

EFFECT OF BRAIN-BASED LEARNING ON CRITICAL THINKING OF
GENERAL SCIENCE STUDENTS AT ELEMENTARY LEVEL

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Abstract

The purpose of this study was to evaluate the effect of based on brain-based learning to teach General Science for enhancing students critical thinking. The study was experimental in nature and used pretest posttest control group design. The target population for this experimental study was all General Science students from Kotli district. The study conducted by using two groups that was experimental group and control group and thirty students in each group were randomly selected. Four units (9,10, 11 and 12) were selected from General Science textbook of 8th class published by Azad Jammu and Kashmir Text-book Board, 2023 for this experiment. The researcher developed 32 lesson plans from theses selected units to treat the control and experimental groups. The critical thinking test developed by Alson King was adapted as research instruments were applied before and after intervention as pretest and post-test respectively. The control group of students was taught through traditional method and experimental group of students was taught through brain-based method for eight weeks. After the last session of intervention same pretest was administrated as posttest. Collected data was analyzed by using Statistical Package for the Social Sciences (SPSS) version 23. The researcher used paired sample t-test for testing the research hypotheses. The findings of the study confirmed that brain-based method was effective to improve critical thinking of students in General Science subject. It was concluded that using brain-based method to teach General Science subject has significantly better results in improving critical thinking of students than traditional method. Moreover, critical thinking of students can be improved in General Science subject at elementary level if teachers apply brain-based method in classrooms.

Keywords: Brain-based method, Traditional method, Critical thinking, and Academic achievement, Elementary level.

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INTRODUCTION

A learning process is defined as interdisciplinary that use brain-based instruction can be focused to answer of the question that what is the most efficient way for the brain learning mechanisms?" Brain-based instruction used such teaching strategies that enhance or improve abilities of learners to integrate and process the information into meaningful ways. Brain based learning also focus on how the learner brain processes information into meaningful way full his /her in depth and thoughtful understanding of concepts. In such type of instruction, teachers are suggested not to match characteristics of learners with their learning styles or with the subject matter or presentation method.

BACKGROUND OF THE STUDY

Brain-based learning aims to enhance learning potential and provides educators with a pedagogical framework compared to traditional methods and models. Applying brain-based instruction to learning may improve academic performance (Duman, 2006). The brain sustainably reorganizes itself through experiences that shape neural routes that will determine how our brain learns. The brain is continuously involved in processes that transfer information from its temporary to long-term memory.

According to Suparta (2018) teachers guide, promote, counsel and instruct their students in their learning, growth and development simply through providing relevant content and methods based on their intellectual abilities. Any intellectually compatible environment enables students to construct their own idea about the meanings of the concept and demonstrate their knowledge through tactful, creative and advance methods; students' intrinsic motivation, positive self-perception and sense of responsibility develop as they interact, cooperate and collaborate in learning situations to become more active participants in the educational process. Additionally, the curriculum must reflect on natural connections to real-life experiences of students. Furthermore, curriculum must be purposeful, comprehensive and meaningful and also based on any particular theme that involves such strategies to fulfill learners' educational needs for their better understanding.

Saleh and Neamah (2020) remarked that brain-based instruction emphasized on how the brain can learns better rather than what to learn. In a meaningful way, the brain receives information but insignificance forces may inhibit the brain functions in processing that information. The brain is considered as the center of intelligence which includes different components like memory, perception, cognition, emotion and attention.

CRITICAL THINKING

Critical thinking is the process of systematically evaluating statements, results, arguments, and experiences to form a reasoned judgment or conclusion. It also assesses the precision, authenticity and validity of data. It is also called a judgment of the statement based on the information received. It evaluates the value and validity of existing knowledge and information. It involves precise, persistent, and objective analysis to justify any argument (Vieira & Tenreiro, 2016). Critical thinking skills are one of the most important skills connecting to the higher-order thinking skills needed for 21st century education. By integrating critical thinking skills into 21st century education systems, education systems will be able to support "long-term learning, problem solving, self-management and physical education".

DEFINING CRITICAL THINKING

In modern education settings critical thinking is now a frequently used term. To understand this term bitterly there are several definitions of critical thinking which are also discussed in this literature. According to Hildebrand (2022) John Dewey believed that

critical thinking is reflective thinking which requires proper mental action to resolve uncertainty, hesitation, or psychological challenges. Paul (2010) defines critical thinking as thinking about thinking. He believes that critical thinking includes psychological skills such as forming hypotheses, looking at problems from multiple perspectives, asking questions, and providing solutions to problems.

STATEMENT OF THE PROBLEM

The theoretical knowledge is commonly in practiced at elementary schools' level that only promotes rote memorization of facts. General Science is included as a compulsory subject in the curriculum at elementary school level. The major objective of teaching General Science is to enhance the critical thinking of students about scientific knowledge. Though General Science textbook is a practical subject which demands innovative techniques for teaching and learning for content understanding. Students learn General Science only through traditional method and there is no practical work. Therefore, experimental study was conducted to explore the effect of brain-based method on critical thinking among General Science students at elementary level.

SIGNIFICANCE OF THE STUDY

This study can be significant for teachers and students to address the lacks in critical thinking skills. The findings of the study can be important to enhance the vision of school administration to promote interactive environment in the classrooms to enhance critical thinking of students. The findings of the study maybe fruitful in revising the General Science curriculum.

OBJECTIVES OF THE STUDY

The objectives of this study were as follows:

1. To determine the effect of brain-based method on students critical thinking in General Science at elementary level.
2. To investigate the effect of traditional method on students critical thinking in General Science at elementary level.

RESEARCH HYPOTHESES

The research hypotheses of this study were as follows:

H₀₁: There is no significant difference in the mean score of students critical thinking taught through brain-based method.

H₀₂: There is no significant difference in the mean score of students critical thinking taught through traditional method.

DELIMITATION OF THE STUDY

The study was delimited to 8th grade General Science students from District Kotli Azad Jammu and Kashmir, Pakistan. Through purposive sampling study was delimited to 60 elementary school students at Government Boys High School Panag Sharif district Kotli.

RESEARCH METHODOLOGY

The research methodology outlines the approach for gathering and analyzing information, as well as the experimental aspects of the study.

RESEARCH DESIGN

This was experimental study which employed a true experimental design with pretest posttest control group design. According to Mackenzie and Knipe (2006), a true experimental design used to establish cause and effect relationships between two or variables by manipulating these variables and randomly assigning participants to different groups in a controlled environment. In this design, random distribution ensures that every participant has equal chances of selection.

POPULATION AND SAMPLE

The population of the study comprised all 8th-grade General Science students from District Kotli, Azad Jammu and Kashmir. Purposive sampling technique was used and one school, Government Boys High School Panag Sharif was selected as no other school from the district have required number of students. The researcher selected sixty students as the sample of this study.

INSTRUMENTS

Critical Thinking Test developed by Alison King in 2017 at Brown University USA was adapted as research instrument and used to measure critical thinking in this study.

VALIDITY OF INSTRUMENT

To refine the test items developed by the researcher, the following procedures were implemented:

1. Ensured that test items were proportionately aligned with the respective tables of specification for each chapter.
2. Obtained feedback from educational experts.

LESSON PLANS FOR BOTH GROUPS (CONTROL AND EXPERIMENTAL)

Lesson plans for control groups were developed using the traditional teaching method and lesson plans for experimental group were developed using the brain-based method.

DATA COLLECTION

An experimental research design was used to conduct this study and the researcher formulate two main groups and further divide these groups randomly into control and experimental groups. After this pretest was given to all the students and results were collected. After the treatment of eight weeks same test with rearranged items were taken from control and experimental groups and results were collected

DATA ANALYSES

Collected data was analyzed by using Statistical Package for the Social Sciences (SPSS) version 23. The researcher use paired sample t-test for testing the research hypotheses. Paired sample t-test for -test was used to compare the score of pretest and posttest.

COMPARISON OF EXPERIMENTAL AND CONTROL GROUP BEFORE INTERVENTION

Data received from pretest of experimental and control group before intervention. The data were analyzed to test the knowledge of the sample in 8th grade students in general science subject before the intervention.

TABLE NO 1: PRETEST SCORE OF CRITICAL THINKING

	Group	N	Mean	Std. Dev.	t	df	P value
Pretest score	Experimental	30	4.43	3.617	.391	58	.697
	Control	30	4.07	3.638			

Table 1 shows the pretest results for students in both the experimental and control groups before intervention. The mean score of experimental group was 4.43, compared to 4.07 for the control group and standard deviation was 3.617 and 3.638 respectively. The slightly higher standard deviation in the control group indicates a greater spread in their scores compared to the experimental group. The significance level of the difference between the two groups was 0.697, which is greater than the alpha value of 0.05, and the t-value was



0.391, which is statistically insignificant. Therefore, the analysis indicated no significant difference between both groups regarding critical thinking skill before the intervention.

TABLE NO 2: CRITICAL THINKING OF CONTROL GROUP

	Group	N	Mean	Std. Deviation	Correlation (Sig)	Sig (2-tailed)
Pair 1	Pre test	30	4.07	3.638	.726 (.000)	.000
	Post test	30	9.23	5.177		

Table 2 shows that the critical thinking scores were assessed by comparing pretest and post-test results. The mean scores for the pretest and post-test were 4.07 and 9.23 which showed the mean score difference of 5.16. While standard deviation was 3.638 and 5.177 respectively, indicating that post-test scores were more dispersed than pretest scores. The improvement in mean scores suggests that students' critical thinking skills improved after the intervention.

The correlation between the pretest and post-test scores was 0.726, with a significance level of 0.000, indicating a positive correlation and an increase in critical thinking. Since the significance level of 0.00 is less than the alpha value of 0.05, it confirmed a significant improvement in critical thinking skills among students in the control group after the intervention.

CRITICAL THINKING OF EXPERIMENTAL GROUP

TABLE NO 3: CRITICAL THINKING OF EXPERIMENTAL GROUP

	Group	N	Mean	Std. Deviation	Correlation (Sig)	Sig (2-tailed)
Pair 1	Pre test	30	4.43	3.617	.18 (.44)	.000
	Post test	30	18.53	5.406		

Table 3 shows that the critical thinking scores were evaluated based on the difference between pretest and post-test results. The calculated mean score of pretest was 4.43 and post-test score was 18.53. The standard deviation for the pretest was 3.617, whereas the post-test standard deviation was 18.53, indicating greater dispersion in post-test scores compared to pretest scores.

The correlation between pretest and post-test scores was 0.18, with a significance level of 0.44. Although this correlation is positive, it indicates a minor increase in critical thinking. The mean score difference between the pretest and post-test was 14.1. Since the significance level of 0.00 is below the alpha value of 0.05, it confirmed a statistically significant improvement in critical thinking skills among students in the experimental group following the intervention.

SIGNIFICANT EFFECT OF BRAIN BASED METHOD AND TRADITIONAL METHOD ON STUDENTS CRITICAL THINKING (HYPOTHESES H₀₁ AND H₀₂)

To analyze the hypotheses following analytical steps have been taken:

H₀₁: There is no significant effect of brain-based method on students critical thinking.

TABLE 4: *SIGNIFICANT EFFECT OF BRAIN-BASED METHOD ON STUDENTS' CRITICAL THINKING*

	Group	N	Mean	Std. Dev.	Correlation	t	df	p value Sig (2-tailed)
Mean score	Pretest	30	4.43	3.617	.622	-18.319	29	.000
	Posttest	30	22.43	6.826				

Table 4 displays that the mean scores were 4.43 for the pretest and 22.43 for the post-test, showing a substantial increase of 18.00 in the mean score post-intervention. This improvement indicates a significant enhancement in students' performance following the treatment. The standard deviations was 3.617 and 6.826 suggesting that the post-test scores were more dispersed compared to the pretest scores.

The correlation between the pretest and post-test scores was .622, which indicates a positive relationship and suggests that the critical thinking skills of students improved following the brain-based learning method. The t-value of -18.319 and the significance level (p-value) of 0.00, which is below the alpha value of 0.05, demonstrated a statistically significant difference in critical thinking before and after the intervention.

Consequently, the null hypothesis (H_{01}) stating that there is no significant difference in the mean score of the brain-based method on students' critical thinking was rejected. The alternative hypothesis (H_1), which posits that there is a significant difference, was accepted, supporting the effectiveness of the brain-based method in enhancing students' critical thinking skills.

H_{02} : There is no significant effect of traditional method on students critical thinking.

TABLE 5: *SIGNIFICANT EFFECT OF TRADITIONAL METHOD ON STUDENTS' CRITICAL THINKING*

	Group	N	Mean	Std. Dev.	Correlation	t	df	p value Sig (2-tailed)
Mean score	Pretest	30	4.07	3.638	.726	-7.942	29	.000
	Posttest	30	9.23	5.177				

Table 5 presents data from the mean scores for the pretest and post-test were 4.07 and 9.23, respectively, indicating a modest improvement in students' performance after the treatment. The standard deviations were 3.638 for the pretest and 5.177 for the post-test, reflecting a greater dispersion in post-test scores.

The correlation between the pretest and post-test scores was .726, demonstrating a positive relationship and suggesting an enhancement in critical thinking skills following traditional instruction. The t-value of -7.942 and the significance level (p-value) of 0.00, which is below the alpha threshold of 0.05, confirmed a statistically significant difference in critical thinking before and after the intervention.

So, the null hypothesis (H_{02}) stating that there is no significant difference in the mean score of the traditional method on students' critical thinking was rejected. Consequently, the alternative hypothesis (H_2) suggesting that there is a significant difference was accepted.

FINDINGS OF THE STUDY

Following findings were made from the analyses of the data.

The students of both groups; experimental and control were tested before the instruction. The pretest mean scores of experimental groups was 0.36 greater on average than the control group scores. The mean score of students of experimental group were 4.43 and control group were 4.07 (Table 4.1). Moreover, standard deviation in experimental and control group is 3.617 and 3.638. The control group data having slightly higher standard deviation shows that the control group data is less spread out or dispersed than the experimental group. The significance level of the difference remains .697 which is more from p value (0.05) and the calculated t value which is .391 is statically insignificant. This indicated that there is no significant difference in the mean score of both experimental and control group groups before intervention. Hence, on the basis of students' pretest scores, it is concluded that both groups remained equal in critical thinking test.

FINDINGS ABOUT OBJECTIVE 1: THE EFFECT OF BRAIN BASED METHOD ON STUDENTS CRITICAL THINKING

The table 4 findings indicated the difference in students critical thinking before and after the treatment. The calculated mean score of pre and post tests were 4.43 and 22.43 respectively. The difference in mean score (18.00) indicated improvement among students after treatment. In addition, the correlation in the pre and post test scores of 30 students in experimental group was .622 which was a positive correlation and indicate increasement of critical thinking of the sample after the treatment. Furthermore, the t-value is -18.319 and the level of significance (p value) was 0.00, which was less than p-value. This calculation indicated that there was a significance difference in pretest and post-test results confirmed that critical thinking of experimental group students, taught through brain-based method was improved after the intervention.

FINDINGS ABOUT OBJECTIVE 2: THE EFFECT OF TRADITIONAL METHOD ON STUDENTS CRITICAL THINKING

The findings of table no. 5 indicated the difference in critical thinking among students before and after the treatment. In addition, the mean score of pretest and post-test were 4.07 and 9.23 respectively which indicated a slight improvement among students after the intervention. Furthermore, the t-value is -7.942 and the p-value (level of significance) was 0.00 which was less than alpha value, indicated that there was a slight significance difference in critical thinking of students who taught through traditional method in control group.

DISCUSSION

The experimental research study was conducted to check the effect of brain-based learning on critical thinking and academic achievement of students. According to Lin (2018) in this modern era every teaching learning process requires that each student must be capable to acquire skills such as communication, problem solving and collaboration, innovation and creativity and most importantly critical thinking skill in order to improve their performance. Brain-based learning improves students' critical thinking skills (Juniatri, Subagia, & Rapi (2022); Anugrah (2022)).

The research study of Zaqiah, Hasanah, Wahyudin & Djohar (2022) highlighted the improvement of students' critical thinking skill of who were taught through BB method in experimental group as compare to traditional method. The results of present study support the above discussed findings of previous studies that brain-based learning improve students' critical thinking. Nasution, Zuela, & Rafli (2020) concluded that students critical

thinking ability we were taught through brain-based method. It was also concluded that experimental group students significantly perform better but there was also an improvement of control group students. The finding of current study also produced same results as students' performance is significantly improved through BB method after the intervention.

CONCLUSIONS

On the basis of findings of the study following conclusions have been drawn:

Brain-based method is more effective than traditional method at elementary level to teach general science because it enhances students learning as learner is considered active participant throughout teaching learning process.

Brain based method is also more effective than traditional method because this method ensures maximize engagement of human brain in a challenging but stress-free environment. Brain based method is effective than traditional method in better understanding of general science concepts in a challenging manner. Experimental group students' critical thinking is significantly high than the control group in general science subject at elementary level. This was due to experimental group students participate and interact with suitable and meaningful content and group discussion. In brain-based class students were also encouraged to ask questions for their better understanding of general science concepts.

RECOMMENDATIONS

1. Elementary teachers may have critical thinking skill and apply this skill in the classroom.
2. Brain-based method is a student-centered method which is equally useful to enhance critical thinking of students. So, it is recommended to apply this method by general science teachers in their class at elementary level to improve critical thinking of students.
3. Curriculum developer and textbook writers may design and develop such materials in textbooks which incorporate different ways of enhancing critical thinking among students.
4. This study was done on General Science subject at elementary level to check the effect of brain-based method on critical thinking of students, So, this method may be investigated on other science or arts subjects at the same or different level.

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