IDENTIFICATION OF THE BRAIN HEMISPHERIC DOMINANCE OF UiTM STUDENTS USING EEG

Ahmad Faris Bin Junaidi
Faculty of Electrical Engineering,
Universiti Teknologi MARA Malaysia,
40450 Shah Alam,
Selangor Darul Ehsan.
farisjunaidi@yahoo.com

Abstract— **The purpose of this study is to identify the brain hemispheric dominance of UiTM students using EEG. It is a study that will compare the usage of the brain used by students from different field of study background. The study has been made on students from the electrical engineering faculty (FKE) of UiTM Shah Alam and also on the students from the faculty of technology creative and artistic (TEKA) of UiTM in Puncak Perdana. Entirely, there are 30 samples all together, 15 of them are from the electrical engineering faculty and the other 15 are from the technology creative and artistic faculty. The comparison between these two faculties was made on the overall maximum value of both hemispheric side of the brain, the BETA maximum value and also on the results obtained from the questionnaire. To acquire the EEG data from the samples, a three minute EEG data reading on the brainwave needs to be done on each sample. In conclusion to this study, from the obtained results, it is evidently that students from engineering background has a dominance of the left hemisphere of the brain and students from the arts background has a dominance of the right hemisphere of the brain.**

Keywords: Electroencephalogram (EEG); Faculty of Electrical Engineering (FKE); Faculty of Technology Creative And Artistic (TEKA)

I. INTRODUCTION

The purpose of this project is to identify the brain hemispheric dominance of UiTM students. It is believed that it is important for students who attempt to enroll into higher education institutions to identify which part of their brains is dominant. This project intends to scientifically prove that students which come from an art background use their right hand side of the brain more than their left side of the brain. And students with engineering background use less of their right side of the brain as compared to their left. A person who is said to be creative usually have a right brain dominance, and meanwhile for a person who is more to logical thinking usually have a left brain dominance. As the attributes left and right hemispheres of the brain are different, this study will assist students to determine what program that suits them best. This will allow the students to gain insight into their thinking style and are able to formulate their learning strategies. The data will be collected using the EEG. The results of the overall maximum value, the maximum value of BETA and the results obtained from the questionnaire is taken into account. The reason of why an analysis was only made on the BETA wave is to observe that, when a sample is in an idle state, which hemispheric side of the brain has a larger reading of the BETA wave as the BETA is associated to the alertness of a person and also when a person is in a concentrating state of mind. The value will indicate whether a sample has right or left hemisphere dominance. 30 human samples were used to collect the brainwave data, 15 from them were taken from the electrical engineering faculty and the other 15 were taken from the arts faculty.

A. Problem Statement

Data from the U.S. Census Bureau revealed in 2000 that one in three Americans drop out of college. This is an increase from the 1960s when one in five discontinued his or her studies. Though research links financial difficulties to dropout rates, there are a number of factors that account for why students decide to leave school. One of the reason students tend to drop out is because they also suffer from lack of motivation, inadequate preparation, and poor study skills [1].

In Malaysia, About 4,800 students drop out of or are expelled from public institutions of higher learning every year. The students usually dropped out of or were expelled because of unsatisfactory academic results, inability to enroll for courses or pursuing studies [2].

One way to reduce the number of dropouts is to assist students on deciding which course to pursue in higher education institutions. This can be done by identifying the student's brain hemispheric dominance. According to Hermann N. states that, people have different thinking processes and different learning styles [3]. Markova D. suggested that, we take on and process in different ways. Some

differences in learning style appear to be related to which side of the brain one prefers to use [4]. Springer S. P. summarized and evaluated the extensive scientific literature on different thinking process of the left and right brain hemisphere of the brain. Left brain thinkers respond best when they can quantify, analyze, and theorize about things. Right brain thinkers learn best when they can explore ideas, discover on their own, and conceptualize what is happening [5].

Based on this, it is important for students who attempt to enroll into higher education institutions to identify which part of their brain is dominant. This project aims to assist students to determine what program that suits them the best by determining the student's brain hemispheric dominance. It is hoped that this will increase the student's academic readiness thus help them to achieve academic excellence.

B. Significance of the study

This study will contribute to students who wish to gain insight into their thinking style and are able to formulate their learning strategies. The study will also augment efforts in creating graduates who will be holistic in thinking, the data will provide with some preliminary insight into potential redesigning of curricular enriching of content and rethinking instructional practices. Faculty members will also be able to make efforts to appreciate and encourage creativity in their students, thus creating a more hospitable classroom environment. The results are very useful to the class instructor/lecturers as they can expand their teaching strategies to meet the thinking style of all students in their classes.

C. *Objective* and Scope of the Study

The following are the main research questions to be explored in this project. In which brain hemispheric do the respondents fall into as analyzed through statistical technique, and also what are the possible explanations for the hemispheric dominance when analyzed in human brainwave classification research.

In order to answer the research questions, two objectives are identified. Which are, to ascertain the brain hemispheric dominance of University Teknologi MARA and also to offer causal explanations into the subjects' brain dominance.

This research is limited to University Teknologi MARA Students. The brain dominance of the students was investigated.

D. Human Brain

The human brain is one of the most important organs in a human body. It is the core of the nervous system. The human brain is protected by a hard skull named cranium and the brain is used to control different kinds of senses like, taste, balance, smell, vision and etc [6]. The most highly developed part of the human brain is the cerebral cortex. The cerebral cortex is an intricate layer of neural tissue that covers the outer surface of the brain. Massive addition of the development comes from the frontal lobes, located behind the forehead. Frontal lobes are responsible for self-control, planning, reasoning, and abstract thought [7].

Another great addition to the development comes from the part of the brain that centralized the visual perception system. The entire brain is enveloped by the skull and three tough membranes. The spaces between these membranes are filled with fluid that cushions the brain and keeps it from being damaged by contact with the inside of the skull. However, the brain is extremely sensitive and delicate and this makes it liable to damages and disease. Common causes brain damage includes are physical trauma such as stroke, or blows to the back of skull. The human brain is also susceptible to disorders which are caused by progressive failure and death of nerve cells such as Parkinson's disease, multiple sclerosis, and Alzheimer's disease [6] [7].

E. Brainwaves

The human brain produces five types of waves, which each one of it has its own distinctive function. The waves are ranged from 0-100 over of frequency. Table 1 shows the function and range of each type of the waves [8].

Table 1. Brain State Followed by the Range of Frequency

	Frequency (Hz)	Meaning	
Delta	up to 4	A person is in deep sleep and in babies.	
Theta	4-7 Hz	A person is drowsy or in arousal. Young children's brainwave.	
Alpha	8-12 Hz	A person is awakened and truly relaxed. Or during closed eyes.	
Beta	13-30 Hz	A person is awaken and alertness condition.	

F. Electroencephalography

Electroencephalography (EEG) is a medical imaging technique that reads scalp electrical activity generated by brain structures [3]. Nowadays EEG is used in clinical practices. Due to its ability to detect brain activities, it is use in cases of seizure, as it creates clear abnormalities on a standard EEG study. Apart from that, it is also used in the diagnosis of coma and brain dead. EEG used to be the first line method for the diagnosis of tumors, stroke and other focal brain [3]. In this project the EEG equipment that was used in order to collect data from the human samples. There are five probes all together, channel 1 was used for the right hand side of the brain and the channel 2 was used for the left side of the brain. And there was a probe for ground which was place on the centre of the forehead of the sample.

II. METHODOLOGY

This research has been conducted at The Biomedical Research Laboratory for Human Potential, Faculty of Electrical Engineering, UiTM Shah Alam and also at the Faculty of Technology Creative And Artistic (TEKA) UiTM in Puncak Perdana. The methods of obtaining the results will be further discussed in this section. Many steps have to be made in order to obtain an artifact free result. These steps are summarized in the flow chart as figure 1.

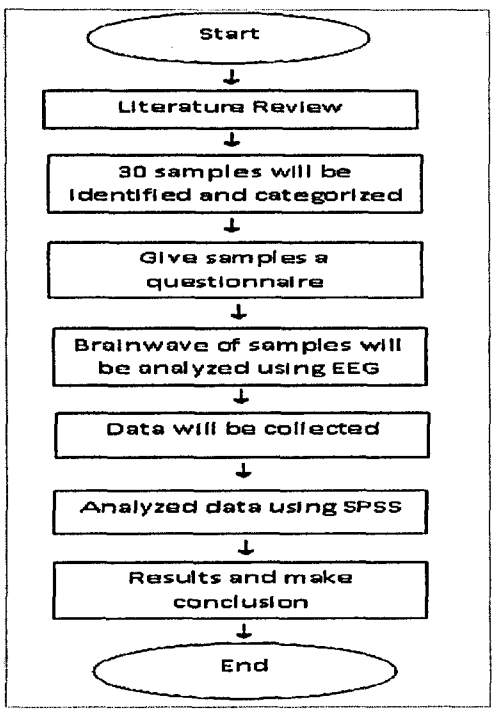

Figure 1. Flow chart of Methodology

A. Experiment procedure

First the Samples will be identified and categorized. Then, the sample fills up the questionnaire and profile form. Following to that is, the sample will than sit on a chair with headrest and is relaxed. When the sample is seated, five electrodes with conductive paste will be connected to the samples' forehead and ear lobe. At this point, the sample will be asked to relax again and try not to focus on anything. This is to avoid artifact from thinking condition. Finally, the brainwave of the sample will analyzed using EEG, and the activities of the brainwave will be recorded.

B. Questionnaire

Before taking the brainwave data of a sample, they will be asked to fill in a questionnaire. The questions consist of two sections.

i) Section A: personal details
ii) Section B: left and right brain test

The questionnaire acts as a guideline to the results obtained. It is also to make sure that the results from the actual study and from the questionnaire is not to differ from each other. In other words, both of the results are used to complement each other.

In regards to the left right brain test, the questions in it are design to know whether a person has which dominance side of the brain. Basically there are about 32 questions in the left and right brain test and each one of the questions has its own predefine characteristic that will point to which dominance of the brain a sample has. The samples will choose the description or the characteristic that applies to them and then the chosen answers will then be calculated to establish a result in concluding which dominance of the brain a sample has.

C. Data Collection

In order to obtain an artifact free data, several steps needs to be taken prior to it. All samples must first answer a questionnaire before sitting for the EEG data acquisition. The EEG data acquisition takes about 3 minutes. The sample will be sited on a chair with a headrest and is relaxed. Then, the sample's forehead will be swabbed with an alcohol swab to clean the skin. Next, the swab will be wiped off, to dry the skin before the forehead of the sample is placed with probes on their forehead. There are 5 probes all together as shown in table 2.

Table 2. Placement of the probes

Probe	Position
Channel 1	right side of the forehead
	right earlobe
Channel 2	left side of the forehead
	left earlobe
Ground	center of the forehead

After each one of the probes has been placed on the sample's forehead, the sample will then be blindfold to make sure that the data acquired from the sample is not affected by any artifacts, due to active work of the brain. When all of that has been done, the first run of the data acquisition will be made and the graph of the brainwave of the sample will be check for any errors or artifacts.

Subsequently, if there is no error to the graph of the brainwave of the sample, a second run of the data acquisition using the EEG method will be made and the data collected from it will be stored and analyzed. Finally, when the 3 minutes is over, the blindfold will be taken off and the probes will be removed from the sample's forehead and the sample's forehead will be cleaned with an alcohol swab.

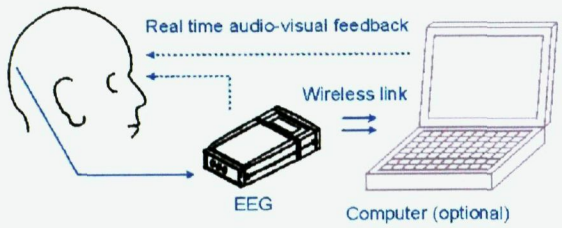

Figure 2. Illustration of the data collection process

D. Data Analysis

There are all together 30 samples, and all of the brainwaves that has be stored will be analyzed using the statistical tool "SPSS version 12". The data will be analyzed on the mean frequency value of all BETA waves, the overall of the maximum frequency value and also the BETA wave maximum frequency value to make a comparison between the left side of the brain and the right side of the brain. And comparison of the actual EEG data acquisition and the questionnaire to will be made, just to distinguish whether is there any difference between the actual experiment and the questionnaire.

III. RESULTS AND DISCUSSION

The result is divided into three parts which are questionnaires analysis, the overall of the maximum frequency value and also the BETA wave maximum frequency value. All consequences were analyzed to see the difference between the right hemisphere and left hemisphere of the brain.

A. Overall maximum value

Figure 3 and 4 shows the distribution in the column chart for the maximum value for each side of the brain hemisphere for FKE and TEKA respectively. From figure 3, it is calculated that the max value of the right hemisphere is 2354 Hz meanwhile for the left hemisphere, it is at a value of 2878.97 Hz. As for the value of min, the right hemisphere is valued at 30.84 Hz and the left hemisphere is 64.82 Hz. For the median readings from the graph, the right hemisphere is at 124.27 Hz and the left hemisphere is 132.21 Hz. And as for figure 4, the max value of the right hemisphere is 2080.96 Hz meanwhile for the left hemisphere, it is at a value of 1970.16 Hz. As for the value of min, the right hemisphere is valued at 55.43 Hz and the left hemisphere is 54.13 Hz. For the median readings from the graph, the right hemisphere is at 143.07 Hz and the left hemisphere is 144.28 Hz. It is observe that FKE has a higher value of the both side of the brain hemisphere in terms of the overall maximum value. And as for the min value of the left hemisphere, FKE has a greater value compared to TEKA and for the right hemisphere, TEKA reads a higher value in comparison to FKE. Meanwhile for the median value, TEKA has a larger value in both sides of the hemisphere as compared to FKE. As for figure 5, it is showing the difference in the overall maximum value of both sides of the hemisphere of the brain for engineering (FKE) and art (TEKA) students, where it is seen that the right hemisphere of FKE is valued at 2354 Hz and the left hemisphere is at 2878.97 Hz. And as for TEKA, the readings from the graphs shows that the right hemisphere is at 2080.96 Hz and the left hemisphere is at 1970.16 Hz. From that graph, it is observed that majority of the engineering students has a dominance of the left hemisphere of the brain which relates to logical and analytical thinking. Meanwhile as for the art students, it is seen from figure 5 that majority of them has a dominance of the right hemisphere of the brain which is the side of the brain that contributes to creative thinking. From figure 5, we too can observe that in overall, engineering students brainwave readings has a higher value in both of the hemisphere of the brain. The values are mention above, on the figure 3 and 4. This is possibly due to the high intensity of their learning subjects taken in their study program. It also can be interpreted with engineering students has a

more active brain activity compared to art students. Meanwhile, Figure 6 and 7 shows the scatter distribution of each hemisphere of the brain with the correlation coefficient line. The closer the value of the correlation coefficient line is to unity, the more balanced the usage of the brain hemisphere is. Hence, from figure 6 and figure 7, the correlation value of FKE is 0.5945 and the correlation value for TEKA is 0.4891. It is observed that FKE students have a more balance usage of the brain hemisphere compared to TEKA students. It is maybe caused by the learning syllabus which FKE students had underwent in their study program, where some of the syllabus might have encouraged the usage of both sides of the hemisphere of the brain.

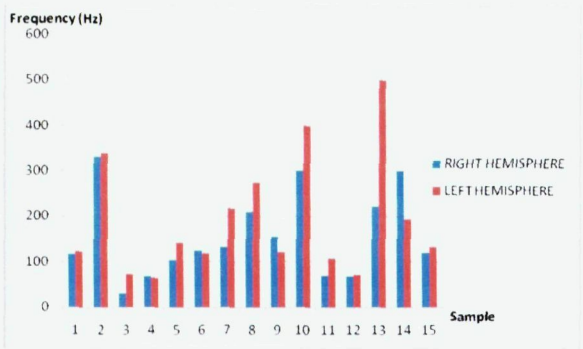

Figure 3: Overall max value of FKE

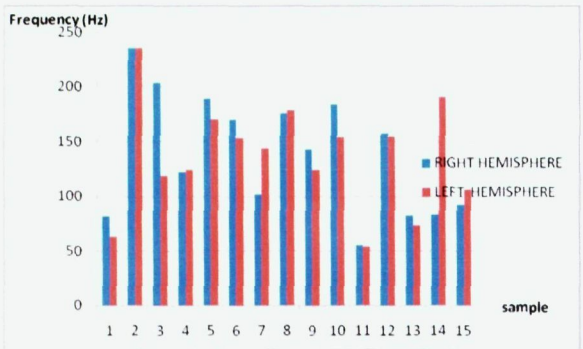

Figure 4: Overall max value of TEKA

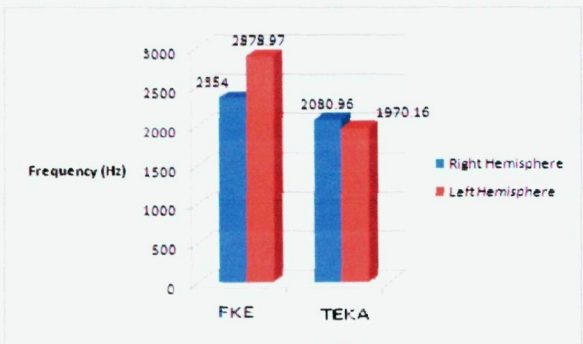

Figure 5: Total of the overall max value

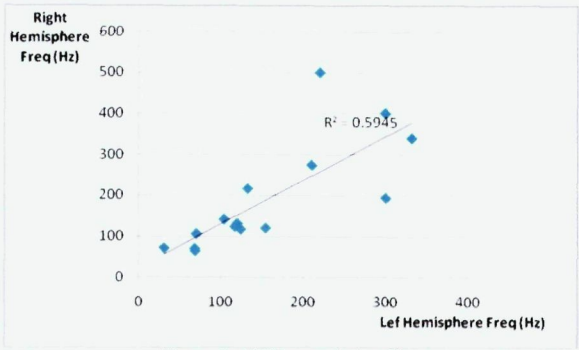

Figure 6: FKE correlation line

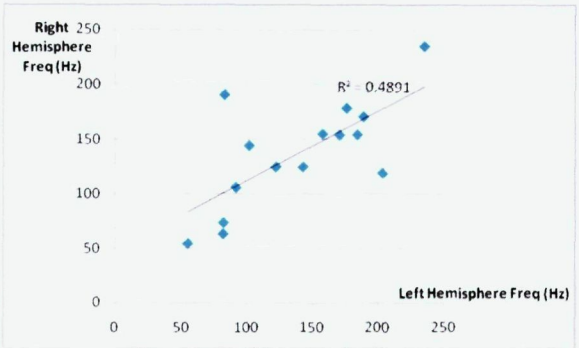

Figure7: TEKA correlation line

B. Maximum beta value

As for this section of the graph analysis, Figure 8 and Figure 9 present the maximum value of the beta reading for engineering students and art students. The beta wave is associated with alertness and concentration state of the brain. The beta waves range from 13 to 30 Hz. It is calculated that, from figure 8, the max BETA value of the right hemisphere is valued at 162.86 Hz and for the left hemisphere it is at a value of 196.15 Hz. The min BETA value of the right hemisphere is 3.91 Hz and the left hemisphere is 4.54 Hz. Meanwhile, for the median BETA value, the right hemisphere reads at 9.87 Hz and the left is 10.47 Hz. For figure 9, the max BETA value is calculated at 151.49 Hz for the right hemisphere and the left hemisphere is at 135.46 Hz. The min value of the right hemisphere is 4.84 Hz and the left hemisphere is 4.71 Hz. Meanwhile, for the median BETA value, the right hemisphere value is at 8.03 Hz and the left hemisphere is 6.64 Hz. It is observe that, FKE has a larger reading in max BETA value for both of the hemisphere compared to TEKA. And as for the min BETA value, TEKA has a larger reading on both side of the hemisphere compared to FKE. For the median BETA value, it is seen that FKE has a larger value on both sides of the hemisphere of the

brain as compared to TEKA. Figure 10 displays the total beta value calculated for each hemisphere of the brain whereby the first graph is the illustration of the engineering students and the second graph is illustration of the art students. From the figure above, we can construe that engineering students has a higher level of concentration compared to the art students. Also, from the display above, it is evident that at a natural state of the brain activity, an engineering student has a dominance of the right hemisphere of the brain and the art students have a dominance of the left hemisphere of the brain. This graph is also made to support the results of from the maximum value of the hemisphere of the brain.

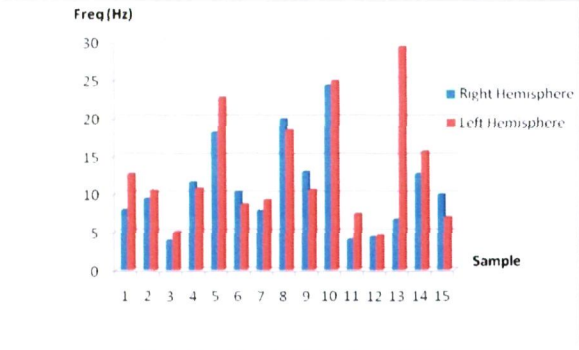

Figure 8: Max BETA value of FKE

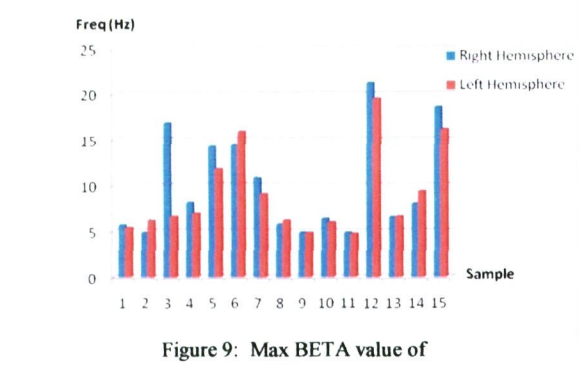

Figure 9: Max BETA value of TEKA

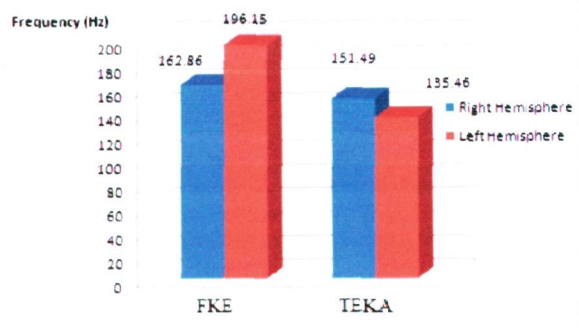

Figure 10: Total of max BETA value

C. *Questionnaire results*

For the last division of the result analysis, the summary of the outcome of the questionnaire that was distributed to the samples before sitting for the EEG data acquisition is discussed. Figure 11 and 12 also acts as a reference to the data results that was taken from the sample using the EEG. Figure 11 and figure 12 comfirms that the conclusion and disccussion of the previous two analysis is correct. Figure 11 displays the percentage of the hemisphere side of the brain where it is calculated that a dominance of the left hemisphere of the brain is used by majority of the engineering students and there's a small number of students with a balance brain usage. This percentage is compared to the art students with numbers more on the right hemisphere of the brain. Figure 12 furthermore shows that nill number of students has a balanced brain usage.

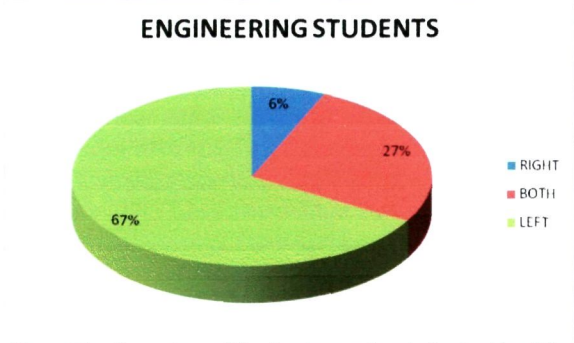

Figure 11: Percentage of the dominance hemispheric side of the brain of FKE.

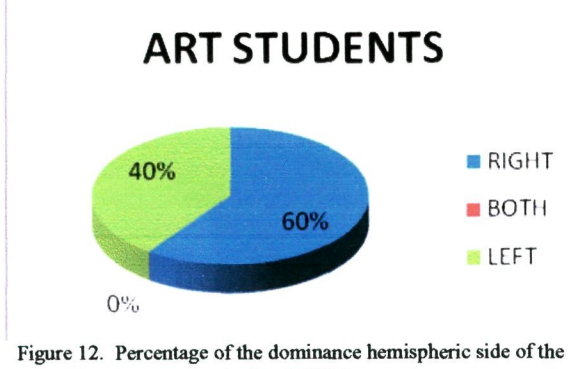

Figure 12. Percentage of the dominance hemispheric side of the brain of TEKA.

IV. CONCLUSION

In general, a human brain has two hemispheres. Which is the left and right hemisphere of the brain, in which, the left hemisphere of the brain controls numerical computation and language and meanwhile, the right hemisphere of the brain controls the imagination and creativity of a person. Normally, someone with a dominance of the right hemisphere of the brain is said to be creative and for a person to have a dominance of the left hemisphere of the brain more analytical and have a more logical ways of thinking compared to the person who has a dominance of the right hemisphere brain. The results from this study support the brain lateralization theory. Engineering students are evident as left brain thinkers and art students are right brain thinkers. And also, it is found that FKE students have a more balanced usage of the hemisphere of the brain compared to TEKA students.

Based on these findings, high school student who have completed their tertiary education and seeking for the right program to be pursued in higher education institutions may benefit from this research. By identifying their brain hemispheric dominance, it is hoped it will assist them to maximize their brain ability in academic field thus reducing the number of university dropouts. By understanding the brain dominance, students also will be able to formulate their leaning strategy. Insights form this project is beneficial for lecturers and faculty members to design syllabus and create teaching and learning environment that suits the students thinking style.

V. RECOMMENDATION

Future works from this project can be extending to wider scopes. It is suggested that more variety of samples can be used to get more comprehensive result. A study on factors that would affect the dominance of the brain hemisphere and also a study to maybe classify the type of the brainwave with the suitable study program. As for this project, samples are from engineering and arts background. Future work should include students from multimedia background as it requires student to be both creative and logical.

REFERENCES

[1] Martindale, G, (2009). Available at http://www.stateuniversity.com/blog/permalink/College-Drop-Out- Rates-Who-s-to-Blame-.html

[2] http://www.themalaysianinsider.com/index.php/malaysia/20585?task=view

[3] Hermann, N (1989), The Creative Brain, Lake Lure, NC : Nedd Hermann Group.

[4] Markova, D. (1991), The Art of Possible – A Compassionate Approach to Understand the Way People Think and Communicate, Conari Press.

.[5] Springer, S. P. and Deutsch, G (1989), Left Brain, Right Brain, New York, WH Freeman.

[6] http://en.wikipedia.org/wiki/Brain

[7] http://en.wikipedia.org/wiki/Human_brain

[8] http://en.wikipedia.org/wiki/EEG