Correlating Brain Dominance and Hand Preference to Academic Tracks: A Case for Senior High School Students (SHS) in the Philippines

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Abstract

This study explored the correlation of hand preference to brain dominance of senior high school students (SHS) in the Philippines using the Hermann Brain Dominance Instrument (HBDI) questionnaire. Students were asked to accomplish the questionnaire and their scores were evaluated to confirm the theory of Sperry (1981) which suggested that the brain dominance of a person is lateral to his hand preference. Further, the characteristics of students in the four (4) academic strands for SHS were also assessed to verify if students have chosen the appropriate track that could enhance their skillset as individuals. Results revealed that Sperry's theory was conclusive since most of the students with right hand preference demonstrated left-brain dominance and possessed the characteristics of being analytical, logical, and critical thinkers which are appropriate for the academic track they were enrolled in while students with left-hand preference are creative thinkers and artistic and exhibited dominance of the right side of the brain. Students who posses the character of being logical and have above average ability in mathematics and problem solving may pursue careers in science, technology, and engineering since these professions require analysis of data, perform various calculations, and create innovative designs. Consequently, the study will aid not only the students in finding the best profession suited for them in the future but will also help the teachers in assessing the profiles of their students to identify the suitable teaching methodologies in the classroom.

Keywords
Brain dominance, left and right brain hemisphere, hand preference, academic strands

1. Introduction

High school students all over the world encounter problems on finding the right career path and program that will suit their personality and skills or raise awareness on their academic track. Students commonly display limited awareness and substantial belief ambiguity, especially regarding lower-ranked options thereby showing significant heterogeneity in students' initial knowledge and learning patterns across demographics and socioeconomic characteristics (Giustinelli and Pavoni, 2017). Students strive in conceptualizing their future or preferred career because of lack of comprehension on their skills, peer pressure, and financial incapacity. Social researchers like Bancroft, A. et al. (2017) observed the generalization danger --- which is the phenomenon of "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" --- in academic settings. In another study, Korkmaz (2015) pointed out several factors that are considered to affect the career choices of high school students and these include: gender, parents' educational level, family income, and school type. While the different academic programs all over the world help and guide students of their career paths to take, it is still a challenge of how precise these tend to be. In the Philippines,

the success of the reform made by the government on primary and secondary education, called K to 12 program is still under study and factors and policies are still needed to address the challenges that Filipino students face (Okabe, 2013). Montebon (2014), however, pointed out that one of the values and benefits of this program is the positive effect towards the way students learn science concepts and acquire scientific skills, academic attitudes, and develop values. The new curriculum included assessments or examinations for Grades 10 and 12 to identify students' abilities in leaning and innovation, IT and media, effective communication, and life and career.
To guide senior high school (SHS) students of the right career they could take, particularly to verify if their current academic strand is suitable for their skills and abilities, this study will utilize the application of brain hemisphericity using Sperry's (1981) "Split-Brain Experiments" that is said to conduce the functions of the left and right side of the brain. Pearce (2019) recalled that Sperry discovered the right side of the brain as the weaker and dyslexic side that lacks better cognitive understanding prior to the dominant side while the left side as being more into the analytical and verbal compounds of thinking. This study will also explore the correlation of hand preference to brain dominance to aid the teachers in assessing the profiles of their students and help them identify the suitable teaching methodologies in the classroom.

2. Literature Review

The idea that the left and right hemispheres exhibit different patterns of thought has caught the public attention and has inspired several education researchers. Soyoof, et al. (2014) investigated the effects of students' brain dominance on the degree of their vocabulary retention and found that both-brained learners are better in vocabulary retention since they use two hemispheres of their brain equally in getting new information. Another study by Oflaz (2011) correlated the two (2) sides of the brain to learning the English language using cognitive learning procedure through brain dominance examination. Left-brained students displayed better results in reading analysis while the other side showed better visuals and performance with wordy subjects. Further, it is also evident that there is a significant difference between students with different brain dominance in terms of learning ability: left-brained memorized the sequence of letters in a word, while right-brained memorized the image of the whole word (Thaha and Mohammed, 2019). Chen, et al. (2019) were able to explore and uncover the relationship between the functional hemispheric lateralization and creative thinking ability and identified the features of hemispheric interaction in relation to visuospatial and verbal creativity. With this, educators should consider having a well-balanced learning styles by exploring different teaching methodologies and classroom activities suitable for different types of learners. Regardless of their own brain dominances and learning style profiles, teachers should be sensitive to learning requirements of students with different structures depending on these individual differences in the classroom. Providing opportunity for students to use their brain hemispheres makes learning more effective and flexible (Amzat, 2011). Singh (2015) mentioned that mathematics is considered as a big part in science, engineering and philosophy as it uses more of the logical aspect than observation. His study on interaction effect of brain hemispheric dominance and self-concept on academic achievement in mathematics showed that there is a significant relationship established in one of the interactions of the study. Further, he found that there is a significant relationship among the different categories of self-concept of the students with their academic achievement scores in the subject matter.

The use of hands in writing and learning has also been studied by various researchers in different fields. Different theories have been put under study for the brain laterality of left-handers, right, either, both or some combination of these (Hancock and Bever, 2013; Grey, et al., 2017). The individual differences for handedness must be acknowledged by the theories of evolution and history of handedness that these differences are characteristics of all human groups in modern populations wherein the majority is right-handed (Annett, 2002). Marcori, et al. (2019) suggested that neural asymmetries related to handedness are likely a consequence of lateralized practice since they correlate with modifications in the behavioral patterns. Other researchers have also explored the use of visual, auditory, reading, kinesthetic or VARK model of Fleming and Mills (1992) to determine the characteristics of a left-right distinction. The visual and kinesthetic components associated with the right hemisphere is more a model of perceptual style rather than cognitive style and does not address the different modes of thinking exhibited by sequential/holistic styles (Morris, 2006).

Engineers can be more than logical and creative, and technical professionals such as engineers are using primarily the left hemisphere of their brain to function effectively. Engineering entails logical and sequential collection and analysis of data, calculation, and creating designs to meet requirements. Thus, this type of work requires a lot of problem-solving activities. Although engineers primarily are left-brained, they can also identify creatively and innovatively

and pursuing opportunities (Waelsh, 2012). Kumar and Sharma (2016) related the brain dominance of a leader towards total quality management (TQM) which has two (2) distinctive results identified as continuous improvement and innovation. The study aimed to prove whether the left-brained dominant leaders emphasize on continuous improvement, and the right-brained dominant leaders are more focused on innovation. They explored the different characters of right and left-brained TQM leaders whose approach are different while supporting the principles of TQM such as strategic planning and decision making, in relation to the continuous improvement and innovation that they hypothesized for the specific leaders' brain side. The study revealed that the left brain has the top-down control which is accountable for skillsets that includes judgmental thinking, tactical planning, and persistent intelligent; the qualities factually accounted for people who have distinct rational, logical, and abstract cognition. The right brain side, on the other hand, controls the bottom-up which is associated to empathy, creativity, and flexibility, skills that relies on creative thinking, communications, and expression. Moreover, right-brained leaders were discovered to be more inclined to innovation than the left-brained ones who focuses more on continuous improvement and planning.

3. Methodology

The study involved Grade 12 students of senior high school education in one of the premier universities in the Philippines, to see if the results of their brain lateralization assessment can be linked to their preferred degrees or programs in undergraduate education. The sample size of students enrolled in the four (4) academic strands --- Science, Technology, Engineering and Mathematics (STEM); Accountancy, Business and Management (ABM); Humanities and Social Sciences (HUMSS); and General Academic Strand (GAS) --- were computed using the Slovin's formula, the mathematical model also utilized in other researches (German and Catabay, 2018; Huang, et. al., 2019).

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Using a 10% margin of error, a total of 173 students from the four (4) academic tracks were given ample time to complete the Hermann Brain Dominance Instrument (HBDI) questionnaire (Herrmann, 1995), an organizational material used to analyze the brain dominance of a specific person based on their handedness and other affecting factors.

The instrument has 120 questions clustered into eleven (11) sections as follows: a) biographical information - containing the respondent's personal data such as gender and academic strand, b) handedness – identified based on how the respondent holds a writing material, c) school subjects - ranking of three (3) school subjects from 1- being the best to 3 – the least, to gauge what subject is most preferred and relate it to brain dominance, d) work elements – scaling of work-related elements to identify which brain side is used to think, e) key descriptors – identifying eight (8) adjectives that best describes the respondents, f) hobbies – selection of six (6) out of a list of hobbies the respondent is currently enjoying or engage in, g) energy level - selecting either being a day person or night person, h) motion sickness – sensing how the respondent reacts to the motion of a vehicle, i) adjective pairs – choosing a descriptive word out of two (2) choices, j) introversion/extroversion – understanding how the respondent dwells with other people, and k) 20 questions considering the respondent's agreement on different scenarios or situations.

In a period of one (1) week, the questionnaires were distributed to the SHS students of the HEI. Students in each class/section were given 30 minutes to answer the questionnaire. A facilitator was present during the time to assists the students. Upon completion, the responses were checked and recorded. The group examined three (3) STEM classes, two (2) ABM classes, two (2) HUMSS classes, and one (1) for GAS. Using the record of responses, analysis of variance (ANOVA) was performed to prove if there are any significant differences among the responses of the four (4) groups.

4. Results and Discussion

4.1 Science, Technology, Engineering and Mathematics (STEM) Academic Strand

The STEM academic strand focuses on the fields of science, mathematics, and technology. The foundation of this strand is heavy on analysis, critical thinking, and mathematical computations. Those who chooses this strand may enter careers in engineering, health and medicine, architecture, IT, and other technology-related math-based

foundation programs. Figure 1 presents the scores of students with right hand preference where 31.16% or twenty-four (24) out of seventy-seven (77) posted high scores that range from 83 - 97.

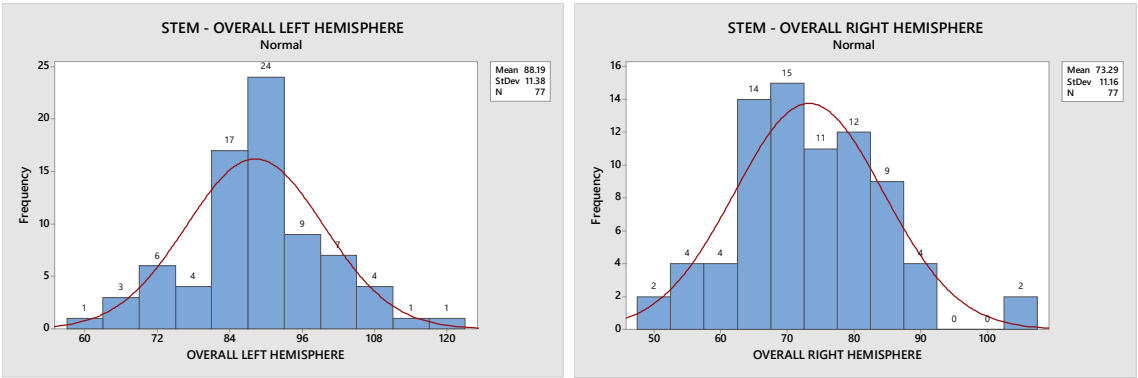

Figure 1. Overall Left and Right Hemisphere Histogram (STEM): Right-hand Preference

The data show that more STEM students with right hand preference have higher scores on their left dominant brain side, as the range of scores on their right hemisphere yielded better values, corresponding to 84.42% for dominance on the left hemisphere and only 15.58% on the right side. Following Sperry's (1981) theory, the skillset of right-handed people would fall on their left hemisphere. The results of the overall STEM data justify the theory of lateralization of hand to dominant brain hemisphere and validated that the skillset of students enrolled in the STEM track is appropriate for those with a dominant left brain. Computing for the mean and standard deviation of the scores in overall left and right hemisphere, with values of 88.19 and 11.38 for the left, and 73.29 and 11.16 for the right, respectively, show high variability which suggests that the level of dominance of both hemispheres are distant from one another. Thus, this proved that most respondents are only dominant on a specific side of the brain which is the left side.

Figure 2 presents the scores of students with left hand preference. It can be seen that students' scores range from 72.5 to 77.5 with a frequency of 50% or 7 out of 14. Still on the working theory, left hand preference falls on the opposite of the STEM skillset, but it is seen that the theory of lateralization is still justified since majority of the left-handed students are dominant on their right brain side, with higher scores on the right hemisphere. Similarly, a majority of eight (8) out of fourteen (14) students or 57.14% proved the accounted theory of lateralization for left-handed. However, the students' skillsets are not favorable to their chosen academic track as the right hemisphere is more focused on linguistic characteristics. The standard deviations for left-handed students have values of 10.39 and 9.76 for the left and right hemisphere, respectively. This suggests high variability among the scores and implies that one side of the brain is more dominant than the other.

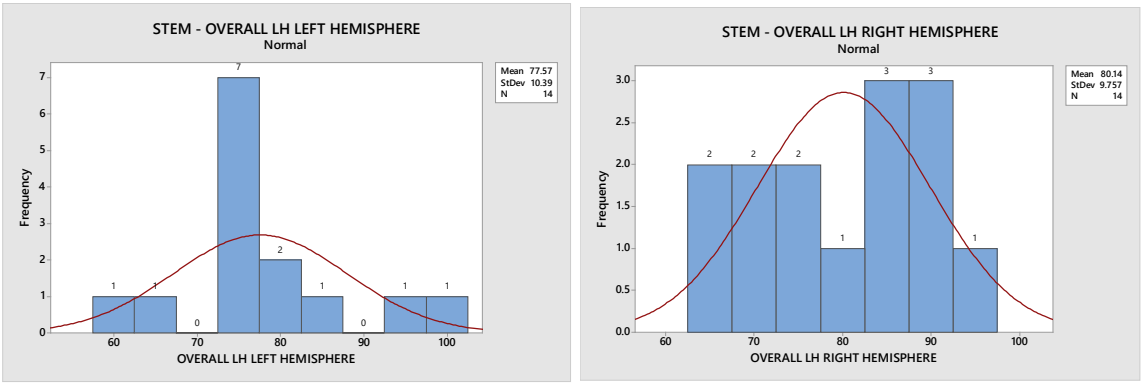

Figure 2. Overall Left and Right Hemisphere Histogram (STEM): Left-hand Preference

4.2 Accounting, Business and Management (ABM) Academic Strand

The ABM academic strand focuses on financial management, business management, and corporate operations. This track can lead students into career of management and accounting for key positions in sales and marketing, human resources, project management, accounting, and others. Figure 3 shows the results for students with right hand preference. Students' scores for the left hemisphere range differently, from 75 - 81, 81 - 87 and 87 - 93 with a frequency of eleven (11), six (6), and eight (8) out of thirty-seven (37) respondents. This suggests higher result compared to the right hemisphere, with varying range of 67.5 - 72.5, 72.5 - 77.5 and 77.5 - 82.5. The figures illustrate similarity to the STEM data, which suggests that students from ABM track have dominant scores on the left hemisphere. Overall, 78.38% of the respondents has dominant left brain which mean that majority of them demonstrated the following characteristics that are needed for their future careers: analytical, logical, and pays attention to detail. The standard deviations of 11.72 and 11.28 for the left and right hemisphere suggests high variability which means that majority of the students have a dominant side.

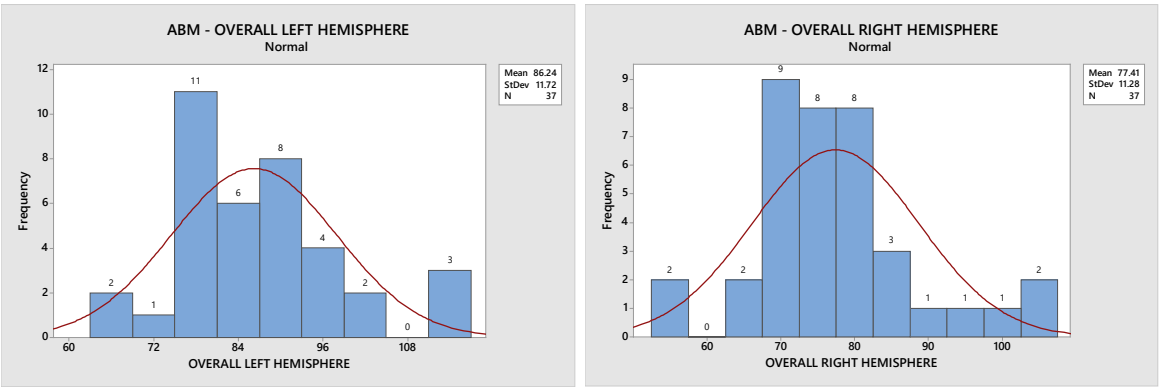

Figure 3. Overall Left and Right Hemisphere Histogram (ABM): Right-hand Preference

Interpretation of results for students with left-hand preference was hardly conclusive because only five (5) students were found to be left-handed. This would mean that overall assumption for this group would not be entirely representative of their population. To satisfy the objectives of the study, data for this group is still presented in Figure 4. Data shows that students' score for the left hemisphere ranges from 75 - 85 with a frequency of two (2) out of five (5) while two (2) students also got scores between 82.5 - 87.5 for the right hemisphere. In addition, three (3) students show dominance of the right hemisphere.

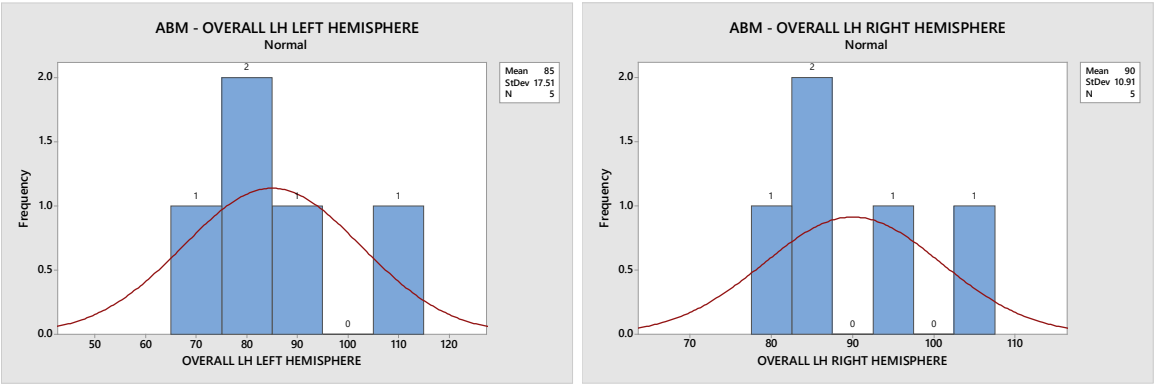

Figure 4. Overall Left and Right Hemisphere Histogram (ABM): Left-hand Preference

4.3 Humanities and Social Sciences (HUMSS) Academic Strand

The HUMSS strand focuses on creative thinking, ideal for those who are artistic, creative, and imaginative. This track is suited for careers in journalism, communication arts, liberal arts, education, and other social science-related profession. Results for students with right-hand preference is exhibited in Figure 5. Notice that only five (5) out of twenty (20) students got high scores for the left hemisphere while more students posted higher test results for the right hemisphere, with range of 87.5 - 92.5. Overall, thirteen (13) out of twenty (20) or 65% of the group has a dominant right side of the brain.

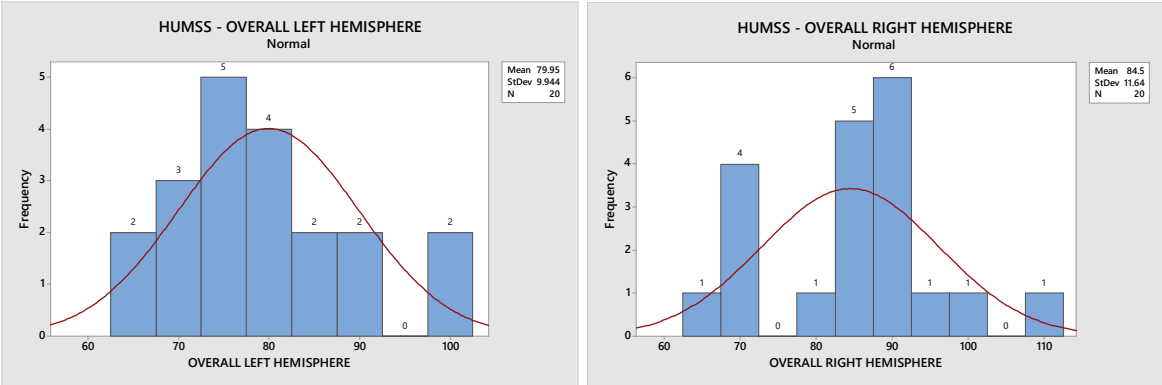

Figure 5. Overall Left and Right Hemisphere Histogram (HUMSS): Right-hand Preference

Contrary to the brain lateralization theory of having a right-left, handedness-dominant brain side, the result still proved that majority of the students are on the right academic track since they possess the skill set appropriate for their future careers. Like the other strands, the standard deviation for this group possess high variability and signifies dominance of one side of the brain.

For students with left-hand preference, illustrated in Figure 6, the result was somewhat inconclusive because only six (6) students were found to be left-handed. However, all six (6) of them demonstrated dominance on the right side of their brain which confirms the relationship of having left handedness to the characteristics of the right hemisphere --- holistic thinking, arts, and visualization --- best suited for careers in the field of creative thinking, journalism, and writing.

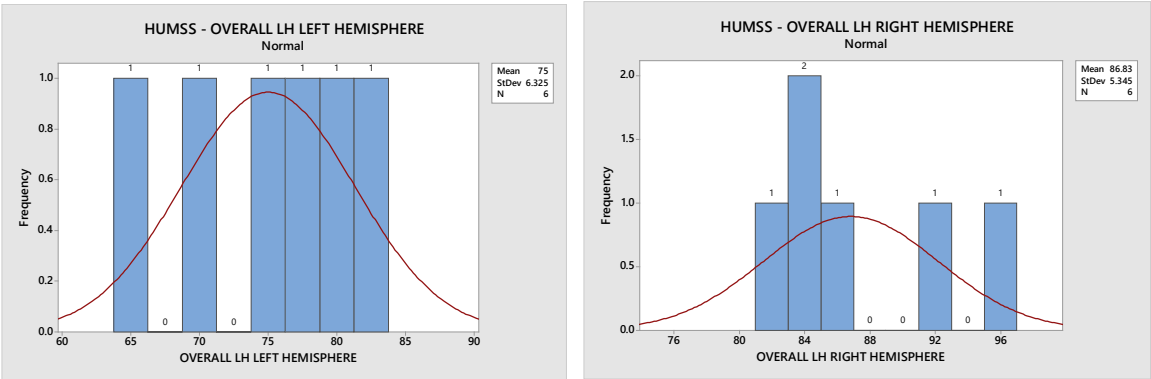

Figure 6. Overall Left and Right Hemisphere Histogram (HUMSS): Left-hand Preference

4.4 General Academic Strand (GAS)

While the other strands are career-specific, GAS is suited for students who are still undecided on which career to take. Students can choose electives from the different academic strands under this track. The subjects include Humanities, Social Sciences, Applied Economics, Organization and Management, and Disaster Preparedness. Figure 7 shows the results for respondents with right-hand preference.

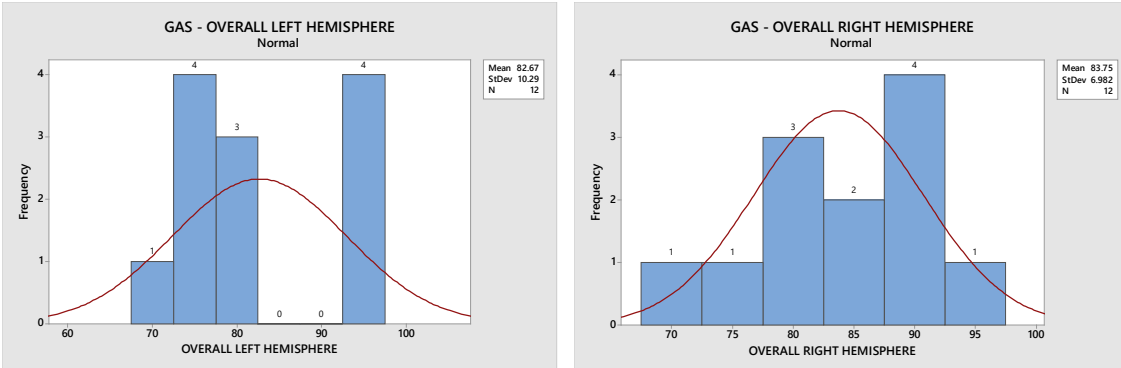

Figure 7. Overall Left and Right Hemisphere Histogram (GAS): Right-hand Preference

The data show inconsistency of scores for both hemispheres, with varying frequency range of 72.5 - 77.5 and 92.5 - 97.5 for the left and 87.5 - 92.5 for the right hemisphere. This signifies the suitability of why these students opted for the GAS strand, because they are unaware of the skills that they possessed and are still uncertain of the career path they would take. The results are equal for both brain hemispheres. There was an even distribution of brain dominance for this group since six (6) out of twelve (12) or 50% of students have dominant left-side and another 50% have a dominant right side. Finally, since all students were right-handed, interpretation for left-hand preference was not established.

4.5 Comparison of STEM, ABM, HUMSS, and GAS Strand

Tables 1 and 2 display the summary of results on brain lateralization with hand preference for senior high school students in the subject HEI. It is evident that 84.42% of STEM students showed dominance on their left hemisphere, while only 15.58% on the right one. According to the theory of Sperry, the skillset of right-handed people would fall on their left hemisphere. The results of the overall STEM data justify the theory of lateralization of hand to dominant brain hemisphere and validated that the skillset of the STEM program is best suited for those with a dominant left brain. On the ABM strand, the results are fairly similar to the STEM strand as skillset for both strands are identical to one another, with values of 78.38% for the left hemisphere and 15.58% for the right hemisphere. The HUMSS strand showed opposite characteristics from those in the STEM and ABM but revealed an almost perfect justification for the working theory, meaning that most of the students in the strand are appropriate for their skillset and their chosen track. Moreover, the evidence of the theory is highly recognizable in the HUMSS track where 100% of the left-handed and 65% of the right-handed have dominant right side of the brain. Lastly, GAS strand is known to offer the middle skillset apart from the other three (3) groups and was designed for those who are uncertain in their abilities and dream professions. The result of 50% and 50%, for the left and right brain dominance, suggested the same. Students enrolled in this track could be properly guided in order to help them realize the best careers suited for them in the future.

Table 1. Summary of Results for Students with Right-Hand Preference

Right-Hand Preference	Dominant Left Hemisphere	Dominant Right Hemisphere
STEM	84.42%	15.58%
ABM	78.38%	21.62%
HUMSS	35%	65%
GAS	50%	50%

Table 2. Summary of Results for Students with Left-Hand Preference

Left-Hand Preference	Dominant Left Hemisphere	Dominant Right Hemisphere
STEM	42.86%	57.14%
ABM	40%	60%
HUMSS	0%	100%

GAS	0%	0%

Table 3 presents the result of ANOVA for the STEM strand. With a p-value of 0.000 for students with right hand preference, the result is seen as highly significant as it is ≤ 0.05. This result suggested that the theory of brain lateralization was proven. In the theory, those who have right handedness often have dominant left-brain side which characteristics involved having analytical and mathematical skillset. The skillset that the students have is seen appropriate for their chosen program.

Table 3. ANOVA Result for STEM Strand – Right-Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	8558	8557.8	63.35	0.000
Error	152	19314	127.1		
Total	153	27872			

Table 4. ANOVA Result for STEM Strand – Left- Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	8558	46.29	0.46	0.506
Error	26	19314	101.58		
Total	27	27872			

The p-value of 0.506 in Table 4 referring to those with left-hand preference suggests that there is no significant relationship between the variables; thus, accepting the null hypothesis. Students that have left handedness would significantly have dominant right side of the brain which is contradictory to what skillset their chosen track offers. The high p-value suggests that the students in STEM with left handedness fall on the grounds of a sample size that have equivalent mean, this suggests that the right brain dominant and the left-brain dominant STEM students have no statistical relationship, and the results are highly different without either dominant brain side standing out. This may be because of the contradictions of those left-handed with also a left-brain side, that have skillset relative to STEM strand.

For the ABM strand shown in Table 5, the right handedness for left hemisphere against the right hemisphere resulted into a p-value of 0.001 which is less than 0.05, meaning that the results obtained prove significance on the theory of brain lateralization that a person's brain dominance is lateral to his hand preference. Thus, rejecting the null hypothesis. In addition, their brain lateralization might affect to boost students' performance on their strand. ABM strand is inclined to numerical solutions and computations and is fit for financial computation and marketing strategies. It is seen to be appropriate to the respective academic track and suggests that the skillset is matched. Thus, the theory is again proven to be correct.

Table 5. ANOVA Result for ABM Strand – Right-Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	1445	1445.0	10.93	0.001
Error	72	9520	132.2		
Total	73	10965			

For ABM students with left hand preference, comparing the left and right hemisphere resulted to a p-value of 0.602. This means that the results obtained prove insignificance to the theory of brain lateralization. On contrary, these students are seen to be unfit to their respective academic track and suggests that their skillset is mismatched. Since they are left-handed, they are probably more creative and imaginative and therefore should pursue careers in other fields and not in ABM.

Table 6. ANOVA Result for ABM Strand – Left- Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	62.50	62.5	0.29	0.602
Error	8	1702.00	212.75		
Total	9	1764.5			

The results for HUMSS students for right hand preference has a p-value of 0.192, as presented in in Table 7. This suggests that there is no significant difference between the two variables. In this group, their skillset or character involving the left side of the brain is seen as contradicting to their chosen academic track. The high p-value suggests that the connection between the means of the given data have no relationship to one another.

Table 7. ANOVA Result for HUMSS Strand – Right-Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	207.0	207.0	1.77	0.192
Error	38	4451.9	117.2		
Total	39	4658.9			

Consequently, responses of left-handed students yielded a p-value is 0.006 which is less than the significance level of 0.05. The result shows high significant difference between the two means. Left-handed people tend to be more creative or artistic therefore majority of them are right-brained. As explained, HUMSS is an academic track that focuses on logic, language, and critical thinking of the students. It shows that the theory proves that majority of the HUMSS students are on the right academic track since they chose the program that is related to their skillset.

Table 8. ANOVA Result for HUMSS Strand – Left- Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	420.1	420.1	12.25496	0.006
Error	10	342.8	34.28		
Total	11	762.9			

Finally, for GAS, the p-value of 0.766 was computed for students who are right-handed, and no student preferred to be left-handed. Students who are enrolled in this track are still undecided to which career they would like to pursue. In summary, a high p-value for this group suggests uncertainty in students' characteristics.

Table 9. ANOVA Result for GAS Strand – Right-Hand Preference

Source	df	Adj SS	Adj MS	F-Value	P-Value
Factor	1	7.042	7.042	0.09	0.766
Error	22	1700.92	77.314		
Total	23	1707.96			

The result can help students enhance their skillset and take up courses that would eventually fall on what dominant brain side they have. Numerous electives from the other strands are offered to the students of this strand to further enhance their abilities and help them decide which career path they should follow. The theory can serve as a guide in finding the suited profession that matches their mindset and that can complement the skills they acquire.

5. Conclusion

The theory stating that individuals may be left-brained or right-brained means that people in general have specific skillset unique to the activities of the brain. The working theory of Split- Brain Experiment of Sperry suggested that the brain dominance of a person is lateral to his hand preference. Following this theory, this study centered on the

comparison of academic skills of students enrolled in the various academic strands in Senior High School education in the Philippines. Examination results of selected group of students revealed how majority appropriately selected the specific track they are in where 84.42% with right hand preference and 42.86% with left hand preference for STEM students and 78.38% and 40% of the right and left handed, respectively, for ABM students demonstrated dominance of the brains' left hemisphere, a character appropriate for those who are analytical logical, and critical thinkers. On the other hand, 65% of the right-handed and 100% of the left-handed students in HUMSS track exhibited dominance of the right side of the brain, suitable for careers in journalism, communication arts, liberal arts, education, and other social science-related profession of students who are artistic, creative, and imaginative. Finally, students enrolled in the GAS strand, who are all right-handed, displayed contrasting characters since half of them have dominant right side and another half with dominant left side. This suggests that students in this group may take careers either in engineering, technology, journalism or social science profession in the future.

Future researchers may explore on correlating the dominant brain side to the academic scores or grades of students to create a profile on which field their motor skills are mostly accustomed to, and for these students to fully develop their expertise. Using the academic scores or grades, researchers can create a comparison on the connection of their dominant hemisphere to their grades in different courses that varies among skillsets from both brain side. Another subject to consider is involving the junior high level for them to know which of the senior high academic track best suited their abilities and character. Exploring these studies can help students assert their personal traits and relate those to their academic skillset which would be beneficial in continuing a path or career suitable for them may it be in the fields of engineering, medicine, and architecture, or the shift to the aesthetics of creative arts and literature.

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