

CHAPTER III

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter, it will be explained that the steps for conducting the research in order to keep researcher focused on the objective of this research. This chapter explains the detailed object and focus of research also the conceptual model of the research.

3.2 RESEARCH OBJECT

The object of this study is the mental fatigue of students that will face national examination especially science students when studying Physics. The objective measurement of mental fatigue is using electroencephalograph (EEG). EEG records the brain waves distinguished by their different frequency ranges which are alpha (α), theta (θ), and beta (β) (Sanei & Chambers, 2007). In accordance to the previous research, the amplitude of the alpha and theta rhythms significantly increased and the amplitude of the beta rhythm significantly decreased, while the mental fatigue level is increased (Babiloni, 2012).

3.3 RESEARCH SUBJECT

The subject of research is students in 3rd grade of senior high school in SMA N 1 Kasihan Bantul. The research has applied to 4 students. There are several requirements for the respondent, which are:

1. All respondents had no neurological and psychiatric mental problems that would affect performance (Wascher et al., 2014).
2. All respondents were instructed to abstain from cigarettes, caffeine, and alcohol for 12 hours before the experiment (Jaehne et al., 2012; Mun et al., 2014).
3. All respondents should have a full night's sleep for 6-8 hours before the experiment (Mun et al., 2014; National Sleep Foundation, 2008).
4. All respondents have similar interest on the Physics (Zhao et al., 2012).
5. All respondents are in motivated condition (Zimmerman, 1989).

Besides, the interest point and score of Physic subject should be identified to get a uniform background of research subject.

3.4 COLLECTING DATA METHOD

3.4.1 TYPE OF DATA

Primary data is data obtained directly from the research subject which conducted by experiment and direct measurement. The data that obtained in primary data is the electroencephalogram contain wave that will be processed and gaining about frequency, amplitude, and time of wave.

3.4.2 RESEARCH INSTRUMENT

Research instrument refers to the tools used in this study in order to collect or process the data. Instrument in this study include:

1. OpenBCI Ganglion Biosensing Board (4-channels) is used to record brain activity (EEG)
2. OpenBCI GUI 2.1.1 is a software tool for visualizing, recording, and streaming data from the OpenBCI Boards.
3. CSR 4.0 Bluetooth Dongle is a mini USB Bluetooth adapter to show EEG live
4. Gold cup electrode cables is a ribbon cable with 10 passive gold electrodes
5. Signa electrode gel is a conductive liquid medium to detect the electrical activity under skin
6. Adhesive bandage as electrode paste to adhere the electrodes to the scalp
7. Alcohol as a cleaner for electrode before and after the experiment conducted
8. Table and chair as equipment for respondent sit when taking a part in the experiment
9. Physics book contains of subchapter that will be learned and some questions
10. Personal computer 13” used for presenting video on non-autodidact session
11. Sound Level meter is instruments capable for measuring the intensity of sound waves
12. Lux meter is an instrument that measures brightness
13. Thermometer is a device that measures temperature
14. Matlab R2016a is a software that is used for processing the EEG raw signal
15. IBM SPSS Statistic 22 is a software that is used for statistical analysis

3.4.3 LOCATION

The research will be conducted at the Laboratory of Computer Science and Electronics, Computer Science and Electronics Department, Faculty of Mathematics and Natural Science, Gadjah Mada University, Yogyakarta.

3.4.4 EXPERIMENT DESIGN

During the experiment, each respondent sits in comfortable position on the seat that has been provided. Experiment uses two different learning methods which is reading book as autodidact learning method and watching video as non-autodidact learning method (Simons, 1989). Each learning method is performed on both different condition whereas Dunn et al., (2002) revealed that 47 percent of high school students were late morning and afternoon learners, 40 percent were early morning learners, and remain was early night owls learners. So that, this study takes late morning and afternoon as types of learning condition. Thus, experiment consists of 4 sessions and 1 trial each session that included as subject experiment and shown in Figure 3.1 below.

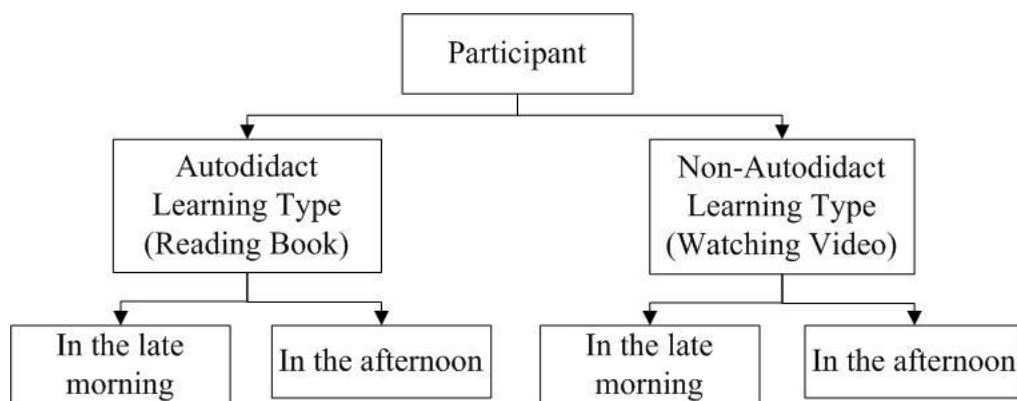


Figure 3.1 Experiment Design

Each experiment requires 5 minutes of briefing and getting used to be in a class, 90 minutes for studying, and 30 minutes for doing a test. The total experiment takes 125 minutes per respondent for each learning tools. Time duration for studying is decided based on duration time of regular studying in school.

Experiment design in this research is treated the same way with work place setting on school, which respondent is occupied in layout shown in Figure 3.2 below.

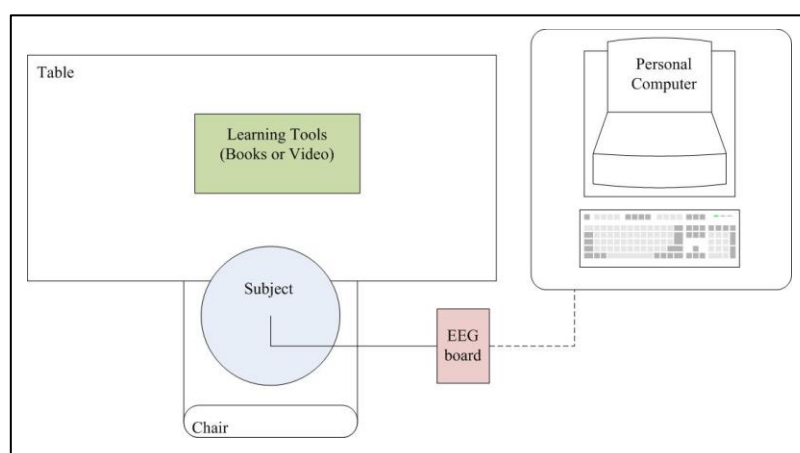


Figure 3.2 Experiment Layout

Four electrodes of Sn will be placed at frontal (F3 and F4) and Parietal (P3 and P4) according to the 10-20 system. 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. Meanwhile, parietal lobe integrates sensory information, specifically dealing with spatial sense and navigation. Another function is 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. Furthermore, (Babiloni, 2012) and Yin & Zhang (2017) stated that those electrodes (F3, F4, P3, and P4) have been commonly validated to analyse mental fatigue. The location of channel is shown in Figure 3.3 below.

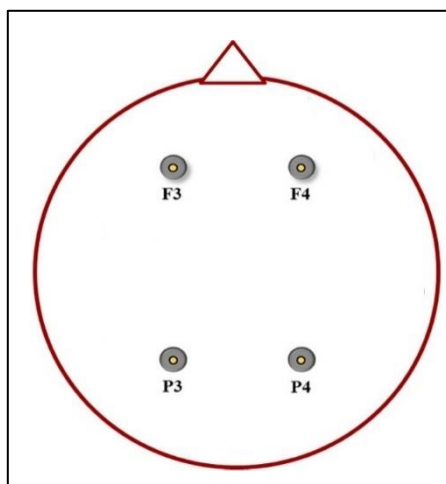


Figure 3.3 EEG Channel

3.4.5 TASK DESIGN

Experiment consists of 4 sessions and 1 trial for each session. In each session, respondent learns subchapter of Physics subject that is Electromagnetic Induction. This subchapter is the most difficult chapter among others (Hartanti T, personal communication, August 28, 2017). Babiloni (2012) expressed that the more demanding task, higher mental fatigue. Thus, this is reasonable to take this subchapter as task in this experiment.

The respondent is asked to learn Electromagnetic Induction in four different conditions which are autodidact learning method in the late morning, autodidact learning method in the afternoon, non-autodidact type in the late morning, and non-autodidact type in the afternoon. Autodidact learning method is the condition when respondent is self-taught by reading book that can be seen on Appendices 20. The book is taken from Physics book for class 3rd Senior High School by Handayani & Damari (2009). Meanwhile, non-autodidact type is the condition when respondent is watching video showing about someone is explaining the matter on blackboard by Sibejo (2016). Display of video is shown on Figure 3.4 below.

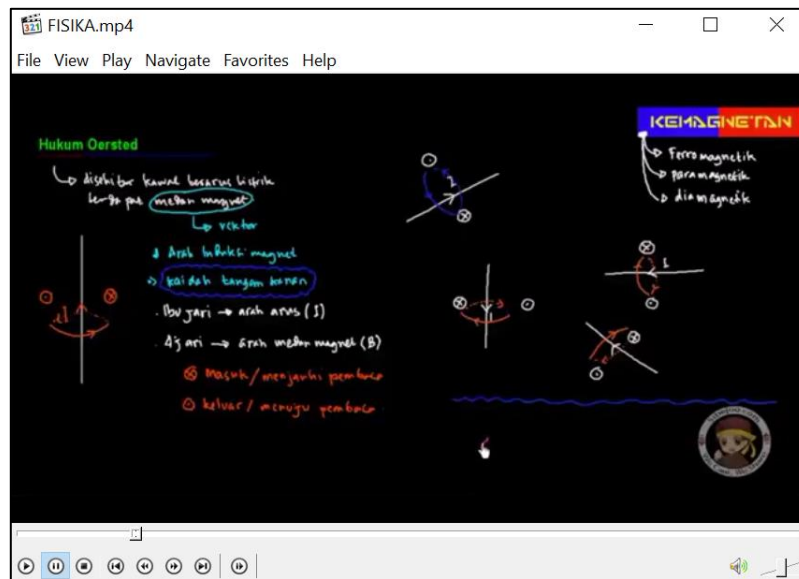


Figure 3.4 Display of Video
(Source: Sibejo, 2016)

At the same time, EEG tools is turned on to record brain activity on P3, P4, F3, and F4 when respondent learns Electromagnetic Induction for 90 minutes in each session. After it, respondent is asked to answer 10 questions related to the matter in 30 minutes that can be seen on Appendices 18 and Appendices 19.

3.4.6 EXPERIMENT PROCEDURE

The experiment is carried out for 2 days for each respondent because there are 4 sessions consist of 1 trial for each session. In the first day, at 8.55 in the late morning, respondent does first session by learning Physics using randomly learning method either autodidact or non-autodidact. It finishes until 11.00 and continued at 13.00 in the afternoon for second session. Respondent rests for 2 hours between late morning and afternoon session where based on Nishihara et al., (2014), mental fatigue can be recovered for stopping doing a task after 1 hour. Therefore, two hours rest is able to recover mental fatigue of respondents. In second session, respondent learns using different learning method compared to the previous one. In

the next day, respondent does the third and fourth session on the same order as the previous day. The experiment timeline for each session can be seen in Figure 3.5 below.

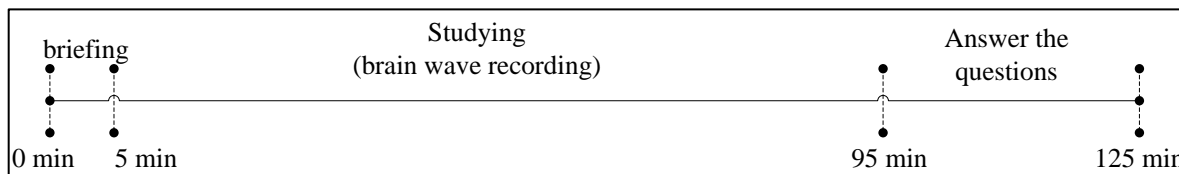


Figure 3.5 Experiment Timeline

Before doing the experiment, researcher prepares all the instruments also cleans the electrode with alcohol. Then, the order of experiment on each session could be resumed as follows:

1. Asking respondent to sit
2. Researcher finds the location of P3, P4, F3, and F4 on scalp.
3. Attaching electrode that has been given Signa electrode gel and uses adhesive bandage for adhering it. Electrodes are attached on P3, P4, F3, and F4 on scalp, and on both ears as ground.
4. Respondent is given a briefing and 5 minutes for getting used to be in a class and make sure that respondent has already been focused to study the Physics.
5. EEG is turned on for recording brain activity when respondent learns on first session.
6. Respondent learns subchapter Electromagnetic Induction using chosen learning method for 90 minutes.
7. EEG is turned off.
8. Remove the electrode from the scalp.
9. Respondent is asked to answer 10 questions for 30 minutes.
10. Respondent finishes first session of experiment.

3.5 DATA PROCESSING METHOD

Data processing method in this research is executed by reading the result experiment that recorded by Electroencephalograph with type OpenBCI Ganglion. Its signal interpretation was done using software OpenBCI GUI 2.1.1 in visualizing, recording, and streaming data. In recording brain activity, variable used in this study are learning method and condition.

Based on OpenBCI Ganglion type, there is a signal interference with a frequency of 50 Hz coming from electrical problems. Meanwhile, EEG signal frequency that is observed (theta, alpha, and beta) are in the range of 0 – 50 Hz. Related to this, two steps of processing are needed to be done which are Notch and Band Pass Filter. Notch filter is used to reject narrow frequency at 49-51 Hz to reject noise due to electrical problems and leaves the rest frequency. Band pass filter is used to select frequency from EEG data that will be used which is theta (4-8 Hz), alpha (8-13 Hz), and beta (13-30 Hz). Notch and band pass filter is processed using Matlab R2016a.

3.6 DATA ANALYSING METHOD

Data analysis is applied by employing signal analysis and non-parametric statistical analysis. Signal analysis is derived by calculating root mean square (RMS) of result after going through processing data. Beside it, Wilcoxon Signed Rank Test is done for identifying the difference between learning method and condition.

3.6.1 ROOT MEAN SQUARE CALCULATION

Electroencephalograph analysis is done by observing the signal that has been processed. It is done to find out on what seconds respondent will feel mental fatigue. A person can be said experiencing mental fatigue when alpha and theta rhythms of brain wave significantly increased, while the beta rhythm significantly decreased in amplitude (Babiloni, 2012; Wascher et al., 2014). In order to see the shift of amplitude easier, the RMS was calculated (Atmaji & Perwira, 2017; Soewardi et al., 2015). The formula of RMS is shown in Equation 3.1 below.

$$\bar{x}_i = \sqrt{\frac{1}{N} \sum_{i=1}^N x_i^2} \quad \dots(3.1)$$

Where:

N = amount of data

X = value of data

3.6.2 STATISTICAL ANALYSIS

3.6.2.1 WILCOXON SIGNED-RANK TEST

The Wilcoxon signed-rank test is a nonparametric statistical hypothesis test used when comparing two related samples (Wilcoxon, 1946). In this study, this test is used to identify significance different of final score and early time for increasing Alpha and Theta data between autodidact and non-autodidact learning type, and also late morning and afternoon condition. The hypothesis used in this study is:

H_0 : there is no significant different between two related samples

H_1 : there is significant different between two related samples

If the significance value ≥ 0.05 the H_0 is accepted that means, there is no difference significantly. However, if the significance value < 0.05 then H_0 is rejected which means there is a significant difference between groups of samples.

The input for this statistical test is 4 data of final score and 4 data of early time for increasing Alpha and Theta in combination of learning type (autodidact and non-autodidact) and condition (late morning and afternoon). The output obtained is the difference value between autodidact learning type in both condition, non-autodidact learning type in both condition, late morning condition by both learning type, and afternoon condition by both learning type whether in significant or insignificant different.

3.7 CONCEPTUAL MODEL

The flowchart of the research is shown in Figure 3.6 below.

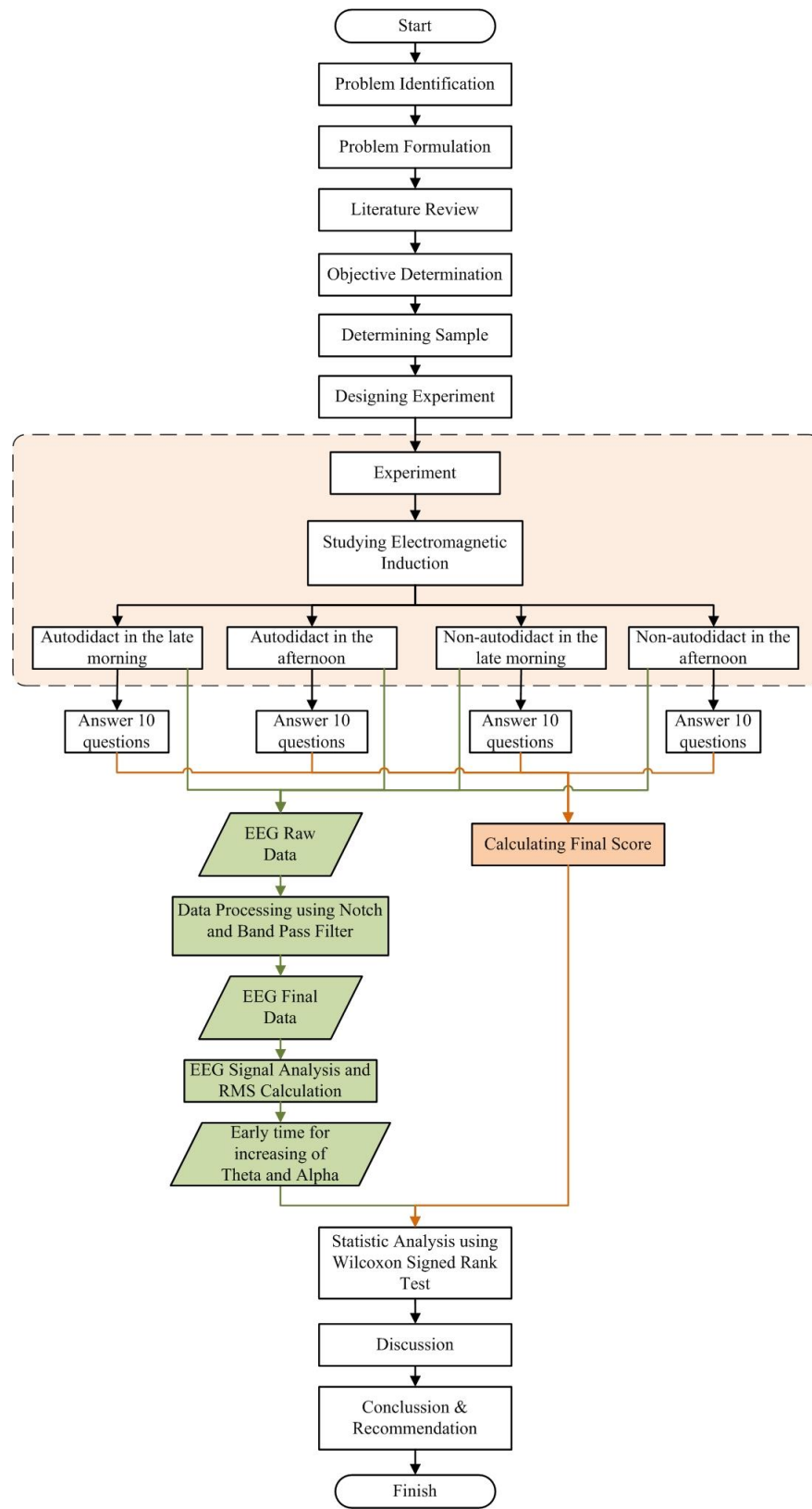


Figure 3.6 Research Flowchart

Based on Figure 3.6 above, it can be seen that the research is executed under several steps. It is started by identifying the problem and continued by formulating it. The fundamental problem on this research is average national examination's score of Physics in Bantul. Even the score for Physics subject in Bantul increased in 2017 while the score for Physics in Yogyakarta was always decreasing in last 3 years, the average score for Physics in Yogyakarta is still bigger than Bantul in each year. Then, it was known that mental fatigue student's factor has high effect in accomplishing a success. Literature study is done to carry out deeper about mental fatigue and the method to analyse it. Based on previous research, Electroencephalograph (EEG) is a sensitive tool in fluctuation of vigilance and has been shown mental fatigue that able to lowering performance. It is continued by determining the objective of research. The objective is the comparative of student's mental fatigue level while studying the Physics using book and video in the late morning and afternoon.

Henceforth, the next step is determining the sample and designing the experiment. Experiment consists of 4 sessions and 1 trial each session which is autodidact in the late morning, autodidact in the afternoon, non-autodidact in the late morning, and non-autodidact in the afternoon. The total experiment is 125 minutes per session. Respondents are asked to learn about subchapter of Physics subject that is Electromagnetic Induction. Four electrodes of Sn will be placed at frontal (F3 and F4) and Parietal (P3 and P4) according to the 10-20 system. Open BCI Ganglion Biosensing Board (4-channels) is used to record brain activity (EEG). Then, the experiment is done toward 4 students as respondents. Answering 10 question after each session is obligation.

Moreover, the raw data is processed using Notch and Bandpass by Matlab to get desired final data. Final data is analysed by calculating Root Mean Square (RMS). RMS is done in order to know the early time for amplitude shifting of Theta, Alpha, and Beta.

Wilcoxon Signed Rank Test is done as non-parametric statistic to demonstrate the difference between two related samples of the study. It uses to know the difference of final score and early time for increasing Theta and Alpha between different learning methods and conditions.

Furthermore, researcher analyses based on data processed which is the result of non-parametric statistic. Finally, researcher can conclude and provide recommendation based on the analysing data processed.