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DEVELOPMENT OF BRAIN BASED LEARNING PROGRAM FOR ENHANCING CRITICAL THINKING COMPETENCY AMONG SECONDARY SCHOOL STUDENTS AND VERIFY ITS EFFECTIVENESS

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ABSTRACT

In the present research work, the researcher employed a quantitative approach to develop a Brain-Based Learning (BBL) program aimed at enhancing critical thinking competencies among secondary school students and to verify its effectiveness. The study population comprised secondary school students, and a representative sample of 40 participants was selected using a probability sampling design, specifically the random sampling method, to ensure unbiased selection. The development phase involved designing a structured BBL program grounded in cognitive neuroscience principles and tailored to foster critical thinking skills, including analysis, evaluation, and problem-solving. The effectiveness of the program was assessed using a pre-test and post-test design with a validated critical thinking competency questionnaire. The findings indicate that the Brain-Based Learning program significantly improves critical thinking competencies among secondary school students, demonstrating its effectiveness as an educational strategy for fostering essential cognitive skills.

INTRODUCTION

Critical thinking is a cornerstone of 21st-century education, essential for empowering students to analyze, evaluate, and solve complex problems effectively. For secondary school students, developing critical thinking skills is particularly important, as it equips them for academic success, active citizenship, and lifelong learning. However, traditional teaching methods often fall short in fostering these skills, emphasizing rote memorization over higher-order thinking. Brain-Based Learning (BBL) offers a transformative approach to address these challenges. Introduced by Renate Nummela Caine and Geoffrey Caine, BBL is grounded in principles of cognitive neuroscience, emphasizing the alignment of educational practices with the brain's natural functioning.

The Caine and Caine proposed 12 core principles of Brain-Based Learning, which include:

1. The brain is a parallel processor.
2. Learning engages the entire physiology.
3. The search for meaning is innate.
4. The search for meaning occurs through patterning.
5. Emotions are critical to patterning.
6. The brain processes parts and wholes simultaneously.
7. Learning involves both focused attention and peripheral perception.

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8. Learning always involves conscious and unconscious processes.
9. We have at least two types of memory: spatial and rote.
10. Learning is developmental.
11. Complex learning is enhanced by challenge and inhibited by threat.
12. Each brain is uniquely organized.

These principles underline the holistic nature of learning, emphasizing the interplay between cognition, emotions, and environmental factors.

In addition to these principles, the Caine and Caine conceptualized BBL within three interactive dimensions:

1. **Relaxed Alertness:** Creating a low-stress, high-challenge environment that fosters engagement and reduces fear.
2. **Orchestrated Immersion:** Designing learning experiences that fully immerse students in meaningful and rich content.
3. **Active Processing:** Encouraging reflection and application of new knowledge to solidify understanding.

Background of the Study

In recent years, there has been a growing recognition of the need to equip students with critical thinking skills to navigate an increasingly complex and information-driven world. However, educational systems worldwide often prioritize content delivery over skill development, leaving students underprepared for real-world challenges.

Existing research highlights the potential of BBL to enhance learning outcomes across various domains, yet there remains limited exploration of its application in developing critical thinking skills specifically. This study aims to fill this gap by designing and implementing a BBL program tailored to enhance critical thinking among secondary school students, providing empirical evidence of its efficacy.

LITERATURE REVIEW

Critical thinking is widely acknowledged as a crucial skill for secondary school students, essential for navigating the complexities of the modern world. Authors such as Paul and Elder (2008) have explored critical thinking frameworks, emphasizing its role in fostering analytical, evaluative, and problem-solving abilities. Similarly, Facione (2011) highlighted the importance of critical thinking in education, focusing on its cognitive and dispositional dimensions. Research by Ennis (2011) further elucidated critical thinking as a reflective and reasonable process crucial for decision-making. These foundational works have paved the way for integrating critical thinking into educational practices, yet challenges remain in its systematic development within classrooms.

Brain-Based Learning (BBL), as conceptualized by Caine and Caine (1990), offers a promising framework to enhance critical thinking. Their 12 principles, including the importance of emotional engagement, pattern recognition, and the interdependence of body and mind, have been widely studied. For instance, Jensen (2008) explored the application of BBL in classrooms, emphasizing its alignment with the natural learning processes of the brain. Authors such as Sousa (2011) have examined how BBL strategies, such as orchestrated

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immersion and active processing, create engaging and cognitively stimulating environments. Despite these advancements, there remains a paucity of research specifically examining the intersection of BBL and critical thinking development, particularly among secondary school students. This study seeks to address this gap by designing a targeted BBL program and verifying its effectiveness in fostering critical thinking competencies.

OBJECTIVE

To develop, implement, and evaluate a Brain-Based Learning program for enhancing critical thinking competencies among secondary school students.

RESEARCH METHOD

Experimental Method: This method was used to find the effectiveness of Brain Based learning for enhancing critical thinking at secondary level. All the students of standard tenth St. Sadique School, Nasik constitute the population of the present research study. Sampling is done by purposive sampling where two groups 40 each were formed as control group and experimental group. The researcher used true experimental design i.e. Campbell and Stanley's (1963) Pretest-Posttest Control Group Design. The test was researcher made.

DATA ANALYSIS AND INTERPRETATION

Table no.1 : Pre-Test Scores (Control Group)

Sr. No	Class Interval	Midpoint(x)	Frequency(f)	fx	d	Fd	fd2
1	0-8	4	6	24	-3	18	54
2	8-16	12	8	96	-2	-16	32
3	16-24	20	14	280	-1	-14	14
4	24-32	28	8	244	0	0	0
5	32-40	36	4	144	1	4	4
Total			40	768		-44	104

Mean of Pre-Test:

Mean = ∑f / ∑fx = 40768 = 19.2

Standard Deviation of Pre-Test:

σ=i/N√N×∑fd2−(∑fd)2

Standard Deviation= Ϭ= σ=408×40×104−(−44)2

Standard Deviation= Ϭ= 0.2×2224≈6.67

Results for the Pre-Test (Control Group):

- Mean score: 19.2
- Standard Deviation: 6.67

Table No.2 : Pre-Test Scores (Experimental Group)

Sr. No.	**Class Interval**	**Midpoint (x)**	**Frequency (f)**	**fx**	**d**	**Fd**	**fd²**
1	0-8	4	5	20	-4	-20	80
2	8-16	12	10	120	-3	-30	90
3	16-24	20	12	240	-2	-24	48
4	24-32	28	8	224	-1	-8	8
5	32-40	36	5	180	0	0	0
Total			40	784		-82	226

Mean of Pre-Test (Experimental Group):
Mean = ∑f / ∑fx = 40784 = 19.6
Standard Deviation of Pre-Test (Experimental Group):
σ=Ni √N×∑fd2−(∑fd)2
Substituting values:
$\sigma = 8/40 \times \sqrt{40 \times 226 - (-82)^2}$
σ= 0.2 × √2316 ≈ 6.81

Results for the Pre-Test (Experimental Group):

- Mean score**:** 19.6
- Standard Deviation**:** 6.81

Table no.3: Post-Test Scores (Control Group)

Sr no	**Class Interval**	**Midpoint(x)**	**Frequency (f)**	**fx**	**d**	**fd**	**fd²**
1	0-8	4	3	12	-4	-12	48
2	8-16	12	8	96	-3	-24	72
3	16-24	20	14	280	-2	-28	56
4	24-32	28	10	280	-1	-10	10
5	32-40	36	5	180	0	0	0
Total			40	848		-74	186

Mean of Post-Test (Control Group)
Mean = ∑f / ∑fx = 40848 = 21.2

Standard Deviation of Post-Test (Control Group):
$\sigma = i/N \times \sqrt{N \times \sum fd2 - (\sum fd)^2}$
Substituting values:
$\sigma = 8/40 \times \sqrt{40 \times 186 - (-74)^2}$
σ = 0.2 × 1964 ≈ 6.27

Results for the Post-Test (Control Group):

- Mean score: 21.2
- Standard Deviation: 6.27

Table no.4: Post-Test Scores (Experimental Group)

Sr.no	Class Interval	Midpoint(x)	Frequency (f)	fx	d	fd	fd²
1	0-8	4	0	0	-4	0	0
2	8-16	12	2	24	-3	-6	18
3	16-24	20	6	120	-2	-12	24
4	24-32	28	15	420	-1	-15	15
5	32-40	36	17	612	0	0	0
Total			40	1176		-33	57

Mean of Post-Test (Experimental Group):

Mean = $\sum fx/\sum f$ = 117640 = 29.4

Standard Deviation of Post-Test (Experimental Group):

$\sigma = i/N \times \sqrt{}N \times \sum fd2 - (\sum fd)^2$

$\sigma = 40/8 \times \sqrt{}40 \times 57 - (-33)^2$

$\sigma = 0.2 \times 1191 \approx 5.47$

Results for the Post-Test (Experimental Group):

- **Mean score**: 29.4
- **Standard Deviation**: 5.47

Table No.**5**: Significance of difference between mean pretest scores and mean posttest scores of control group

Test	N	Mean(x)	SD	t	0.05	p
Pre test	40	19.2	6.5	1.54	0.02	5
Post test	40	21.4	6.27			

Table No.6: Significance of difference between mean pre test scores and mean post test scores of experimental group

Test	N	Mean(x)	SD	t	0.05	p
Pre test	40	19.6	6.81	6.93	0.02	5
Post test	40	29.4	5.8			

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Table No.7: Significance of difference between mean post test scores of experimental group and mean post test scores of control group

Group	**N**	**X(Mean)**	**SD**	**t**	**0.05**	**p**
Experimental	40	19.6	6.27	-7.45	0.02	5
Control	40	29.4	5.47			

Interpretation

The mean posttest score of the experimental group was significantly higher than that of the control group, with a calculated t-value of 7.45, which is much greater than the critical value of 2.02 at the .05 level. This leads to the rejection of the null hypothesis that there is no significant difference between the post-test performances of the two groups. The data confirms that the experimental group performed significantly better than the control group in their post test scores, demonstrating the effectiveness of the treatment in improving performance in life science.

Results

The study demonstrates that brain-based learning significantly enhances students' scientific literacy in life science, outperforming traditional teaching methods. These results underscore the importance of incorporating innovative, neuro-cognitive-aligned strategies in science education to achieve deeper understanding and retention among secondary school students.

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