CHAPTER V

DISCUSSION

5.1 SINGLE TRIAL

The experiment was conducted for 4 sessions and 1 trial each session. Singe-trial method refers to method that considers the variance within subjects. Based on Pernet et al., (2011), there are two broad families of methods that can be distinguished into univariate methods extract information among trials in space, time, or both; and multivariate methods extract information across space, time, or both, in individual trials. Univariate methods or single trial analyses can help to provide a systematic mapping between (i) brain activity and stimulus information space, (ii) brain activity and subject's behavioural variability, and (iii) brain activity measured using different imaging techniques.

Based on Pernet et al., (2011), single trial was possible to be done on EEG study. Meanwhile, Chen et al., (2013, 2014) and Zhao et al., (2012) did their experiment using single trial on continues task. Those experiments were done for measuring mental fatigue by recording brain wave using EEG that similar with the experiment design on this research.

5.2 WAVE BRAIN ANALYSIS

The experiment was done by recording the wave brain on Frontal (F3 and F4) and Parietal (P3 and P4) lobes using EEG. Cheng & Hsu (2011) explained that the Frontal lobes have been found to play a part in impulse control, judgment, language production, working memory, motor function, problem solving, sexual behavior, socialization, and spontaneity. Parietal lobe integrates sensory information, specifically dealing with spatial sense and navigation. Another function is the ability for comprehending numbers and the manipulation of objects. This area is responsible for sensation, or the ability of the brain to use senses to detect different environmental entities. Damage to this lobe can cause eyesight problems, left and right hemisphere confusion, inability to perform mathematical solutions, reading and writing problems, and symbol comprehension.

On each lobe, brain waves distinguished by their frequency which Theta, Alpha, and Beta waves. According to Sanei & Chambersm (2007), Theta waves (4-8 Hz) appear as consciousness slips toward drowsiness. Alpha waves (8-13 Hz) had been thought to indicate both a relaxed awareness without any attention or concentration. Beta waves (13-30 Hz) are the usual waking rhythm of the brain associated with active thinking, active attention, focus on the outside world, or solving concrete problems.

Based on the result of amplitude RMS graphic on Frontal (F3 and F4) and Parietal (P3 and P4) lobes by autodidact and non-autodidact in the late morning and afternoon condition, it showed that Beta always had the highest amplitude compare to Theta and Alpha in the beginning time of learning the Physics. Then, in the certain minute, there was a changes of amplitude where amplitude of Theta and/or Alpha increased and higher than amplitude of Beta. It means that the active thinking was happened in the beginning time of learning the Physics whereas the ability to read, understand the lesson, memorize and solve the problems was appeared. Then, on the certain time, those abilities were decreased and the respondent was in a relaxed awareness without any concentration and drowsiness condition.

According to Wascher et al., (2014), mental fatigue of a person during cognitive task was able to indicate when Alpha and Theta rhythms significantly increased, while Beta rhythm significantly decreased in amplitude. It means that a relaxed awareness without any concentration and drowsiness condition that got on a person during cognitive task indicated as mental fatigue state.

5.3 SCORE OF STUDY ANALYSIS

Based on Table 4.2, by autodidact method in the late morning, the result of final score (67.5 of 100) was the highest among others. In the afternoon, the result of final score (52.5 of 100) was lower than the result of final score in the late morning condition. By non-autodidact method in the late morning, the result of final score (52.5 of 100) was higher than the result of final score in the afternoon (50 of 100).

Wilcoxon Signed Rank Test revealed that average score of study between the learning method (autodidact and non-autodidact) and condition (late morning and afternoon) was not significantly different ($P > 0.05$), which are shown in Table 5.1 below:

Table 5.1 Wilcoxon Signed Rank Test Result on Score of Study

Table	Result	Asymp. Sig
4.4	4 data: Autodidact (afternoon) < Autodidact (late morning)	0.059
4.5	3 data: Non-autodidact (afternoon) < Non-autodidact (late morning) 1 data: Non-autodidact (afternoon) = Non-autodidact (late morning)	0.102
4.6	3 data: Non-autodidact (late morning) < Autodidact (late morning) 1 data: Non-autodidact (late morning) = Autodidact (late morning)	0.109
4.7	2 data: Non-autodidact (afternoon) < Autodidact (afternoon) 2 data: Non-autodidact (afternoon) = Autodidact (afternoon)	0.108

5.4 EARLY TIME FOR GETTING MENTAL FATIGUE

Based on Table 4.3, by autodidact method in the late morning, early time for declining the concentration of respondents started in range between 48 to 61 minutes or at average 54.25 minutes. In the afternoon, respondents started to decline of the concentration in range between 25 to 34 minutes or at average 29.25 minutes. By non-autodidact method in the late morning, early time for declining the concentration of participants started in range between 57 to 82 minutes or at average 65.75 minutes. In the afternoon, respondents started to decline of the concentration in range between 21 to 39 minutes or at average 28.5 minutes. The declining of concentration meant that respondents started to get mental fatigue (Wascher et al., 2014).

Wilcoxon Signed Rank Test revealed that average early time for getting mental fatigue between the learning method (autodidact and non-autodidact) and condition (late morning and afternoon) was not significantly different (P > 0.05), which are shown in Table 5.2 below:

Table 5.2 Wilcoxon Signed Rank Test Result on Early Time for Getting Mental Fatigue

Table	**Result**	**Asymp. Sig**
4.8	4 data: Autodidact (afternoon) < Autodidact (late morning)	0.068
4.9	4 data: Non-autodidact (afternoon) < Non-autodidact (late morning)	0.066
4.10	3 data: Non-autodidact (late morning) > Autodidact (late morning) 1 data: Non-autodidact (late morning) = Autodidact (late morning)	0.109
4.11	2 data: Non-autodidact (afternoon) < Autodidact (afternoon) 2 data: Non-autodidact (afternoon) > Autodidact (afternoon)	1.000

5.5 CONDITION VARIABLE ANALYSIS

As the experiment that has been done, there was a variable about conditions which are late morning and afternoon condition. Based on Table 5.1 about score of study statistical test result and Table 5.2 about time for respondent reached a mental fatigue statistical test result, late morning condition was better in score of study and longer in time for getting mental fatigue than afternoon condition.

Slameto (2013) expressed that student had fresher mind and a better physical condition in earlier day compared to the student's condition in the afternoon. It is stated that a student will find it more difficult in receiving information in the afternoon due to the exhausted body condition. Vollmer et al., (2013) also stated that morning method person in learning style gets both better grading and higher attention.

Moreover, it was noted that the experiment performed in the late morning showed 26.7˚C as the room temperature, and 31.9 ˚C in the afternoon experiment. Kulve et al., (2017) mentioned that the sleepiness of a person is significantly higher while reaction time is slower in warm exposure. Romeijn et al., (2012) expressed that alertness will reduce when room temperatures increases; while Lan et al., (2011) stated that a high ambient temperature could reduce the performance on reaction time tasks. Thus, based on room temperature, previous study was in line with the experiment result, where the room temperature of afternoon experiment was warmer than the one in the late morning experiment and went along with the fastest time in starting mental fatigue.

In addition, the lighting level of late morning experiment (79 Lux) was brighter than afternoon experiment (70 Lux) resulting in a longer time in starting mental fatigue in the late morning. It was approved by Romeijn et al., (2012) that bright light could reduce the sleepiness and improve a task performance. So that, learning process in the late morning had better performance based on score of study and early time for getting mental fatigue result.

5.6 LEARNING TYPE VARIABLE ANALYSIS

Another variable is learning types which are autodidact and non-autodidact learning type. Based on Table 4.2 and Table 4.3, it can be summarized that in the late morning:

a. By autodidact learning type, the early time for getting mental fatigue was 54.25th minute with result score of study was 67.5 of 100.
b. By non-autodidact learning type, the early time for getting mental fatigue was 65.75th minute with result score of study was 52.5 of 100.

Based on that, in the late morning, autodidact learning type had shorter early time for getting mental fatigue than non-autodidact learning type. On the contrary, autodidact learning type had higher result final score then non-autodidact learning type.

Based on Van Oers (1987) in Simons (1989), there are two aspects of student activities during learning, which are quality and quantity of learning activities. Quality of learning activities is quality of information that students got while quantity of learning activities is an effort to get the information during studying. Quality of learning activities in the late morning can be seen by the result score of study gotten where autodidact learning type had higher result final score interpret as better quality of learning activities then non-autodidact learning type with significant difference as much as P=0.109. Moreover, Based on Simons (1989), a student who decided to learn by autodidact learning type have to exert more effort. Meanwhile, based on Babiloni (2012), the more demanding task that needed more effort result higher mental fatigue. It was in line with the result of early time for getting mental fatigue in the late morning, where autodidact learning type needed more effort resulted more earlier time for getting mental fatigue than non-autodidact learning type with significant difference as much as P=0.109 for early time mental fatigue comparison.

Meanwhile, based on Table 4.2 and Table 4.3, it can be summarized that in the afternoon condition:

a. By autodidact learning type, the early time for getting mental fatigue was 29.25th minute with result score of study was 52.5 of 100.
b. By non-autodidact learning type, the early time for getting mental fatigue was 28.25th minute with result score of study was 40 of 100.

It can be seen that autodidact learning type has longer early time for getting mental fatigue and higher result score of study than non-autodidact learning type in the afternoon with significant difference as much as P=1.000 for both early time mental fatigue and P=0.108 for result score of study comparison.

Furthermore, based on Lodewijks (1982), science student in autodidact learning type is performed better than student in a learning sequence predetermined by teachers and Van der Sanden (1986) in Simons (1989) stated that some students performed better on a practical construction task without instruction than with detailed and explicit advice from a teacher. So that, autodidact learning type had better performance based on early time mental fatigue and score of study result.