

Study of Academic Achievement in Mathematics in Relation to Brain Hemispheric Dominance

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Abstract: *The purpose of this study was to determine if there exist any relationship between hemispheric dominance and academic achievement in mathematics of the students of XI and XII class and to find the level of brain hemispheric dominance of the boys and girls. Study reveals that there is no significant relationship between academic achievement in mathematics and hemispheric dominance but boys and girl students differ significantly from their level of brain dominance.*

Keywords: Hemispheric dominance, SOLAT (Style of learning and thinking), Academic achievement in mathematics.

1. Introduction

Together with the philosophy, mathematics is the oldest academic discipline to mankind. Every culture on earth has developed some mathematics. In some cases mathematics has spread from one culture to another. Now there is one predominant international mathematics and this mathematics has quite a history. It has roots in ancient Egypt and Babylonia, and then grew rapidly in ancient Greece. Mathematics written in ancient Greek was translated into Arabic. About the same time some mathematics of India was translated into Arabic. Later some of this mathematics was translated into Latin and became the mathematics of the Western Europe. Over a period of several hundred years it became the mathematics of the world. Origin of mathematics is hidden in the evolution of nature. Creation of nature and mathematics are closely related. Mathematics is the science in which calculations are prime. It is an exact science and involves high cognitive abilities and powers.

1.1 Nature of Mathematics

Mathematics has its own language and symbols which cut short the lengthy statements. It helps in the expression of ideas or things by giving them the exact form. In other words mathematics is the language which was created by the mind of man. Lindsay a great mathematician remarks "Mathematics is the language of physical sciences and certainly no more marvelous language was ever created by the mind of man."

Mathematics is the science of logical reasoning where results are developed through a process of reasoning. By far most significant development in mathematics was giving it firm logical foundations. This took place in ancient Greece in the centuries proceeding Euclid. Logical foundations give mathematics more than just certainly the tool to investigate the unknown. As a science of abstract objects, mathematics relies on logic rather than an observation.

1.2 Importance of Mathematics

It is said that mathematics is the gate and key of all sciences. According to the famous philosopher Kant "A science is exact only if so far as it employs mathematics." So all scientific education which does not commence with

mathematics is said to be defective at its foundation. Neglect of mathematics works injury to all subjects.

One who is ignorant about mathematics cannot know other things of the world. Kant says "A natural science is a science if so far it is mathematical." And mathematics has played very important role in building up of modern civilization by perfecting all sciences. It is the queen of all sciences and language of the nature.

1.3 Human Brain and its Hemispheres

The human brain is a paired organ and consists of two halves (cerebral hemispheres) that look pretty, much similar but are not alike. Each hemisphere has functional specializations, different functions have neural mechanisms localized primarily in one half of the brain. The two halves of the brain cerebral cortex execute different functions. This theory was developed by Nobel Prize winners –Roger Sperry and Robert Ornstein. It helps in understanding our behavior, our personality and our abilities to use the proper mode of thinking when performing different tasks. The hemispheres are jointed by the corpus collosum, which is a bundle of millions of nerves that transmit data from one hemisphere to the other and helps them communicate.

1.4 Brain Hemispheric Dominance

Brain hemispheric dominance is the use of the different sides of the brain in learning and listening patterns that is to mean, the consistence of using one side of the brain over the other. Herrmann (1995) "Brain dominance was expressed in terms of how we prefer to learn, understand and express something." The term brain is used to describe the thinking modes of the brain. Although a function may depend more on one hemisphere than the other (e.g., language, motor control), the notion that one hemisphere is dominant and the other is non dominant is possibly too simplistic for describing most tasks (Gabbard, 1997). The term is also called Brain-Based Learning or Hemispheric Dominance or Cerebral Dominance.

1.5 Characteristics of the Left Brain Dominance

Intellectual, remembers names, verbal respond to instructions and explanations, experiments systematically and with control, makes objective judgements, planned and

structured, prefers established, certain information, analytic reader, reliance on language in thinking and remembering, prefers talking and writing, prefers multiple choice tests, control feelings, not good at interpreting body language, rarely uses metaphors and favours logical problems solving.

1.6 Characteristics of the Right Brain Dominance

Intuitive, remember faces, responds to demonstrated illustrated or symbolic instructions, experiment randomly and less restraint, make subjective judgements, fluid and spontaneous, prefers elusive, uncertain information, synthesizing reader, reliance on imaging in thinking and remembering, prefers drawing and manipulating objects, prefers open-ended questions, more free with feelings, good at interpreting body language, frequently uses metaphors, and favours intuitive problem solving.

1.7 Left Brain v/s Right Brain

Generally left or right brain i.e. left hemisphere or right hemisphere of our brain process information in different ways. Concept was developed by Roger W. Sperry an American psychologist in 1960. He discovered that human brain has two very different ways of thinking. One (right brain) is visual and process information in an intuitive and simultaneous way looking first at the whole picture than the details. The other (left brain) is verbal and process information in an analytical and sequential way looking just at the pieces then putting them together to get the whole. Sperry was awarded Nobel Prize for this left and right brain theory in 1981. Theories states that the right brain focuses on the visual and processes the information in intuitive and simultaneous way while the left brained person process the information in verbal and analytical way.

Certain individuals possess qualities that make them double dominant. Their preferred mode of thinking allows them to use both hemispheres equally. Individuals that display a double dominance are able to use both sides of the brain to logically process thoughts and create intrinsic values and decisions. This stage is called whole brain dominance or integrated dominance.

According to McCluskey and Parish, (1993) left hemisphere of the brain has been described as analytic in orientation, focuses on individual elements within a field and analyses them sequentially. The left hemisphere also supports speech in the vast majority of people, and there is growing evidence that the left brain when it comes to analyzing fine details in vision, auditions, and touches (Haseline, 1999). That is the left hemisphere processes verbal and non- verbal sequential information.

In contrast, the right hemisphere has been described as holistic is thought to be more creative and rational in nature, and is predisposed to see wholes simultaneously (McCluskey and Parish, 1993). The right cerebral hemisphere, by contrast, does a better job than the left in reading facial expressions, decoding tone of voice in speech, and comprehending the big picture in visual, auditory, and tactile stimuli. The function of the right brain is single stage,

parallel processing of many elements of information as a single whole.

2. Review of Related Literature

Steinberg(1993) continues that the brain assigns as it were certain structures and functions to certain hemisphere of the brain. Language, logical and analytical operations, and higher mathematics, for example, generally occur in the left hemisphere of the brain, while the right hemisphere is superior at recognizing faces and taking in the structures of things globally without analysis. This separation of structure and function in the hemisphere is technically referred to as lateralization or more popularly as handedness.

Bruer(1999) showed that girls to be more left hemisphere dominant, which means that they are better at analytical problem solving and verbal tasks. He also indicated that boys use the right hemisphere and perform better at drawing, painting, mathematics and visual verbal tasks. He encourages teachers to incorporate both parts of the brain in each lesson.

Bransford(2003) a current researcher in learning theory and brain based education, believe that the main goal of education is to help students to develop intellectual tools and learning strategies to be productive member of society . Current research in learning theory revealed that teachers should implement a multidisciplinary approach.

Vengopal & Mridula(2007) conducted a study aimed at examining the hemispheric preferences for information processing and style of learning and thinking in children. Study consists a sample of 250 students of class VIII consisting of boys and girls from five English medium schools. SOLAT (style of learning and thinking) developed by Dr. D. Venkataraman (1994) was used for collecting data. Study revealed that there was significant difference in the right and left brain dominance, preference of information processing among boys and girls, and also indicated that boys were more right hemispheric dominant and girls were more left hemispheric dominant

Kanmani & Annaraja (2010) designed a study to find out the influence of brain dominance and achievement in computer science of degree students. Brain dominance was developed from Alert scale of cognitive style by Loren D Crane. The study shows that there are three types of brain dominance were present namely moderate left brain, middle brain and strong right brain dominance. Study reveals that the middle brain dominant students have better achievement in computer science than the moderate left brain and strong right brain dominant students.

Riasat(2010) study the impact of brain based learning on students academic achievement to see the effect of brain based learning environment in secondary schools. Sample was divided in two groups, Experimental group and controlled group; each group having 25 students. Experimental group was taught by brain based techniques and controlled group by traditional method for data collection. It was revealed from the study that brain based

learning has positive effect on student's academic achievement.

3. Achievement in Mathematics

Trow (1960) Considered academic achievement as the attained ability or degree of competence of an individual in school tasks which is usually measured by some standardized tests and output or achievement of the student is expressed in percentages or grades. This is a relative measure of the position of individuals in a group. Dyer (1960) says "Academic achievement is the sum total of information a student has at his command when he finishes a course of instruction.

According to **Spence and Helmreich (1983)** "Academic achievement is the task oriented behavior that allows the individual's performance to be evaluated according to some internally or externally imposed criterion that involves the individuals in competing with others or that otherwise involves standard of excellence."

4. Significance of the problem

There is wide spread interest among all the countries in improving the level of achievement in Mathematics in schools. Apart from the economic benefits, it is argued that this would bring by better preparing young people for numeracy demands of modern workplaces and raising the overall skill levels of the workforce. There are also social benefits tied to improving access for large numbers of young people to post school education and training opportunities and laying stronger foundations to skills for lifelong learning. The interest in raising levels of achievement has led to a focus on identifying the range of factors that shape achievement as well as understanding how these factors operate to limit or enhance the achievement in different groups of students.

The Importance of scholastic or academic achievement has raised several important questions for educational researches. What factors promote achievement of the students? How far do the different factors contribute towards academic achievement? Many factors has been hypothesized and researched upon.

4.1 Objectives of the Study

The present study was undertaken by keeping in view the following objectives:

- 1) To find out the level of Brain Dominance of senior secondary stage students.
- 2) To study the relationship between academic achievement in Mathematics and Brain dominance.

4.2 Hypotheses

On the basis of above mentioned objectives the following null hypotheses have been framed.

H1. There is no significant difference between level of left or right brain dominance of students.

H2. There is no significant relationship between academic achievement in mathematics and brain dominance (left or right).

Tools used: The following Research tools are used to collect data for the study.

1. Brain Dominance test. SOLAT (style of learning and thinking),(By D. Venkataraman, 1994)
2. Achievement test in Mathematics (Developed by the Investigator)

4.3 Sample

In the present study researcher had selected a sample of 600 students from XI and XII class from the Government and Non-Government senior secondary Schools of Hoshiarpur, Jalandhar and Nawanshahar districts of Punjab.

5. Results and Discussion

In this section of analysis a preliminary assessment was performed on the basis of data collected from the students. The following table 1 gives the descriptive analysis of the academic achievement and dimensions of the brain hemispheric dominance.

Table 1: Distribution of the male and female students in terms of their brain dominance

Sex	Right Dominance	Left Dominance	Whole Dominance	Total
Boys	216(49.3%)	58(61.7%)	26(38.2%)	300
Girls	222(50.7%)	36(38.3%)	42(61.8%)	300
Total	438(73.0%)	94(15.7%)	68(11.3%)	G.T.=600

Chi Square = 8.996, $df = 2$, $p = 0.011 < 0.05$

Hypothesis H1

Chi square test of association was performed at 0.05 levels of significances for the assessment of the presence of association among the gender and brain dominance among the students. It is analyzed that the null hypothesis H1 assumed is rejected and there is significant association presents, as it reflects that majority of the boys are left brain dominant whereas majority of the girls are whole brain dominant while on being right brain dominance approximately both the sexes are in equal proportion.

The analysis of the table 1 reveals that among all students surveyed 73.0% was found to be right brain dominant students and among them 50.7% were the girls and 49.3% were the boys respectively. The 15.7% of the total students were found to be left brain dominant students and among them 61.7% was the boys and 38.3% of the students were girls. The proportions of whole brain dominant students were 11.3% of the total students and among them 61.8% were the girl students while 38.2% are the boys.

Table 2: Descriptive analysis of the academic achievement and dimensions of the brain hemispheric dominance of the students

Category	Mean	Standard Deviation	Median	Minimum	Maximum	Skewness	Kurtosis
Academic Achievement	74.35	14.487	75.00	36	100	-0.281	-0.708
Right Dominance	2.20	0.824	2.00	1	9	2.792	17.270
Left Dominance	17.97	5.560	18.00	0	34	-0.213	0.141
Whole Dominance	2.52	2.594	1.00	0	9	0.989	-0.097

The analysis of the academic achievement scores of the students from the table 2 shows that on an average they had scored 74.35 with standard deviation of 14.48 and 50.0% of the students had scored below and above 75.0 marks. The minimum marks scored by any of the student were 36 while maximum score of the student was 100. The data obtained for the student's academic achievement is negatively skewed as the co-efficient of skewness $s_k = -0.281$ which is negative and the graph of the data is platykurtic in nature as co-efficient of kurtosis is $\beta_2 = -0.708$.

The analysis of the brain dominance scores of the student's i.e. right brain dominance from the table 2 shows that on an average they had scored 2.20 with standard deviation of 0.824 and 50.0% of the students had scored below and above 2.0 marks. The minimum right brain dominance score by any of the student was 1.0 while maximum score of the student was 9.0. The data obtained for the students right dominance is positively skewed as co-efficient of skewness $s_k = 2.792$ which is positive and the graph of the data is leptokurtic in nature as co-efficient of kurtosis $\beta_2 = 17.270$.

The analysis of the brain dominance scores of the students i.e. left brain dominance from the table 2 shows that on an average they had scored 17.967 with standard deviation of 5.560 and 50.0% of the students had scored below and above 18.0 marks. The minimum left brain dominance score by any of the student was 0.0 while maximum score of the student was 34.0. The data obtained for the students left dominance is negatively skewed as co-efficient of skewness $s_k = -0.213$ which is negative and the graph of the data is leptokurtic in nature as co-efficient of kurtosis $\beta_2 = 0.141$.

The analysis of the brain dominance scores of the students i.e. whole brain dominance from the table 2 shows that on an average they had scored 2.52 with standard deviation of 2.59 and 50.0% of the students had scored below and above 1.0 mark. The minimum whole brain dominance score by any of the student was 0.0 while maximum score of the student was 9.0. The data obtained for the students whole brain dominance is positively skewed as co-efficient of skewness $s_k = 0.989$ which is positive and the graph of the data is platykurtic in nature as co-efficient of kurtosis $\beta_2 = -0.097$.

Table 3: Correlation analysis of the academic achievement in mathematics and the brain hemispheric dominance of the students

		Right Dominance	Left Dominance	Whole Dominance
	Karl-Pearson Co-efficient of correlation			
Academic achievement in mathematics		-.069	.069	.026

	P value	.093	.091	.531
	N	600	600	600

Hypothesis H2: From Table 3 the brain hemispheric dominance of the students with their academic achievement in mathematics shows that null hypothesis H2 is accepted as there is no significant relationship was established among the brain hemispheric dominance of the students and their academic achievement in mathematics. It is analyzed that the correlation co-efficient between the academic achievement in mathematics and the right brain dominance is $r = -0.069$ which is negative not significant at .05 and .01 level of significance. Also further it is analyzed that the correlation co-efficient between the academic achievement in mathematics and left brain dominance is $r = 0.069$ which is positive and again not significant in nature and lastly the correlation co-efficient of the whole brain dominance of the students and their academic achievement in mathematics is $r = 0.026$ which is also positive but not significant at any level of significance.

6. Findings

The present study reveals that that majority of the boys are left brain dominant whereas majority of the girls are whole brain dominant, while on being right brain dominance approximately both the sexes are in equal proportion. Further it is revealed that there is no significant relationship between brain hemispheric dominance and academic achievement in mathematics for boys and girls.

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