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Brain-based Learning in Physics of Grade 7 Students

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Abstract
This study aimed to develop lessons in Physics using Brain-Based Learning, determine the learners' learning styles along brain dominance and determine the effects of the developed lessons using brain-based learning on students' conceptual understanding, critical thinking skills, creative thinking skills, interest to-wards Physics and learners' learning styles along brain dominance. The study utilized the pre-experimental one-group-pretest-posttest design to the 20 Grade-7 students of Masbate School of Fisheries for SY 2020-2021. The data were collected using the researcher-made conceptual understanding test, critical thinking skills test, and creative thinking skills test along with the adopted Brain Dominance Assessment by Davis (1994), VAK Learning Style Inventory by Chislett MSc and A Chapman (2005) and the Interest checklist of Samaupan (2018). Significant findings were revealed: (1)The learning styles of the learners before the conduct of the study are the following: left brain-auditory, left brain-visual, right brain-kinesthetic, and whole brain-kinesthetic. Furthermore, the identified learning styles of the learners after the conduct of the study are the following: left brain-visual, left brain- auditory, right brain-auditory, right brain-kinesthetic, and whole brain- visual; (2)Six lessons in Grade-7 Physics under the topics on motion, waves and sound were developed using brain-based learning with the following features: inquiry-learning, integration of creative activities, ap-plication of brain-based learning, and design for flexible learning; (3)Significant improvements were revealed on students' conceptual understanding, critical thinking skills, creative thinking skills, and interest to-wards Physics after implementing the brain-based learning lessons. However, there were no significant changes in the students' learning styles along left and right brain dominance. Nevertheless, improvements were observed in the utilization of both the left and right hemispheres of the brain. Hence, the results of this study give educators and curriculum developers bases to incorporate Brain-Based Learning into their teaching practices to improve student learning outcomes in Physics education.

Keywords: Brain-Based Learning; Brain Dominance; Conceptual Understanding; Creative Thinking Skills; Critical Thinking Skills; Interest towards Physics

Introduction
Improving the quality of basic education in the Philippines is crucial. It is necessary. Recognizing its im-portance enables economic advancement. Ramos and Mourelle (2019) established a positive and significant correlation between secondary and higher education and economic growth in Spain. This data demonstrated the correlation between a country's economic standing and the quality of its education.

Macha, et al. (2018) reported a significant decrease in the achievement rate of Filipinos in basic education, attributing it to inadequate funding. UNICEF highlighted that despite being a middle-income country with sufficient resources to support education, many Filipino children are still experiencing poverty and illiteracy.

Experts consider science crucial for fostering the economic progress of a nation inside modern education. Science is typically described as a methodical pursuit that structures and categorizes information based on actual data and evidence concerning the cosmos. Science is crucial in various aspects of modern life, including education, medicine, industry, entertainment, business, and the environment. It often reflects the economic condition of a particular community or an entire country. Fischer (2005) highlighted the correlation between economic growth and science and technology, stating that technological advancements accounted for 80% of growth between 1909 and 1949 in the United States. Drori (1998) stated that societies are evaluated according to their scientific literacy and performance. Science education is crucial for driving future scientific breakthroughs and economic growth.

Science education aims to cultivate students' curiosity and enthusiasm in the cosmos by promoting scientific thinking. The goal is to enhance learners' scientific literacy abilities so they may become influential and engaged members of society capable of making in-formed decisions using scientific knowledge that significantly affects their lives (DepEd, 2013). This promotes the advancement of scientific literacy in students, enabling them to effectively address challenges and become astute decision-makers, significantly impacting their future quality of life. Teaching learners the scientific method is equivalent to teaching them critical thinking, problem-solving, and decision-making skills. Currently, various research studies are centered on scientific education.

Ambag (2018) argues that science education in our country is not a strong point. The Philippines consistently demonstrated poor performance in many inter-national surveys. An example is the findings from the Trends in International Mathematics and Science Study (TIMSS). In 2003, the country's ranking in high school mathematics was 34th out of 38 countries, while in high school science, it was 43rd out of 46 participating countries. Fourth grade participants in primary education ranked 23rd out of 25 countries in both math and science. It is based on the 2010-2011 Global Competitive-ness Report from the World Economic Forum (2010). The Philippines ranks 112th in Science and Mathematics. The 2018 Programme for International Student Assessment (PISA) revealed that Filipino students per-formed poorly in Science, Mathematics, and English compared to other international students. Their scores were below the average scores of participating countries in the Organization for Economic Cooperation and Development (OECD). The Philippines rated worst in reading comprehension with 340 points, which is below the survey average of 487 points. It also came second to last in science with 357 points and mathematics with 353 points, both below the average of 489 points in those areas.

Based on 2014 figures, the passing rate for the national achievement exam (NAT) in elementary school is 69.21%, and in high school, it is 43.38%. The Filipino pupils' scores in the National Achievement Test (NAT) confirmed their low performance in various areas, including science. The Department of Education (2016) presented the students' NAT (MPS) results at the secondary level from 2009 to 2014. The NAT MPS results from 2010-2014, which were 46.56, indicated a significant deviation from the department's target satisfactory grade of 65.00 by 2016. In the academic year 2016-2017, Filipino students in Grade 6 performed poorly on the Nation-al Achievement Test (NAT) with a Mean Percentage Score (MPS) of 30.94. The Bicol Region achieved a Mean Percentage Score (MPS) of

28.75% on the same test, while the Masbate Province Division obtained an MPS of 26.29%. Results of the test indicate that 44.02% of examinees are classified as Not Proficient, 54.10% as Low Proficient, 1.83% as Nearly Proficient, and just 0.05% as Proficient in Science. This out-come demonstrated that a small percentage of the students are considered proficient in science subjects.

According to Puerto's (2018) study, Masbate Province achieved the following Mean Percentage Scores for Science in the NAT Results during the school years 2005-2006 to 2013-2014: 38.99%, 39.50%, 31.14%, 45.32%, 50.73%, 42.73%, 42.40%, 39.68%, and 39.17% respectively. The Province of Masbate's performance in the National Achievement Test varied but remained consistently below the Department of Education's standard threshold of 75%, the national aim (Fontellar, 2014).

This statistic can assess and ascertain the current methods of teaching the subject. Dr. Josette Biyo mentioned that science education in the Philippines is hindered by the absence of a strong scientific culture, and the science taught at the elementary level is not engaging. Student creativity is hindered along with student engagement and decision-making. The lack of a science culture among Filipino learners and the absence of learning activities that promote active learning contributed to the low state of science education in the Philippines.

Filipino students demonstrate inadequate retention of learned concepts, deficient reasoning and analytical skills, and limited communication abilities, leading to difficulties in articulating their thoughts and opinions on various subjects using their own language (UP NISMED, 2005). Learners faced problems related to motivation, student intellectual capacity, instructor characteristics, learning material, instructional re-sources, curriculum, and parental support (Sadera, Torres & Rogayan, 2020). The results were caused by various factors including teachers' academic qualification deficiencies, inadequate professional involvement, teaching experience, large class sizes, and the recurring issue of insufficient learning materials, technologies, and facilities for effective lesson delivery. Another element to consider is the teaching technique employed by teachers. Many teachers still utilize traditional teaching methods without considering the individual variances among learners and how it impacts their learning. Deciding on the best suitable plan, approach, or strategy to effectively educate learners is a hard task that teachers face regularly. Research indicates that to effectively offer student learning, it is essential to have content that is appropriate for the learners, together with pedagogical approaches and methods that are in line with the learning competencies and objectives. A teaching approach that allows learners to understand how their brains naturally learn could enhance the quality of education by fostering deeper and more meaningful learning experiences.

Brain-Based Learning (BBL) focuses on how the brain absorbs and organizes information to facilitate lifelong and meaningful learning, as described by Caine & Caine (1994). It offers a way to effectively educate all students, who are distinct individuals, by incorporating brain-based learning methods. Zull (2002) asserted that education involves the skill of altering the child's cognitive processes. BBL assists instructors in promoting life-long learning in students by adhering to its principles and aligning with the brain's functioning. It promotes significant learning in students, hence enhancing their academic performance. It offers equal opportunity to all learners, regardless of their differences. BBL is considered an advanced method rooted in neurology and cognitive science research to assist educators in the field of education. Duman's (2010) study demonstrates that Brain-Based Learning positively impacts students' achievements in the experimental group and highlights individual differences in how learners acquire knowledge. BBL was found to have a favorable effect on the academic accomplishment of learners, as evidenced by their scores on the achievement exam as compared to learners in the control group. Estrada et al. (2019) conducted a study that explores the correlation between students' various learning styles based on brain dominance and emotional intelligence. Variances in learners' learning styles have a positive effect on emotional intelligence development, with right hemisphere-related styles showing a greater benefit. Multi-dimensional learning methodologies in education should be utilized to promote effective teaching and learning for the holistic development of learners. It will tackle the learning challenges of the students and ultimately make the process of education more manageable for teachers.

Masbate School of Fisheries is the largest technical vocational school in Masbate province, with 1,853 students enrolled for the 2019-2020 academic year from various barangays in Milagros Municipality. MSF experienced a decline in NAT MPS from the school years 2013-2014 to 2014-2015, with scores of 56.24 and 42.63, respectively. It demonstrates the inadequate aca-demic achievement of the students across various sub-jects, including science.

This study aimed to enhance the performance of grade 7 Physics students at Masbate School of Fisheries. This study aimed to identify the various learning styles of students based on left and right brain dominance, develop Grade 7 Physics lessons using brain-based learning, and determine the effects of brain-based learning on students' conceptual understanding, critical thinking skills, creative thinking skills, interest in physics, and learning styles related to left and right brain dominance. Furthermore, improving students' learning styles and left-right brain dominance aims to help teachers deal with the declining academic performance of children.

The researcher believed that by allowing students to engage both brain hemispheres through various activities tailored to brain dominance, learning outcomes would be more significant, captivating, and efficient. Improving the quality of Science Education in the school and the entire region would enhance science education by improving students' performance in the subject of physics.

Statement of the Problem

The study aimed to develop lessons in Physics using Brain-Based Learning and determined its effects in enhancing the performance of Grade 7 students of Masbate School of Fisheries for SY 2020-2021.

Specifically, this study sought to find answers to the following sub-problems:

1) What are the learning styles of students along with right brain and left-brain dominance?
2) What lessons in Physics may be developed using brain-based learning with the following features:
   a) inquiry learning;
   b) integration of creative activities; and
   c) designed for flexible learning?
3) What are the effects of the developed lessons using brain-based learning on students'?
   a) Conceptual understanding
   b) Critical thinking skills
   c) Creative thinking skills
   d) Interest towards Physics
   e. Left brain and right brain learning style

Scope and Limitation

The study focused on the development of Physics lessons and the impact of brain-based learning on stu-dents' learning outcomes. It aimed to assess students' conceptual understanding, critical thinking skills, creative thinking skills, interest in Physics, and learning styles in relation to brain dominance. The research was conducted at Masbate School of Fisheries during the 2020-2021 academic year, with a Grade 7 class using blended learning methods. The study specifically addressed the least learned competencies in motion, waves, and sound. The developed lessons incorporated brain-based learning steps and were delivered through a combination of modular offline learning and online distance learning. The findings aimed to identify significant differences in students' results before and after implementing the brain-based learning lessons. The study had limitations regarding the focus on learning styles, brain dominance, and specified learning outcomes, without a discussion on brain activity in response to different stimuli.

Materials and Methods

This study employed developmental and descriptive research methods, involving 20 Grade 7 students of Masbate School of Fisheries for SY 2020-2021 under the pre-experimental one-group-pretest-posttest design illustrated below.

$$0_1 \qquad\qquad x \qquad\qquad 0_2$$

Where:	0_1	=	pretest;
	x	=	intervention (developed lessons using brain-based learning)
	0_2	=	posttest

The researcher developed six Grade 7 Physics lessons focusing on Motion, Waves, and Sound for K-12 education. The lessons covered the most essential learning competencies outlined by the Department of Education for pandemic learning needs and identified the least mastered competencies from Masbate School of Fisheries SMEA's reports for the academic year 2019-2020. Three lessons were developed to enhance the primary learning competency by facilitating chunking for improved comprehension by learners. Mehring and Edwards (2011) suggested breaking down courses into smaller chunks to help the working memory process more information and enable teachers to effectively communicate important concepts to pupils. The lessons were designed based on the K to 12 Curriculum Guide and implemented the Department of Education's 7E secondary science instructional model: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. The lessons incorporated inquiry-based learning, creative activities, and flexible learning design. The six lessons include (1)distance and displacement, (2)speed and velocity, (3)acceleration, (4)graphical motion representations, (5)waves, and (6)sound.

This study utilized brain-based learning with the following steps: activation; clarifying outcomes and paint the big picture; making connections and developing meaning; doing the learning activity; demonstrating students' understanding; review for students' retention; and, previewing the next topic. This study supported the brain-based learning principles in the development of the lesson. These brain-based learning principles integrated into the study are the following: the brain is a complex adaptive system; the brain is social; the search for meaning is innate; emotions are critical to patterning; learning involves both focused attention and peripheral attention; complex learning is enhanced by challenge and inhibited by threat, and every brain is uniquely organized.

Sampling Method

The researcher utilized purposive sampling to select respondents with specified characteristics to achieve the study's aims. The COVID-19 pandemic has disrupted traditional classroom teaching; hence, the researcher chose Grade 7- Galileo learners due to the limited availability of flexible learning options for the normal program class at Masbate School of Fisheries for SY 2020-2021. The learners in this class received self-learning modules, offline and online materials, and a virtual class once a week. The students in this area will receive lessons based on Brain-Based Learning, which will be taught by the researcher. The intervention's effects will be assessed by comparing the learners' results before and after the study.

Data Collection

The study measured the effects of the developed lessons in Physics using Brain-Based Learning in determining the conceptual understanding, critical thinking skills, creative thinking skills, interest towards Physics, and left brain and right brain learning styles of the learners before and after the conduct of the study.

The study utilized the following instruments: (a) Evaluators' assessment tool for the developed lessons and tests, (b) conceptual understanding test, (c) critical thinking skills test, (d) creative thinking skills test, (e) Interest Checklist adopted from Samaupan (2018), (f) Brain Dominance Assessment (Davis, 1994), and (g) VAK Learning Style Self-Assessment Questionnaire (Chislett MSc & A Chapman, 2005). The conceptual understanding test, critical thinking skills test and creative thinking skills test were validated by 9 experienced Science Teachers and was piloted on 35 students. The reliability of the conceptual understanding exam was assessed using Kuder-Richardson Formula 20, while the reliability of the critical thinking skills test and creative thinking skills test was determined using Kuder Richardson Formula 21. The conceptual understanding exam yielded a value of 0.7665. Thus, the conceptual comprehension exam that was created is rational and reliable. The KR-21 was used to calculate the reliability of the critical thinking skills test (0.894) and the creative thinking skills test (0.963). Both tests were deemed reasonable, hence the produced critical thinking skills test and creative thinking skills test were considered reliable.

Data Analysis

The pre-test and post-test results analyzed descriptively. A T-test for two dependent samples was used to determine the effects of Brain-based lessons in Physics among students in terms of their conceptual understanding, critical thinking skills and creative thinking skills. On the other hand, mode will be used to determine the most preferred learning styles of the learners and their interest towards Physics before and after the conduct of the study.

Results

Learning Styles of Students along with Right Brain and Left-Brain Dominance Before the Conduct of the Study

Table 1 below shows the learning styles of students along with Right Brain and Left-Brain Dominance before the conduct of the study. Seven (7) learners were categorized as left-brain, visual; eight (8) learners were categorized as left-brain, auditory; three (3) were categorized as right-brain, kinesthetic; and two learners were categorized as whole brain, kinesthetic.

Table 1. Learning Styles of Students along Right Brain and Left Brain Dominance Before the Conduct of the Study

Learning Styles	Brain Dominance		
	Left Brain	Right Brain	Whole Brain
Visual	7	0	0
Auditory	8	0	0
Kinesthetic	0	3	2
TOTAL	**20**		

The data shows that many of the Grade 7 students were classified as left-brain dominant learners having auditory with the most preferred learning style.

Lessons in Grade 7 Physics using Brain-Based Learning

The lessons developed in Grade 7 Physics incorporating Brain-Based Learning were the following: distance and displacement; speed and velocity; acceleration; graphical motion representations; waves; and sound. The lessons incorporated inquiry learning, creative activities, and flexible learning design. The six developed lessons received outstanding ratings from evaluators based on various criteria: (a) validity of the lesson components, including objective criterion (4.53), learning content (4.80), assessment (4.87), and 7E's Lesson Proper (4.79); (b) inquiry learning (mean rating of 4.68); (c) integration of creative activities (mean rating of 4.77); and (d) flexible learning design (mean rating of 4.74). Every lesson was rated outstanding by the evaluators. The researcher included the evaluation experts' ideas for improving the created lessons. The developed lessons obtained an outstanding mean rating of 4.75 for lesson validity and a 4.73 mean rating for various features.

Effects of the Developed Lessons using Brain-Based Learning

a. Conceptual Understanding

Table 2 shows the Comparison of the Pretest and Posttest of Grade 7 learners on Conceptual Understanding Test.

Table 2. Comparison of Pretest and Posttest on Conceptual Understanding Test

Concepts	PRETEST		Interpretation	POSTTEST		Interpretation	Mean Gain
	Mean	PL (%)		Mean	PL (%)		
1. Describing Motion: Distance vs. Displacement	2.4	40	LM	4.05	67.5	NM	1.65
2. Describing Motion: Speed vs. Velocity	2.5	50	LM	2.6	52	NM	0.10
3. Describing Motion: Acceleration	3.1	44.29	LM	4.25	60.71	NM	1.15
4. Describing Motion: Visual Representation	4.3	53.75	NM	5.45	68.13	NM	1.15
5. Waves	2.85	57	NM	3.75	75	M	0.90

6. Sound	2.7	45	LM	3.65	60.83	NM	0.95
TOTAL	**17.85**	**48.34**	**LM**	**23.75**	**64.03**	**NM**	**5.90**

The study's results indicate that the learners' overall performance level improved from low mastery to near mastery, with a percentage increase of 15.69%. However, the learners' performance in the posttest was still below the expected mastery level set by the Department of Education. Only one out of the six topics discussed reached the mastery level, specifically the concept of waves. The topic of speed and velocity showed a slight increase in performance levels but remained the least mastered topic. The learners' mean gain was 5.90, and statistical analysis confirmed that the data was normally distributed, allowing for the use of t-tests. The pretest and posttest scores showed a significant increase, indicating that the implementation of brain-based learning significantly improved the learners' conceptual understanding of Physics lessons. The findings suggest that the developed lessons, incorporating features such as inquiry learning, creative activities, and flexible learning design, positively impacted the students' conceptual understanding.

b. Critical Thinking Skills

Table 3. Comparison of Pretest and Posttest on Critical Thinking Skills Test

Concepts	PRETEST		Interpretation	POSTTEST		Interpretation	Mean Gain
	Mean	PL (%)		Mean	PL (%)		
1. Hypothesis Testing	0.3	7.5	NoM	0.95	23.75	NoM	0.65
2. Reasoning	3.95	49.38	LM	5.85	73.13	NM	1.9
3. Argument Analysis	4.8	40	LM	8.7	72.5	NM	3.9
4. Problem solving	1.4	35	LM	3.15	78.75	M	1.75
TOTAL	10.45	32.97	LM	18.65	62.03	NM	8.2

The table displays the scores of learners from their pretest and post-test on the Critical Thinking Skills test for Physics lessons before and after the implementation of lessons utilizing Brain-Based Learning (BBL). Scores rose during the posttest.

The data indicates that the learners' performance level increased from 32.97 to 62.03, showing a 29.06% improvement from low mastery to near mastery. The study revealed that the learners' performance in the posttest was still below the Department of Education's expected mastery level of 75%. This indicates that the learners lacked proficiency in most of the critical thinking skills that were identified.

Moreover, the data indicated that out of the four critical thinking skills assessed, only one skill achieved mastery with a performance level of 78.75% following the introduction of brain-based learning courses. Problem-solving is the most proficient critical thinking skill among learners. The results indicate that the learners have a strong command of problem-solving skills by incorporating brain-based learning. The outcome indicated that the pupils had acquired the skill to assess solutions to a problem.

The learners' critical thinking skills in hypothesis testing showed minimal improvement from pretest (PL= 7.5) to posttest (PL=23.75), indicating no mastery both before and after the implementation of brain-based learning. Therefore, it can be inferred that this domain is the least proficient among the learners.

The two critical thinking skills improved from low mastery levels to near mastery levels for the learners. The Reasoning skill increased from a performance level of 49.38% to 73.13%, while the argument analysis skill improved from 40% to 72.50%. The skills shown an average increase of 1.9 and 3.9, respectively. The results indicated a minor improvement in the learners' capacity to assess the accuracy of facts and provide reasoning for their argument.

The learners demonstrated an average improvement of 8.2 with an overall performance level of 62.03%. Analyzed the impact of an increase in the learners' critical thinking abilities test scores using a t-test. The table indicated that there was an increase in learners' scores after the implementation of brain-based learning, as seen in the pretest (M=10.90, SD = 3.24) and posttest (M=20.90, SD = 3.42) results. The results indicate a 10.0 rise in the mean score of the learners from the pretest to the posttest. The learners' scores in the post-test exhibit greater dispersion and deviation from the average compared to their scores in the pretest.

The study results indicated a significant difference in the learners' critical thinking skills using a t-test, with a t-stat value of -12.74 and a p-value of less than 0.01 at an alpha level of 0.05. The study found that incorporating brain-based learning led to a considerable enhancement in learners' test scores for critical thinking skills. The learners' scores improved, indicating the growth of critical thinking skills. Brain-Based Learning positively impacts the enhancement of critical thinking skills in Grade 7 Galileo students during their Grade 7 Physics classes.

c. Creative Thinking Skills

Table 4 shows the results of the learners before and after the conduct of the study.

Table 4. Creative Thinking Skills Test Scores of the Learners Before and After the Conduct of the Study

Scientific Creative Thinking Skills	*Scores (Mean)*		*Mean Gain*
	Pretest	Posttest	
Unusual Use (UU)	7.1	17.4	10.3
Technical Production (TP)	6.35	10.35	4
Scientific Imagination (SI)	7.6	13.8	6.2
Sensitivity to Science Problem	5.05	8.65	3.6
TOTAL	26.1	50.2	24.1

The table displays the results of learners in a pretest and posttest for creative thinking skills before and after using brain-based learning in the study. Scores showed improvement following the study's adoption. Normality test and t-test for two sample means were utilized to assess the impact of the created lessons on the creative thinking skills of Grade 7-Galileo learners.

The t-test for Paired Two Sample Means was utilized to assess the impact of brain-based learning on the creative thinking skills of grade 7 students by comparing pretest and posttest results. The pretest findings had a mean of 26.1 and a standard deviation of 12.53, whereas the posttest data had a mean of 50.2 and a standard deviation of 21.69, indicating a score improvement following the research implementation. The learners achieved an average increase of 24.1.

The difference is statistically significant with a t-value of -6.63 and a p-value less than 0.01 at a significance level of 0.05. Brain-based learning enhanced the exam scores of the learners in their creative thinking skills. The learners' scores improved, indicating learning has transpired. Brain-Based Learning enhances the development of creative thinking skills in grade 7 Physics lessons.

Furthermore, the table shows that the unusual use of creative thinking skills had the highest mean gain of 10.3, followed by scientific imagination with a mean gain of 6.2, and technical production with a mean gain of 4. The sensitivity to science problem creative thinking skill got the slightest increase of learner's progress with a mean gain of 3.6. The learners achieved an average increase of 24.1 points, moving from an average pretest score of 26.1 to an average post-test score of 50.2.

d. Interest towards Physics

Table 5 shows the learners' interest towards Physics before and after the conduct of the study through the administration of an Interest Checklist adopted from the study of Samaupan (2018).

Table 5. Grade 7 Learners' Interest towards Physics Before and After the Conduct of the Study

Categories	Mode		Mode	
	Before	**Interpretation**	**After**	**Interpretation**
Enjoyment in Physics	3	Somehow Interested	4	Interested
Appeal of Physics Activities	3	Somehow Interested	5	Very Interested
Appreciation of the Importance of Physics	4	Interested	5	Very Interested

The data indicates that most learners appreciated the importance of Physics in real-life before the study was conducted. The learners concurred that the knowledge gained in their Physics lesson is crucial for their everyday life. his category obtained an interesting interpretation based on the learners' responses before the study. However, the majority of learners were indecisive on the two more categories on the Interest checklist: Enjoyment in Physics and Appeal of Physics Activities. These obtained "somehow interested" based on the consolidated responses of the learners. Before the study, majority of learners did not select Physics as their favorite subject, and studying Physics did not provide them happiness or confidence. Some areas in Physics were perceived as boring by students. This can elucidate why students don't get enjoyment from Physics studies and perceive Physics as only "somehow interesting".

On the other hand, data shows the learners' responses following the implementation of the developed lessons. Most learners find Physics enjoyable, with the majority responding "Agree". It may be inferred that majority of learners are currently interested in the subject of Physics. The Appeal of physics activities and appreciation of the importance of physics in real life both obtained the highest frequency of ratings among learners. Based on the results, it is evident that learners found the appeal of physics in real life and appreciation of the importance of Physics as very interesting. Based on the data, it is evident that once the study was implemented, the majority of learners have shown a positive shift in their interest towards the subject. Consequently, the students' enthusiasm for Physics increased.

e. Learning Styles along Left Brain and Right Brain Dominance

Table 6. Grade 7 Learners' Learning Styles along Brain Dominance Before and After the Study

Learning Styles	**Brain Dominance**					
	Left Brain		Right Brain		Whole Brain	
	Before	After	Before	After	Before	After
Visual	7	8	0	0	0	2
Auditory	8	6	0	2	0	0
Kinesthetic	0	1	3	1	2	0
Mean Score (Before the Study)	-0.92					
Mean Score (After the Study)	-0.092					

The introduction of brain-based learning resulted in a data value of -0.092, which is approaching zero. The data displayed the brain dominance test results post BBL implementation, indicating that most learners were still categorized as left brain dominant, but the value approached zero. This suggests that the learners are close to engaging both hemispheres of their brain during the learning process.

The study found that before it was conducted, learners preferred the auditory learning style the most. After incorporating lessons based on brain-based learning, the learners' most favored learning style has changed to visual. This could be attributed to the activities offered to the learners, which predominantly favored visual learning styles due to modular distance learning.

The table also displays the learners' combined learning styles along brain dominance before and after the study. Before the study, learners were classified as follows: 35% were left brain-visual, 40% were left brain-auditory, 15% were right brain-kinesthetic, and 10% were whole brain-kinesthetic among the Grade 7-Galileo learners. After the study, the data revealed a shift in the learners' preferred learning styles based on brain dominance. Specifically, 40% were classified as left brain-visual, 30% as left brain-auditory, 5% as left brain-kinesthetic, 10% as right brain-auditory, 5% as right brain-kinesthetic, and 10% as whole brain-visual.

The pretest results (M=-0.92, SD=1.16) and posttest results (M=-0.092, SD=3.96) indicate an improvement in learners' scores after the study was conducted. The study found that before it began, the learners were classified as left-brain dominant with a high negative mean value of -0.92. The study found that despite adopting brain-based learning strategies, learners were remained predominantly left-brain dominant, with a mean value of -0.092. By applying brain-based learning principles that cater to the development of neural pathways in both hemispheres, learners are likely to experience whole brain development. This was evidenced by data collected using the VAK Learning Style Questionnaire and Brain Dominance Test before and after incorporating brain-based learning lessons. Both pre- and post-BBL values were negative (-0.92 and -0.092), with the posttest value approaching zero, suggesting that learners are close to engaging both hemispheres of their brain during learning.

The t-test results indicated that the difference was not statistically significant, as the t statistic value of -0.83 fell inside the rejection region with a p-value of 0.42 at an alpha level of 0.05. Therefore, the difference is not significant. Implementing lessons based on brain-based learning led to increased test scores among learners but did not have any significant effect on their learning styles.

Discussion

Learning Styles of Students along with Right Brain and Left-Brain Dominance Before the Conduct of the Study

The research findings indicate that the majority of the learners were categorized as left-brain dominant, including 75% of the respondents. These findings align with the results of the study conducted by Deshmukh et.al. (2014), which revealed that the majority of respondents, accounting for 51.30% of the sample, were classed as left-brain dominant learners. In addition, the study conducted by Deshmukh, et.al (2014) found that just 1.54% of the participants w4ere categorized as whole brain or bilateral learners. This aligns with the findings of this study, where only 10% of the learners' population were classified as whole-brain or bilateral. Oflaz (2011) elucidated that educational institutions exhibited a preference for pedagogical approaches that were tailored to accommodate learners with left-brain dominance, while mostly neglecting the needs of right-brain learners. Moreover, conventional classes that rely on lectures and objective test questions mostly cater to learners who are dominant in their left cerebral hemisphere. As a result, students with a greater dominance of the left hemisphere of the brain were cultivated.

Out of the learners' population, three individuals, which accounts for 15% of the total, were identified as right-brain dominant. On the other hand, just two individuals, representing 10% of the learners, were defined as having a whole brain (bilateral) dominance. The study findings demonstrated the school system's preference for left-brain dominant learners by providing activities that specifically cater to their needs. Conversely, the creative abilities of learners who are prominent in the right brain are significantly hindered (Oflaz, 2011). This could be attributed to the fact that the majority of teachers are classed as left-brain dominant. This corroborates the research carried out by Suzani (2018). Therefore, the learners who have a dominant right brain and are frequently neglected performed inadequately in comparison to the learners who have a dominant left brain. The study conducted by Mahendiran and Gnanadevan (2020) uncovered that those with slower learning abilities had right brain dominance, whereas the majority of those with average and above-average learning abilities demonstrated left-brain dominance.

The education system in our country should incorporate activities that cater to all types of learners' cognitive dominance through the Department of Education. Teachers should offer exercises that will enhance the cognitive abilities of all learners. Furthermore, it is crucial to have a thorough understanding of the abilities and capacities of each student in order to provide effective learning opportunities (Mahendiran and Gnanadevan, 2020). To effectively teach, educators must possess the knowledge and skills to engage learners' minds in accordance with their individual preferences (Ellamil et al., 2012). In their study, Mahendiran and Gnanadevan (2020) determined that in order to enhance left-brain functioning in students, it is beneficial to structure activities that focus on processing speed, logical thinking, and tasks that require diligence and memory. These activities have the potential to effectively develop left-brain capabilities.

Supremacy. To enhance the development of learners' brain hemispheres, teachers should offer activities that stimulate the specific hemisphere of the brain that is being targeted for growth. The objective of this study was to enhance the development of both the left and right hemispheres of the learners' brains. In this scenario, the learner can benefit from bilateral dominance of the complete brain during the teaching and learning process (Dülger, 2012). Ghinea and Hadad (2014) argued that in order to foster comprehensive learning experiences, teachers should employ instructional and teaching strategies that engage both hemispheres of the brain. In order to enhance the development of the left-brain hemisphere in learners, teachers can engage students in activities such as delivering lectures and conducting computations, offering logical tasks that entail detecting causal linkages, and providing opportunities for independent work (Celik, 2007). During this period of dominance, the learners shown a preference for engaging in activities like as listening to lectures, participating in vocabulary-related tasks like crossword puzzles, engaging in discussions about abstract concepts, and completing other solitary and silent activities (Connell, 2002).

In addition, teachers can facilitate the development of learners' right brain hemisphere by implementing activities such as theater, image recognition, art projects, manipulatives, graphic designs, and other activities that encourage the stimulation of imagination (Celik, 2007). The individuals with this brain dominance exhibit a preference for engaging in collaborative activities, delivering innovative presentations, and participating in practical tasks (Connell, 2002).Furthermore, the bulk of the learners were auditory learners before the study was conducted. This might be attributed to the conventional method of education, characterized using lectures as the main instructional approach, where learning mostly occurs through verbal communication and auditory reception. Therefore, most learners favored auditory as their preferred learning style. The visual learning style is highly favored by learners, as indicated by the results of the VAK Learning Style Self-Assessment Questionnaire conducted by Chislett and Chapman (2005). Ibrahim and Hussein (2016) elucidated that most students commonly favored a visual learning technique. Learners with the lowest percentage prefer kinesthetic learning approach. Deshmukh, et al (2014) argued that equal attention should be given to all learners and no group should be neglected during the teaching and learning process. Teachers can improve learning circumstances for students by using visual, auditory, and kinesthetic learning activities (Lightbown & Spada, 2003). Additionally, the utilization of learning technologies that may integrate all the characteristics of the VAK Learning approach enhances the effectiveness of learning (Risnawati, Amir & Sari, 2018).

The data analysis showed that, before the study, most learners (40%) were auditory-left brain, 35% were visual-left brain, 15% were kinesthetic-right brain, and 10% were classified as kinesthetic-whole brain learners. The findings of this study were used to establish the learners' initial learning styles and brain dominance before the study commenced. Activities catering to various learning styles and brain dominance were offered. Learners were provided with learning experiences that foster the development of both the left and right hemispheres of their brains.

Effects of the Developed Lessons using Brain-Based Learning in Grade 7 learners' conceptual understanding, critical thinking skills, creative thinking skills, interest towards Physics and learning styles along brain dominance

The key findings of this research revealed that Brain-Based Learning significantly affects the development of the learners' conceptual understanding. The students' conceptual understanding improved due to the use of brain-based learning on the developed lessons supported with the following features: use of inquiry learning, integration of creative activities and flexible learning design. This study is congruent with the studies conducted by Suarsana et al. (2018), Saleh (2011), and Yatim et al. (2022), in which BBL produces a positive effect in increasing the conceptual understanding of the learners, the study of Ramirez and Ganaden (2008), Permana and Kartika (2021), Utomo (2016), and Costillas (2016), in which BBL produces a positive effect in enhancing the critical thinking skills of the learners, and the studies conducted by Adiansha et al. (2021) and Dahlan et al. (2019) and Wijayanti et al. (2021) revealing BBL to significantly the learners' creative thinking skills.

Brain-based learning also enhanced the learner's interest towards physics through the use of integrated games Kelkar (2003), and integration of practical life and other solutions to real-life problems (Cedere et al. (2018).

However, results of the study revealed that brain-based learning does not significantly affect the learning styles of Grade 7 learners along brain dominance. This is parallel to the study conducted by Duman (2010) in which brain-based learning was found to have no significant difference between the learner's achievement levels with different learning styles.

Overall, the developed lessons in Physics using Brain-Based Learning had positive effects on the development of the learners' conceptual understanding, critical thinking skills, creative thinking skills, and interest towards Physics. No significant effect was found in the learning styles of learners along left and right brain dominance. The findings were supported by the mean gain, mode, t-test, students' outputs and studies.

Conclusion and Recommendation

The findings proved that Brain-based learning can be used in teaching Grade 7 Physics to the students. Therefore, it is suggested that teachers may design varied teaching activities that utilize the left and right hemisphere of the brain for a more effective and efficient learning experience, lessons using brain-based learning with the following features including inquiry based Learning, integration of creative activities, and design for flexible learning can be developed for other topics in Physics, and teachers should continue to develop lessons using brain-based learning to enhance the students' conceptual understanding, critical thinking skills, creative thinking skills, and interest towards the subject.

Conflict of Interest

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