-centered instruction has been the norm in most classrooms (Cuban, 2007) [8]. Teacher-centered instruction is an application of behaviorist theories (Gredler, 2008) [11]. The difference between these theories lies in the different roles of the student and teacher in the learning process. The behaviorists believe the teacher guides instruction and the students should be trained to sit quietly and listen (Gredler, 2008) [11]. While the constructivists believe that, the students should guide their own learning and the teacher's role is to facilitate the students in expanding their knowledge (Lattuca, 2006; Schunk, 2007) [6-7]. The implications may specifically address using the brain-based instructional method as an application of constructivist theory.

Significance of the Study

The study is significant in the view point of developing and organizing learners cognitive structure, thinking skill, ability to reflect and understanding of science and other allied courses. The findings from studies show that most of the higher secondary learner do not use self-regulation skill like self-goal setting, self-monitoring to attain the goals. Brain based learning technique helps in constructing new ideas through reflection, organizing it in sequences of brain compatibility i.e. assimilating new knowledge to already existing knowledge and accommodating new with brain compatible form.

Science teachers may benefited from the outcome of the research study because it may provide them information necessary to understand brain compatibility and reasoning patterns of the students and how to design instruction to meet the cognitive demand of the students. This study might be helpful for the curriculum developer to redesign the curriculum based on researches of brain science. The study may benefit the guidance counselors who could use learners' cognitive structure and development as a tool for diagnosis and remediation.

Methodology

a) Design of the study

The central purpose of the study was to examine the effect of Brain Based Learning Strategies on learning achievement in Science of secondary school students. Thus the researcher used true experimental design i.e. Campbell and Stanley's (1963) Pretest-Posttest Control Group Design was used. The diagram of design of current study has been presented in the figure-1

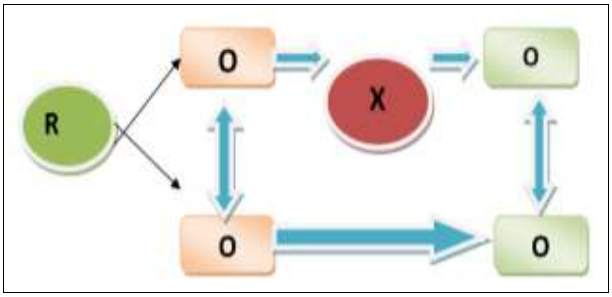

Fig 1: Diagram of Pre-Posttest Control Group Design

b) Population and participants

The target population of the study consisted of all higher secondary school students. The accessible population of the study was all higher secondary students of Balasore, district of Odisha. The researcher has purposively selected Rural Institute of Higher Studies (RIHS), Bhograi, Balasore as the research site of the study. 256 students had been enrolled in Class-XI (+2) of Science stream of RIHS. There were two sections (A & B) having 128 students in each section. The researcher had selected section B for the study by employing lottery method of simple random sampling technique. After verification of the attendance it was found that 96 students of section B had been attending the classes regularly. Finally, the researcher included all 96 students of section-B in the study after getting their consent for participation in the experiment.

In order to form two groups (control and experimental), all 96 students of Class-XI, section-B were taken. The researcher administered Kolb's Learning Style Inventory to ensure the equalization of groups with respect to learning styles. The performance of students on Kolb's Learning Style Inventory revealed that there were 22 Activist (A) learners, 24 Reflector (R) learners, 22 Pragmatist(P) learners, 20 Theorist (T) learners, 03 Activist & Theorist (A&T) learners, 03 Reflector & Theorist (R&T) learners, 01 Reflector learner and 01 Pragmatist (R&P) learner. Taking into consideration of different learning style among learners, the researcher has randomly assigned equally 11 activist learners, 12 reflective learners, 11 pragmatist learners, 10 theorist learners, 01 Activist & Theorist (A&T) learner, 01 Reflector & Theorist learner to each group. The remaining four learners one each from Activist & Theorist (A&T), Reflector & Theorist(R&T), Reflector & Pragmatist and Activist & Pragmatist (A&P) were randomly assigned 02 learners to each group.

The researcher has selected Group-A by using lottery method of simple random sampling techniques for experimental purpose. The Group-B was taught through conventional method as control group. The random sampling technique was employed to select the sample. The sample for this study was comprised of 96 class XI students. The age ranges from 15 – 17 years. The medium of instruction was English. The details of the sample size of the students given in the table-1.0.

Table 1: Detail Sample Size of the Students

Sl. No	Section	Group	Gender		No. of students
			Male	Female	
01	A	Experimental	28	20	48
02	B	Control	29	19	48
Total			57	39	96

a) Instruments for data collection

Data were collected by using Kolb's Learning Style Inventory and self-developed Science Achievement Test (SAT).

1. Kolb's learning style inventory

This inventory is designed to find out the preferred learning styles(s) of learner. Over the years, probably they may have developed learning habits/style(s). The test consists of 80 items spread over 5 different areas. There is no right and wrong responses as well as no time limits. The manual for learning style inventory reported through split-half correlation coefficients to suggest that the instrument is internally consistent. The reliability coefficient is 0.82.

In order to form two groups (control and experimental), all 96 students of Class-XI, section-B were taken. The researcher administered Kolb's Learning Style Inventory to ensure the equalization of groups with respect to learning styles. The performance of students on Kolb's Learning Style Inventory revealed that there were 22 Activist (A) learners, 24 Reflector (R) learners, 22 Pragmatist(P) learners, 20 Theorist (T) learners, 03 Activist & Theorist (A&T) learners, 03 Reflector & Theorist (R&T) learners, 01 Reflector learner and 01 Pragmatist (R&P) learner. Taking into consideration of different learning style among learners, the researcher has randomly assigned equally 11 activist learners, 12 reflective learners, 11 pragmatist learners, 10 theorist learners, 01 Activist & Theorist (A&T) learner, 01 Reflector & Theorist learner to each group. The remaining four learners one each from Activist & Theorist (A&T), Reflector & Theorist(R&T), Reflector & Pragmatist and Activist & Pragmatist(A&P) were randomly assigned 02 learners to each group. The details of the distribution learners into groups (Group A &B) on the basis of results obtained from Kolbe's Learning Style Inventory has been given in figure no 2.0.

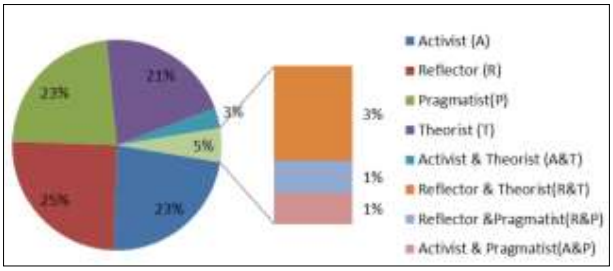

Fig 2: Percentage of learners with respective learning style

2. Science achievement test (sat)

a) Construction of preliminary draft of the test

In this step the investigator constructed the preliminary draft of the test to assess the achievement of students. The test was constructed in such a way that they compelled the students to recall, recognize, reasons and analysis. The entire questions are objective in nature. There are 60 items of 1 mark each. The questions are well directed and clear. Instructions are clearly mentioned on the test. Total time allotted was 1 hour and 30 minutes.

b) Collection of data for item analysis

In item analysis the initial draft of the test was administered in order to select items for the final draft. In this process some items were selected and some are rejected. The total numbers of items are 60 multiple choice questions and the time allotted was for 1 hour and 30 minutes. The answer sheets were collected after the due time allotted. The correct responses are provided with one mark and the incorrect responses are provided with no marks.

The obtained scores were categorized as higher class of top 27% of the total number of students and lower 27% of the total number of students. From the both group item wise total number of students who gave correct responses was found out. The questions having negative validity and validity less than 0.15 were rejected simultaneously. Similarly items wise difficulty value lied between 0 – 0.20

were also rejected which is mentioned in the table accordingly

c) Determining the final draft of the achievement test

On the basis of item analysis, the final draft of the test was determined. The final draft included total number of 40 items of one marks each. The weightage given to each aspect is given as under:

Table 2: Topic wise number of items, marks and weightage.

Sl. No.	Aspects	Number of items	Marks	Weightage
01	Cell: the unit of life (animal & plant)	18	18	45%
02	Structural organization of animal & plant (tissue system)	22	22	55 %
Total		40	40	100

d) Calculation of reliability coefficient

To assess the reliability coefficient test-retest method was applied. The final drafts of the test including 40 items were administered under the similar conditions on the same sample just after two weeks of the administration of the preliminary draft. The reliability coefficient was 0.869, which is found to be satisfactory.

Duration of the Treatment

The researcher had done the study for 12 weeks. He approached to the institute principal and assures him that he will complete the portion whatever their teacher yet to finish within 12 weeks. The researcher interacts well with the biology teachers and observed four classes of them so as to teach the control group.

Procedure of the Experiment and Data Collection

The experiment conducted for a period of twelve weeks. Before conducting experiment, the researcher observed four classes of the science teacher to know about the method of teaching and after that he planned to make two different groups (experimental and control group) and decided to gives some intervention to experimental groups in the form of brain based learning and as usual conventional teaching to control group students (as per the observation of their teacher by the researcher). Then the researcher developed lesson plans for experimental group using brain based learning strategies and control group using conventional methods for the period of twelve (12) weeks. Then the experimental and control groups were exposed to a pre–test in SAT to establish their equivalence before they were exposed to the brain based learning strategies and the conventional teaching methods, respectively. After conducting the pre-test assessment, the experimental group was taught the concepts and structure of Cell (animal & plant life) and structural organization of tissue system (animal & plant) for a period of twelve weeks duration, with brain based learning strategies. The control group was taught the same concepts for the same period of time with the conventional method. In the conventional teaching method, the main methods used were lecture- note-taking sessions, discussion and question and answer methods. After the intervention was over, experimental and control groups were exposed to a posttest in SAT to determine the impact of brain based learning strategies as a instructional tool on learning achievement in Science of the students. The pre-test and post-test scores were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA).

Results

1. Comparison of adjusted mean scores of achievement in science of brain based learning and conventional method groups by taking pre- achievement in science.

In order to find out mean difference between pre-test & post-test scores of Experimental and Control Group in terms of learning achievement, the investigator administered the standardized scale to assess. The requisite scores for finding the mean difference between the scores of Experimental and Control Group students were computed. The details has been given in table 3.0

Table 3: Mean Score Difference of Learning Achievement in Science between Experimental and Control Group after treatment**.**

Categories			Pre-test		Post test		
Variable	Groups	N	Mean	SD	Mean	SD	Gained mean
Learning Achievement in Biology	Experimental	48	18.12	7.78	32.06	7.95	13.94
	Control	48	19.16	7.24	25.41	5.94	6.25

It can be seen from the table no 3.0 that the mean pre-test score of Learning Achievement in science of experimental and control group is 18.12, 19.16and SD 7.78, 7.24 respectively. Also it can be seen that the mean post-test Learning Achievement score of experimental and control group is 32.06, 25.41 and SD 7.95, 5.94 respectively. It can be inferred that the mean gain score of Learning Achievement is 13.94 and 6.25 respectively. So it is cleared that the mean Learning Achievement score increased from pre-test to post-test.

The second objective was to compare adjusted mean scores of Achievement in Science of Brain Based Learning and conventional Method Groups by taking Pre- Achievement in Science. In this objective the levels of treatment were conventional teaching method and BBL method. The data obtained from the two groups were analyzed with the help of one Way Analysis of covariance.

In order to test whether the assumption of normality of scores holds good or not, test of normality was performed on learning achievement. The result of the Shapiro- wilk test has been summarized below in the table No.4.0.

Table 4: Test of normality of achievement scores in Science

Level of Treatment	Shapiro- wilk			
	Statistics	df	Exact significance	Significane Level
Experimental	.954	48	.059	> 0.05
Control	.978	48	.488	> 0.05

From the table 4.0 it is clear that the value of the Shapiro – Wilk statistics for traditional/control group is 0.978 whose significance value with df = 48 is 0.488. This value is greater than 0.05 and thus is not significant at 0.05 level of significance. In the light of this the null hypothesis "The given distribution for learning achievement does not deviate significantly from normality" is not rejected. Similarly the value of statistics for experimental group or brain based learning (BBL) group is 0.954 whose exact significance value with df = 48 is 0.059. This value is greater than 0.05

and thus is not significant at 0.05 level of significance. In the light of this null hypothesis that "The given distribution for learning achievement scores of experimental group do not deviate from normality is not rejected, thus it can be concluded that the learning achievement scores for experimental group and control group are distributed normally

The second assumption to be tested was that of homogeneity of error variance, for which leaven's test was applied using SPSS. The result have been summarized below in table no 5.0.

Table 5: Levene's test of equality of error variance

F	df1	df2	Exact significance	Significane Level
.020	1	94	.887	> 0.05

From the table no 5.0 it is clear that the F- value is 0.020 whose significance value with df = 94 is 0.887. This value is greater than 0.05 and hence is not significant at 0.05 level of significance. In the light of this that the null hypothesis that "The error variance of achievement is not significantly differ across the groups" is not rejected. Thus it can be concluded that the variance of learning achievement score is equal across the groups. Therefore the results of the test of normality and test of homogeneity of variance indicate that the assumption of ANCOVA hold good in the context of the given data, so the investigator is justified in proceeding with the use of one-way ANCOVA for data analysis of the objective.

Table 6: Summary of one – way ANCOVA of achievement scores in science by taking pre- achievement as covariate

Source of variation	df	SS y. x	MSS y. x	F y. x	Exact significance	Significance Level
Treatment	1	1253.930	1253.930	40.598	.000	< 0.01
Error	93	2872.413	30.886			
Total	96	84989.000				

**Significant at 0.01 level

From Table No.9.0 it is seen that the adjusted F-value for treatment is 40.598, whose significance value with df = (1, 93) is 0.000. This value is lesser than 0.01 and hence is significant at 0.01 level of significance. It indicate that the adjusted mean score of learning achievement of student taught through Brain Based Learning (BBL) and conventional method differ significantly when pre- learning achievement was taken as covariate. In the light of this the null hypothesis that "There is no significant difference in adjusted mean scores of learning achievement of students belongs to BBL group and traditional group while pre-learning achievement was taken as covariate is rejected. Further, it has been found that the adjusted mean scores of learning achievement of students taught through BBL is 32.06 which is higher than the corresponding mean score 25.41 of student taught through traditional methods when their mean score were adjusted with respect to learning achievement. Therefore it may be concluded that the BBL was found to be significantly effective than the traditional method in enhancing learning achievement

2. Effect of treatment, gender and their interaction on achievement in science by taking pre- achievement in science

In order to test whether the assumption of normality of scores holds good or not, test of normality was performed on self-regulation of Experimental, control and male, Female respectively. The result of the Shapiro- Wilk test has been summarized below in the table No.5.5

Table 7: Test of normality of learning achievement scores for experimental and control group.

Level of Treatment	Shapiro- Wilk			
	Statistics	df	Exact significance	Significance Level
Experimental	.954	48	.059	> 0.05
Control	.978	48	.488	> 0.05

From the table 7.0 it is clear that the value of the Shapiro – Wilk statistics for traditional/control group is 0.978 whose significance value with df = 48 is 0.488. This value is greater than 0.05 and thus is not significant at 0.05 level of significance. In the light of this the null hypothesis "The given distribution for learning achievement does not deviate significantly from normality" is not rejected. Similarly the value of statistics for experimental group or brain based learning (BBL) group is 0.954 whose exact significance value with df = 48 is 0.059. This value is greater than 0.05 and thus is not significant at 0.05 level of significance. In the light of this null hypothesis that "The given distribution for learning achievement scores of experimental group do not deviate from normality is not rejected, thus it can be concluded that the learning achievement scores for experimental group and control group are distributed normally.

Table 8: Test of normality of learning achievement scores for male and female

Level of Treatment	Shapiro- wilk			
	Statistics	df	Exact significance	Significance Level
Female	.974	39	.499	> 0.05
Male	.973	57	.229	> 0.05

From the table 8.0 it is clear that the value of the Shapiro – Wilk statistics for female is 0.974 whose significance value with df = 39 is 0.499. This value is greater than 0.05 and thus is not significant at 0.05 level of significance. In the light of this the null hypothesis "The given distribution for female learning achievement score does not deviate significantly from normality" is not rejected. Similarly the value of statistics for male learning achievement is 0.973 whose exact significance value with df = 57 is 0.229. This value is greater than 0.05 and thus is not significant at 0.05 level of significance. In the light of this null hypothesis that "The given distribution for learning achievement scores of female do not deviate from normality is not rejected, thus it can be concluded that the self-regulation scores for male and female are distributed normally.

The second assumption to be tested was that of homogeneity

of error variance, for which leaven's test was applied using SPSS. The result have been summarized below in table no 5.7

Table 9: Levene's test of equality of error variance

F	df1	df2	Exact significance	Significance Level
.018	3	92	.997	> 0.05

From the table no 9.0 it is clear that the F- value is 0.018 whose significance value with df = 92 is 0.997. This value is greater than 0.05 and hence is not significant at 0.05 level of significance. In the light of this that the null hypothesis that "The error variance of learning achievement is not significantly differ across the male and female students" is not rejected. Thus it can be concluded that the variance of learning achievement score is equal across the groups.

Therefore the results of the test of normality and test of homogeneity of variance indicate that the assumption of ANCOVA hold good in the context of the given data, so the investigator is justified in proceeding with the use of one-way ANCOVA for data analysis of the objective.

Table 10: Summary of one – way ANCOVA of achievement scores in science by taking pre- achievement as covariate

Source of variation	df	SS y. x	MSS y. x	F y. x	Exact significance	Significane Level
Treatment	1	30.300	1271.24	40.86	.000	< 0.01
Error	91	2831.117	31.111			
Total	96	84989.000				

**Significant at 0.01 level

From Table No.10.0 it is evident that the adjusted F-value for treatment is 40.86, whose significance value with df = (1, 91) is 0.00. This value is lesser than 0.01 and hence is significant at 0.01 level of significance. It indicate that the adjusted mean score of learning achievement in science of male and female differ significantly. In the light of this the null hypothesis that "There is no significant difference in mean gain scores of learning achievement of students belongs to male and female group is rejected. Hence it can be concluded that the achievement in science of students is dependent of their gender.

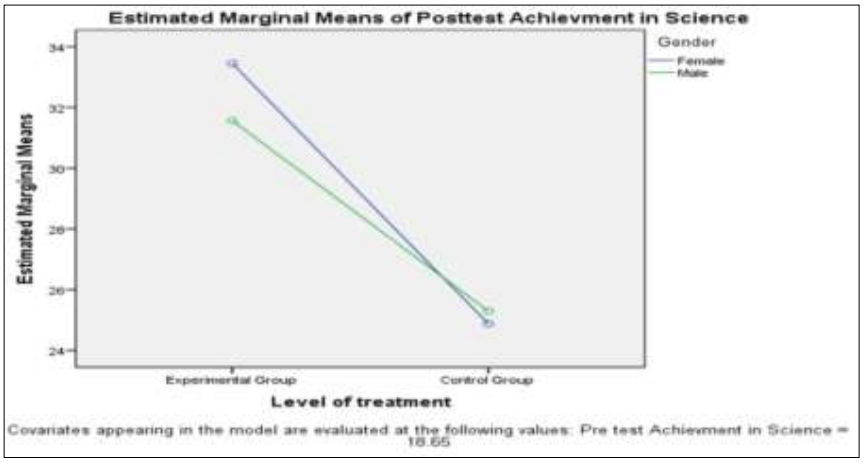

Fig 3: learning achievement of students and their interaction with gender

From the graph no: 3.0 it is evident that the learning achievement of students is dependent of their gender and female appears to be significantly higher learning achievement than male students

Findings

1. The Brain Based Learning strategies was found to be significantly superior to traditional method in terms of learning achievement when pre- learning achievement was taken as covariate.
2. The achievement in science of students was found to be dependent of their gender.

Discussion and Conclusion

1. Comparison of brain based learning strategy with traditional method in terms of learning achievement in science when pre- achievement in science was taken as covariate.

The adjusted F-value for treatment group is 40.598, whose significance value with df = (1, 93) is 0.000. This value is lesser than 0.01 and hence is significant at 0.01 level of significance. It indicate that the adjusted mean score of learning achievement of student taught through Brain Based Learning (BBL) and conventional method differ significantly when pre- learning achievement was taken as covariate The Brain Based Learning strategy was found to be significantly superior to traditional method in terms of learning achievement in science when pre- achievement in science was taken as covariate. This result is in accordance with the findings of Mojavezi and Tamiz (2012) [23], who reported that the result of one way ANOVA reveled that there is a significant difference between the groups based on their achievement. Gozuyesil and Dikici (2014) [27] reveled that brain based learning has a positive, but medium effect on students academic achievement. Akyurek, Erkan; Afacan, Ozlem (2013) [25], using brain-based learning approach the experimental group's success was found to be significant differences in favor of the experimental group.

Brain-based learning approach used in the experimental group's achievement test scores of control group's achievement was determined to be statistically differing in favor of the experimental group. Bilal Duman (2010) [17], the findings of the study revealed that the BBL approach used in the experimental group was more effective in increasing student achievement than the traditional approach used in the control group. Felicidad T Villavicencio, Allan B. I Bernardo, (2013) [26] Positive Academic Emotions Moderate the Relationship between Self-Regulation and Academic Achievement.

2. Comparison of the achievement in science of students in terms of their gender

The fourth objective of the study was to study the effect of Treatment, Gender and their interaction on learning achievement in science by taking Pre learning achievement in science as covariate. On analysis it was found that The achievement in science of students was found to be dependent of their gender Both males and females were benefited from the brain based learning in terms of learning achievement in science in comparison to conventional Method when groups were matched statistically i.e. the adjusted F-value for treatment is 40.86, whose significance value with df = (1, 91) is 0.00. This value is lesser than 0.01 and hence is significant at 0.01 level of significance. It indicate that the adjusted mean score of learning achievement in science of male and female differ significantly. This finding indicates that Gender may be kept in mind while developing brain based learning (BBL) package on learning achievement in science. The brain based learning (BBL) package may not same for both males and females in respect of content, sequence, examples, etc. There was no gender bias in developing the brain based learning (BBL) package for this study. The BBL package contains the same content as presented in the print form in books. The books are same for males and females. Not only this, the Methods of teaching are not different for males and females. Further, the content of BBL package with different strategies and examples were to the level of both males and females. They were able to understand the subject matter. The freedom given was same for males and females. Both males and females asked questions to teacher that was replied to the satisfaction of both males and females. This might be the reason for this finding. From the discussion it may be concluded that the brain-based learning approach is helpful for learning achievement in science among the adolescence. At the same time it is not a panacea for all learning, but it can be used to develop strategies that are based on the current available research.

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