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Research Article

Differential Influence Of Gender On The Effectiveness Of Brain-Based Learning In Achieving Cognitive Instructional Objectives Of Teaching Science

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ABSTRACT

The study aimed to find out the differential effect of gender on the effectiveness of brain based learning in achieving instructional objectives of teaching science at different levels of cognitive domain. The pre-test post-test control group design was used for the study wherein two intact classes of seventh grade students were randomly designated as control group (n = 44) and experimental group (n = 42). Three lesson units from the prescribed science textbook was taught to the students, the control group by using the prevailing Activity Method of Teaching (AMT), and the experimental group by using brain-based learning (BBL). Pre-testing and post-testing of achievement in different levels of cognitive domain (knowledge, understanding, application, analysis, synthesis and evaluation) were done one-day before and one-day after the pedagogic intervention with the help of a teacher made achievement test. The boys and girls were then compared regarding the gain scores of achievement in different levels of instructional objectives by using independent sample t-test. Analysis showed that gender exert significant differential influence on accomplishing knowledge level, analysis level, and synthesis level instructional objectives of teaching science when brain-based learning strategy was adopted in the classroom. Significant gender difference in the accomplishment of knowledge level, understanding level, and evaluation level instructional objectives were noticed when the prevailing activity method of teaching was used.

Key words: *Cognitive domain, Instructional objectives, Brain-based learning, Activity method of teaching.*

Introduction

In today's increasingly technology-driven world, scientific literacy is more important than ever. Understanding basic scientific concepts is essential for making informed decisions about issues such as healthcare, the environment, and technology (Dasic, Kostadinovic, Vlajkovic & Pavlovic, 2024). Children are naturally curious, and science education nurtures this curiosity by encouraging them to explore and investigate the world around them (Bjerknes, Wilhelmsen & Foyn-Bruun, 2024). Science education is not just about acquiring existing knowledge but also about fostering innovation and creativity (Aguilar & Pifarre, 2019). Learning of science encourages critical thinking and problem-solving skills. It fosters curiosity and a spirit of inquiry in students. Achieving cognitive objectives encourages students to ask questions, think creatively, seek answers through experimentation and investigation, develop innovative solutions to scientific problems, and develop a deeper curiosity about the natural world (Jirout, 2020). It also helps students develop a deep understanding of scientific concepts and principles. Attaining cognitive objectives in science education prepares students for higher education and future careers in science, technology, engineering, and mathematics (STEM) fields. Strong cognitive skills are essential for success in advanced science courses and professions that require analytical thinking and problem-solving abilities. This understanding goes beyond rote memorization and enables students to comprehend the underlying principles of scientific phenomena, fostering a lifelong appreciation for science (Dunlosky, Rawson, Marsh, Nathan & Willingham, 2013).
Achieving cognitive instructional objectives in teaching science is essential for preparing students to succeed in an increasingly complex and technology-driven world, fostering a deeper understanding of scientific

principles, and promoting critical thinking, problem-solving, and creativity (Soysal, 2022). In a formal classroom setting, cognitive level educational objectives are highly valued due to their ease of achievement and evaluation (Khalil & Elkhider, 2016). The instructional strategies that the teachers adopt in the classrooms are critical in enabling the students to accomplish the objectives of teaching (Keiler, 2018). Not all instructional techniques are equally effective in helping learners attain various instructional objectives in the cognitive domain. Cognitive science has greatly improved the effectiveness and enjoyment of the learning process. One instance of a contribution from cognitive psychology and neuroscience is brain-based learning (BBL), which entails learning that is in line with the innate learning mechanisms of human brain. The human brain is designed to gather information from the environment, process it, extract meaning from it, and retain it as long as it is not impeded in performing its normal duties (Arun & Singaravelu, 2018). The utilization of teaching approaches in brain-based classrooms is intended to synchronize with the innate learning process of the brain when confronted with authentic real-world scenarios (Winter, 2019). The success of BBL over traditional strategies in teaching science has been established my many researchers (e.g., Bada & Jita, 2023; Lagoudakis, Vlachos, Christidou & Vavougios, 2022). The achievement of instructional objectives in BBL classrooms are highly influenced by learner variables like gender and intelligence (Muraleedharan & Raveendranathan, 2022). Differential influence of gender on the accomplishment of instructional objectives of science in different levels (knowledge, comprehension, application, analysis, synthesis and evaluation) of cognitive domain among elementary schoolers remains as an unexplored area in the research literature. This study is a modest attempt to bridge the research gap.

Objective of the Study

The study aims to find out the differential influence of gender on the effectiveness of brain-based learning (BBL) in achieving instructional objectives of science in different levels of cognitive domain among elementary school students.

Hypotheses of the Study

The following null hypotheses were tested in the study:
H_o1: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving knowledge level instructional objectives of teaching science.
H_o2: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving understanding level instructional objectives of teaching science.
H_o3: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving application level instructional objectives of teaching science.
H_o4: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving analysis level instructional objectives of teaching science.
H_o5: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving synthesis level instructional objectives of teaching science.
H_o6: Boys and girls do not differ significantly regarding the effectiveness of BBL in achieving evaluation level instructional objectives of teaching science.

Methodology

The quasi-experimental study adopted a pretest-posttest control group design. Two intact divisions of seventh grade students (n = 86) were selected from a government aided school from Ernakulam district of the Indian state of Kerala. The classes were randomly assigned to a control group (n = 44) and an experimental group (n = 42). Lesson transcripts following the prevailing Activity Method of Teaching (AMT), lesson plans following Brain-based Learning (BBL), and an achievement test in science were used as tools for pedagogic intervention and collecting data. The content covered under three units (For a pollution free nature, Pressure in liquids and gases, and Breath and blood of life) in the Science Text Book prepared by the State Council for Educational Research and Training (SCERT), Govt. of Kerala, were taught to the control group and experimental group with the help of fifteen 30-minutes lesson plans, the control group with AMT lesson plans and the experimental group with BBL lesson plans. The achievement test was administered on both the control group and the experimental group one day before and one day after the pedagogic intervention to get pre-test and post-test scores. The gain scores of achievement were then calculated for both the control group and the experimental group by subtracting the pre-test scores from the respective post-test scores. The gender groups were then compared by employing the independent sample t-test to test the hypotheses.

Analysis and Interpretation

The gender groups (boys and girls) in both the control group and the experimental group were compared with respect to the gain scores of achievement (obtained by subtracting pre-test scores from the post-test scores) of knowledge level instructional objectives in science. The result of the independent sample t-test performed in this context is given in Table 1.

Table 1: Comparison of gender groups regarding the gain scores of achievement of knowledge level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	2.67	1.28	3.506	.001
	Girls	23	4.00	1.24		
BBL	Boys	20	3.85	1.27	2.959	.01
	Girls	22	2.91	0.75		

The results show significant gender difference in both control group ($t = 3.506$; $p<.001$) and experimental group ($t = 2.959$; $p<.01$) with respect to the gain scores of achievement in knowledge level instructional objectives of teaching science to elementary school students. Inspection of the mean scores of achievement for boys and girls in the control group (AMT) shows that the girls ($M = 4.00$) excel the boys ($M = 2.67$). The trend is reversed in the experimental group (BBL) wherein boys ($M = 3.85$) surpassed the girls ($M = 2.91$) in their knowledge level achievement.

The boys and girls in the control group and the experimental group were compared in regard to the gain scores of achievement in understanding level instructional objectives of science so as to find out whether the groups differ significantly. The data and result of the analysis done in this regard is given in Table 2.

Table 2: Comparison of gender groups regarding the gain scores of achievement of understanding level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	5.19	2.58	2.174	.05
	Girls	23	6.65	1.85		
BBL	Boys	20	8.20	1.77	1.924	NS
	Girls	22	7.23	1.51		

The t-value estimated on comparing boys and girls in the control group with respect to the gain scores of achievement in understanding level instructional objectives is significant ($t = 2.174$; $p<.05$). Scrutiny of the mean scores reveal that girls ($M = 6.65$) outshine the boys ($M = 5.19$) in understanding the concepts and process of science when activity method of teaching is adopted. However, no significant gender difference was noticed in understanding level achievement when taught by brain-based learning ($t = 1.924$; $p>.05$).

The data and result of the comparison of boys and girls in the control group and experimental group with respect to the gain scores of their achievement of application level instructional objectives in science is shown in Table 3.

Table 3: Comparison of gender groups regarding the gain scores of achievement of application level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	3.38	1.20	0.538	NS
	Girls	23	3.17	1.34		
BBL	Boys	20	5.55	1.05	1.064	NS
	Girls	22	5.18	1.18		

The t-values computed for both the control group ($t = 0.538$; $p>.05$) and experimental group ($t = 1.064$; $p<.05$) are insignificant revealing that boys and girls are equally achieved the application level of instructional objectives irrespective of whether the teacher used activity method or brain-based strategies.

Differential influence of gender on the attainment of analysis level instructional objectives of teaching science by adopting activity method of teaching and brain-based learning were find out comparing the gain score of boys and girls in the control group and the experimental group. The result of the two-tailed test performed in this context is given in Table 4.

Table 4: Comparison of gender groups regarding the gain scores of achievement of analysis level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	5.81	2.77	0.656	NS
	Girls	23	6.39	3.09		
BBL	Boys	20	10.50	1.32	3.029	.01
	Girls	22	9.32	1.21		

The t-value obtained on comparing boys and girls regarding the analysis level instructional objectives of teaching science, when taught by activity method, is not significant ($t = 0.656$; $p>.05$). A true difference, however, was observed between boys and girls when brain-based learning was employed ($t = 3.029$; $p<.01$). Inspection of the mean gain scores of the sub-samples in the experimental group reveals that the boys ($M = 10.50$) outshine the girls ($M = 9.32$) in the improvement they made in the achievement of analysis level instructional objectives.

In order to find out the differential effect of gender on the effectiveness of activity method of teaching and brain-based learning, the boys and girls were compared as regards to their gain scores of achievement in synthesis level instructional objectives. The result of the independent sample t-test performed in this connection is given in Table 5.

Table 5: Comparison of gender groups regarding the gain scores of achievement of synthesis level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	1.62	1.02	0.411	NS
	Girls	23	1.74	0.92		
BBL	Boys	20	2.90	.641	2.090	.05
	Girls	22	2.41	.854		

The results show that while there is no significant difference between boys and girls in the control group with respect to the gains cores of achievement in synthesis level ($t = 0.411$; $p>.05$), the experimental group demonstrate a significant gender difference in the attainment of synthesis level instructional objectives of teaching science ($t = 2.090$; $p<.05$). A closer observation of the mean gain scores reveals that the girls ($M = 2.41$) trail behind the boys ($M = 2.90$) in the accomplishment of synthesis level instructional objectives of science when brain-based learning is adopted.

The differential influence of gender on the achievement of evaluation level instructional objectives of science when taught through activity method of teaching and brain-based learning was found out by comparing the gains scores of boys and girls by employing independent sample t-test. The data and result of the analysis is given in Table 6.

Table 6: Comparison of gender groups regarding the gain scores of achievement of evaluation level instructional objectives

Groups	Sub-samples	N	M	SD	t-value	Sig.
AMT	Boys	21	1.90	1.09	2.292	.05
	Girls	23	2.65	1.07		
BBL	Boys	20	2.10	0.79	0.942	NS
	Girls	22	1.86	0.83		

The results indicate that gender has different effect on the outcome of activity method of teaching and brain-based learning regarding the accomplishment of evaluation level instructional objectives of science. The gender based sub-samples differed significantly in achieving evaluation level instructional objectives when taught by activity method of teaching ($t = 2.292$; $p<.05$). The girls ($M = 2.65$) excelled boys ($M = 1.90$) in the achievement of evaluation level instructional objectives. The brain-based learning, however, was alike for both the gender groups in achieving the evaluation level instructional objectives of science.

Conclusion

The analyses exposed that gender of the learners exert significant differential influence on the achievement of knowledge level instructional objectives of teaching science irrespective of whether they are taught through the prevailing activity method of teaching or through the brain-based learning. While activity method of teaching favoured girls rather than boys in accomplishing knowledge level instructional objectives of science, brain-based learning favoured the boys. Though brain-based learning is equally effective for both the gender groups in achieving understanding level instructional objectives, activity method of teaching is more successful with girls than with boys. Gender of the learner is not a significant decisive factor in attaining application level instructional objectives of science when taught through activity method of teaching or brain-based learning. Whereas both the gender groups achieve the analysis level instructional objectives of science almost equally when taught through activity method of teaching, the boys accomplish the instructional objectives better than girls when brain-based learning strategies are employed. Though activity method of teaching enables both the boys and girls equally to achieve synthesis level instructional objectives of science, brain-based learning assists the boys to achieve synthesis level instructional objectives better than girls. Boys and girls differ significantly in the attainment of evaluation level instructional objectives when prevailing activity method of teaching is employed; the brain-based learning, however, eliminate this gender difference.

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