



Efficacy of Brain Based Teaching on Achievement in Biology: Effect of Gender and Intelligence

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Abstract: This quasi-experimental study employed a pre-test post-test control group design to find out the effectiveness of brain-based teaching on achievement in biology among higher secondary school students. The study further explored the differential effect of gender and intelligence on achievement in biology when brain-based teaching is adopted. Four intact classrooms of higher secondary school students (n = 162) were selected from two higher secondary schools of Malappuram district (Kerala) and assigned to control group (n = 85) and experimental group (n = 77). Four chapters of prescribed biology textbook was taught to the groups in 20 classroom hours (50 minutes duration), spreading over 44 days. The control group was taught by the traditional activity method of teaching and the experimental group by brain-based teaching strategies. Pre-intervention and post-intervention measure of achievement in biology was done with 50-item MCQ achievement test. The intelligence of the participants was assessed once with Raven's Progressive Matrices. Analysis of the data revealed that brain-based teaching is superior to activity method of teaching in accomplishing instructional objectives of biology. Gender was found to exert a significant decisive role in the success of brain-based teaching which is more effective with boys than with girls. Brain-based teaching is equally effective for learners with different levels of intelligence.

Key words: Brain-based teaching, Activity method of teaching, Academic achievement in biology.

Introduction

The search for newer methods of teaching is never ending as there is no single method which meet the learning needs of all learners and teaching needs of all teachers either. Practicable methods should be learner-friendly, teacher-friendly and topic-friendly as well. Cognitive science has contributed a lot to make learning an effective and enjoyable business. One such contribution of cognitive psychology and neuroscience is brain-based learning (BBL), where learning takes place in accordance with the way in which the brain is naturally designed to learn. Human brain is designed to gather information from the environment, process them, generate meaning and retain them as long as brain is not prohibited from fulfilling its normal processes (Jensen, 2011; Yasar, 2017). In brain-based classrooms the teacher applies instructional strategies to align with the way the brain learns naturally when exposed to real-life experiences (Winter, 2019; Noreen, Awan & Fatima, 2017). Different than traditional methods, brain-based learning emphasizes meaningful learning instead of memorization. In other words, the brain does not easily learn things that are not logical or meaningful and that structuring constructing is important (Okatahi, Apeh & Iyiegbuniwe, 2020; Duman, 2010). Biology, as a school subject, has long been considered as an easy subject for secondary school students, where achievement is significantly higher than that of subjects like Mathematics, English, Physics, Chemistry (Nair & Bindu, 2016). An increasing trend in underachievement in biology among higher secondary school students of Kerala has been reported from a four year long longitudinal study by Alex (2019). Biology in higher secondary school students is a very important subject as it forms the base for many professional courses in Medicine, Nursing, Pharmacy, Agriculture, Veterinary science, Fishery, Forestry etc. The search for better instructional strategies which are interesting and challenging for both learners and teachers motivated the investigator to experiment with brain-based teaching for its effectiveness in teaching biology.

Objectives of the Study

This study has the following specific objectives in view:

1. To find out the effectiveness of brain-based teaching on achievement in biology of higher secondary school students.
2. To find out the differential effect of gender and intelligence on the effectiveness of brain-based teaching on achievement in biology of higher secondary school students.

Hypotheses of the Study

The following null hypotheses were tested for the study:

1. Hypothesis H_0 (1): There is no significant difference between brain-based teaching and activity method of teaching in terms of achievement of higher secondary school students in biology.
2. Hypothesis H_0 (2): Gender has no significant differential effect on achievement in biology of higher secondary school students taught by brain-based teaching.
3. Hypothesis H_0 (3): Intelligence has no significant differential effect on achievement in biology of higher secondary school students taught by brain-based teaching.

Methodology

The pre-test post-test non-randomized control group design was employed for the study. Four intact classes of eleventh grade (Plus One) students selected from two different schools in Malappuram district (Kerala, India) was assigned to control group ($n = 85$) and experimental group ($n = 77$). The participants in both groups were pre-tested and post-tested for achievement in biology with the help of a 50-item objective type (MCQ) achievement test having acceptable validity and reliability. Four lessons from the prescribed Biology Textbook was taught to both the groups, the control group with traditional activity method of teaching and the experimental group with brain-based teaching. The pedagogic intervention was completed in 20 classes each of 50 minutes duration, spread over 44 days. Intelligence of the participants in each groups was measured with the help of Raven's Progressive Matrices of Intelligence (Raven, 1958). The data were collected and analysed statistically by employing independent sample t-test, paired sample t-test, one way ANCOVA and one way ANOVA with the help of SPSS (version 17.0 for Windows).

Analysis and Interpretation

The control group and experimental group were compared with respect to the pre-test scores of achievement in biology so as to find out the significant difference, if any, before the pedagogic intervention. The data and result of the independent sample t-test is presented in Table 1.

Table 1: Comparison of pre-test scores of control group and experimental group

Samples	N	M	SD	SE _M	t-value	Sig.
Control	85	3.34	1.350	.146	0.845	NS
Experimental	77	3.16	1.442	.164		

The t-value estimated is not significant ($t = 0.845$; $p > .05$), revealing that the control group and experimental group are almost alike before the pedagogic intervention.

The pre-test scores and post-test scores cores of achievement in biology, obtained for the experimental group, were compared to find out whether the pedagogic intervention has contributed considerable achievement of the learners. The data and result of paired sample t-test done in this regard is given in Table 2.

Table 2: Comparison of pre-test and post-test scores of experimental group

Samples	N	M	SD	SE _M	t-value	Sig.
Pre-test	77	3.16	1.442	.164	52.540	.001
Post-test	77	33.97	5.993	.683		

The t-value estimated is significant ($t = 52.540$; $p < .001$). The fact, the post-test scores surpasses the pre-test scores reveals the significant improvement in achievement made by the learners due to experimental intervention.

The pre-test and post-test scores of learners in the control group was also compared to find out whether activity method of teaching (control teaching) was also effective in terms of achievement of learners. Table 3 presents the data and result of the paired sample t-test performed in this context.

Table 3: Comparison of pre-test and post-test scores of control group

Samples	N	M	SD	SE _M	t-value	Sig.
Pre-test	85	3.34	1.350	.146	44.779	.001
Post-test	85	26.15	5.459	.592		

The t-value estimated is significant at 99.9% confidence interval ($t = 44.779$; $p < .001$), exposing that the control teaching is also effective in causing significant achievement in biology.

In order to find out whether brain-based teaching is superior to the traditional method of teaching biology to higher secondary school students, the post-test scores of achievement of the control group and the experimental group were compared by partialling

out the effect of pre-test scores by employing one-way ANCOVA. The data and result of the tests of between subjects effect performed is given in Table 4.

Table 4: Result of the ANCOVA of the post-test scores of achievement in biology of control group and experimental group

Dependent Variable: Post-test scores of Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4732.349a	2	2366.174	126.592	.000	4732.349a
Intercept	11323.855	1	11323.855	605.833	.000	11323.855
Pre-test	2261.031	1	2261.031	120.967	.000	2261.031
Group	2784.666	1	2784.666	148.981	.000	2784.666
Error	2971.929	159	18.691			2971.929
Total	152247.000	162				152247.000
Corrected Total	7704.278	161				7704.278

a. R Squared = .808 (Adjusted R Squared = .800)

The F-value obtained on comparing the post-test scores of achievement in biology for the control group and experimental group, after controlling for the effect of pre-test scores, is significant ($F = 148.981$; $p < .001$). It shows that there is statistically significant difference between students taught by activity method of teaching and those taught by brain-based teaching with respect to their true achievement in biology. Inspection of the marginal means estimated for the control group ($M = 25.916$; $SE_M = 0.469$) and experimental group ($M = 34.236$; $SE_M = 0.493$) shows that learners taught by brain-based teaching excels their counter parts taught by the traditional activity method of teaching.

In order to find out the differential effect of gender on the effectiveness of brain-based teaching on the achievement in biology, the boys and girls in the experimental group were compared in terms of the gain scores (posttest scores minus pretest scores) of achievement. The data and result of the independent sample t-test done in this context is given in Table 5.

Table 5: Comparison of the gain scores of boys and girls in the experimental group

Samples	N	M	SD	SE _M	t-value	Sig.
Boys	36	33.22	4.73	.788	4.250	.001
Girls	41	28.71	4.58	.716		

The estimated t-value is significant ($t = 4.250$; $p < .001$), revealing the presence of a true difference between boys and girls with respect to the actual gain they made in terms of achievement in biology. A closer observation of the mean scores shows that the achievement of boys is significantly higher than that of girls.

In order to find out the differential effect of intelligence on the effectiveness of brain-based teaching on achievement in biology, the participants in the experimental group were categorized into high, average and low intelligent groups based on the scores on Raven's Progressive Matrices. One way ANOVA was then performed to find out whether the high, average and low intelligent learners differ significantly with respect to their gain scores of achievement in biology. The summary of the ANOVA performed in this connection is given in Table 6.

Table 6: Comparison of high, average and low intelligent students in the experimental group with respect to the gain scores of achievement in biology (Summary of ANOVA)

Achievement	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42.699	2	21.349	0.802	NS
Within Groups	1970.756	74	26.632		
Total	2013.455	76			

The result of the one-way analysis of variance shows that there is no significant difference among learners with high, average and low intelligence with respect to the gain score of their achievement in biology ($F = 0.802$; $p > .05$). It exposes that learners in different levels of intelligence have accomplished instructional objectives of biology almost equally when taught by brain-based teaching.

Conclusions

1. The achievement in biology made by students taught by brain-based teaching is significantly higher than that of students taught by activity method of teaching, even after adjusting for their previous knowledge. The brain-based teaching is superior to prevailing activity method for teaching biology in higher secondary schools. Hypothesis H₀ (1) (*there is no significant difference between brain-based teaching and activity method of teaching in terms of achievement of higher secondary school students in biology*) is, subsequently, rejected.
2. Gender of the learner was found to be a significant decisive factor that discriminate higher secondary school students on the basis of their achievement in biology when taught by brain-based teaching strategies. The boys excelled girls in their achievement in biology when taught by brain-based approach. Hypothesis H₀ (2) (*gender has no significant differential effect on achievement in biology of higher secondary school students taught by brain-based teaching*) is, hence rejected.
3. Higher secondary school students with different levels of intelligence are almost alike in their achievement in biology when taught by brain-based teaching strategies. No true difference was noticed among high, average and low intelligent learners with respect to the achievement they made when taught by brain-based teaching strategies. Hypothesis H₀ (3) (*intelligence has no significant differential effect on achievement in biology of higher secondary school students taught by brain-based teaching*) is, therefore, accepted.

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