CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method and Research Design

3.1.1 Research Method and Research Design

The research method that will be used in this research is weak experiment method. Fraenkel, Wallen and Hyun (2011) stated that this design is weak and do not have built-in control for threats to internal validity. In addition to the independent variable, there are number of other plausible explanations for any outcomes that occur to find the effect of predict-observe-explain (POE) strategy on students' conceptual mastery and critical thinking in learning vibration and wave topic on 8^{th} grade secondary school.

This research will use of one group pre-test and post-test design. Therefore, in this study, researcher will use one selected group. According to Fraenkel, Wallen and Hyun (2011), in the pre-test and post-test experiment, researcher assigns a single group and measure or observe not only after giving treatment of some sort but also before.

Table 3.1. One-Group Pre-test and Post-test Design

O	X	O
Pretest	Treatment	Posttest

(Fraenkel, Wallen and Hyun, 2011)

For this research, the diagram of the research design is shown in table below

O	X	O
Pretest: 24 multiple choice questions and 6 essay items were given. (Dependent Variable)	Treatment: Treatment was given to the students using Predict-Observe-Explain strategy	Posttest: 24 multiple choice questions and 6 essay items were given. (Dependent Variable)

The researcher will be using N-gain to determine the magnitude of changing in cognitive aspects. Meanwhile for critical thinking test, researcher will also be

using one class. By using scores and rubrics, the aspects in critical thinking will be measured for each student to determine the development of their critical thinking.

3.2 Population and Sample

The population in this research will be International Junior High School in Bandung which implements the Indonesian National Curriculum of 2013. The population in this research were 8th grade students. The samples were from a class in eighth grade. The samples consist of 18 students with the ages ranging from 13 to 14 years old. 8 students (44%) of the samples were male students while the other 10 students (56%) are female students.

The sampling technique that will be used in this research is Purposive Sampling. According to Fraenkel, Wallen and Hyun (2011), Purposive Sampling is a sampling in which researchers do not simply study whoever is available but rather uses their judgement to select a sample they believe, based on prior information, will provide the data they need. There are 18 students from one class that are assigned as samples in this research.

3.3 Research Instrument

In this research, instrument is necessary to be used for gaining data. There are several types of research instrument that are used in this research. Those instruments are described below.

3.3.1 Pre-test and Post-test

In this research, the researcher used pre-test and post-test instrument to test the students' conceptual mastery and critical thinking in vibration and wave topic for both control group and experimental group. The pre-test will be held

before the groups are given treatment, and the post-test will be given after the groups are given treatment.

Initially, in both pre-test and post-test, the students will be given 50 questions multiple choices test, consisting 26 questions to measure students' conceptual mastery and 24 questions to measure students' critical thinking. However, after giving considerations and processed through validation, the questions were reduced to 24 multiple choices question items of conceptual mastery test and 6 essay question items of critical thinking ability test. The questions for the students' conceptual mastery are based on Bloom's taxonomy by Anderson and Krathwohl (2000), while the questions for the students' critical thinking that are covered by six indicators of students' critical thinking by Ennis. This instrument will be tested and judged by the experts. The aspects that will be tested are:

1) Reliability

According to Fraenkel, Wallen and Hyun (2011), reliability refers to the consistency of the scores obtained —how consistent they are for each individual from one administration of an instrument to another and from one set of items to another.

The formula which will be used to determine reliability is written as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum {\sigma_1}^2}{{\sigma_1}^2}\right)$$

Where:

r_{11} : coefficient of reliability

n : amount of test item

s_1 : score variant of each test item

s_t : total score variant

(Tuckman, 1978)

Table 3.2. The Interpretation Reliability Coefficient

Reliability Coefficient	Interpretation
$0,00 < r_{11} \leq 0,20$	Very Low
$0.20 < r_{11} \leq 0.40$	Low
$0.40 < r_{11} \leq 0.60$	Enough
$0.60 < r_{11} \leq 0.80$	High
$0.80 < r_{11} \leq 1.00$	Very High

(Salwa, 2010)

2) Difficulty level

Difficulty level of an item is inversely related to the proportion of the person who answers the item correctly. The higher the proportion, the lower the difficulty becomes (Escudero, Reyna, Morales, 2000). The formula which will be used to determine difficulty level is written as follows:

$$IF = \frac{B}{JS}$$

Where:

P : difficulty level of an item

B : number of students who answer correctly

N : total number of students

(Brown, 2004)

Table 3.3. The Interpretation of Difficulty Level

The value of P	Interpretation
P = 0	Too Difficult
0, 00 < P ≤ 0, 30	Difficult
0, 30 < P ≤ 0, 70	Medium
0, 70 < P ≤ 1, 00	Easy
P = 1	Too Easy

(Salwa, 2010)

3) Discriminating Power

Discriminating power is the ability of particular question to distinguish between the higher achiever with the lower achiever students. Discriminating power index show the scale from -1 to higher than 0.39, with the negative one represent low discriminating power index. The formula which will be used to determine discriminating power is written as follows:

$$D = \frac{A - B}{\frac{1}{2}N}$$

Where:

D : discriminating power

A : number of correct score answered by lower achiever group

B : number of correct score answered by higher achiever group

N : total number of students in both groups

(Cohen et al., 2007)

Table 3.4. The Interpretation of Discrimination Power

D	Quality	Recommendations
> 0,39	Excellent	Retain

D	Quality	Recommendations
0,30 - 0,39	Good	Possibilities for improvement
0,20 - 0,29	Mediocre	Need to check/ Review
0,00 – 0,20	Poor	Discard or review in depth
< - 0,01	Worst	Definitely discard

(Escudero et al., 2000)

3.4 Research Procedure

The steps of conducting this research are formulated as follows.

3.4.1. Preparation Stage

1) Formulating the problem and research objectives.
2) Defining the dependent and independent variables of the research.
3) Determining the sample and the population of the research.
4) Conducting literature review about predict-observe-explain (POE) learning strategy, students' conceptual mastery, students' critical thinking and vibration and wave topic.
5) Designing research instruments.
6) Testing research instrument.
7) Making revision of research instrument.

3.4.2. Implementation Stage

1) Specifying group for the research.
2) Conducting pre-test to the sample group.
3) Giving treatment to sample group.
4) Conducting post-test to sample group.

3.4.3. Completion Stage

1) Calculating the data.
2) Analyzing the data.
3) Making result and conclusion.

4) Reporting of the research paper.

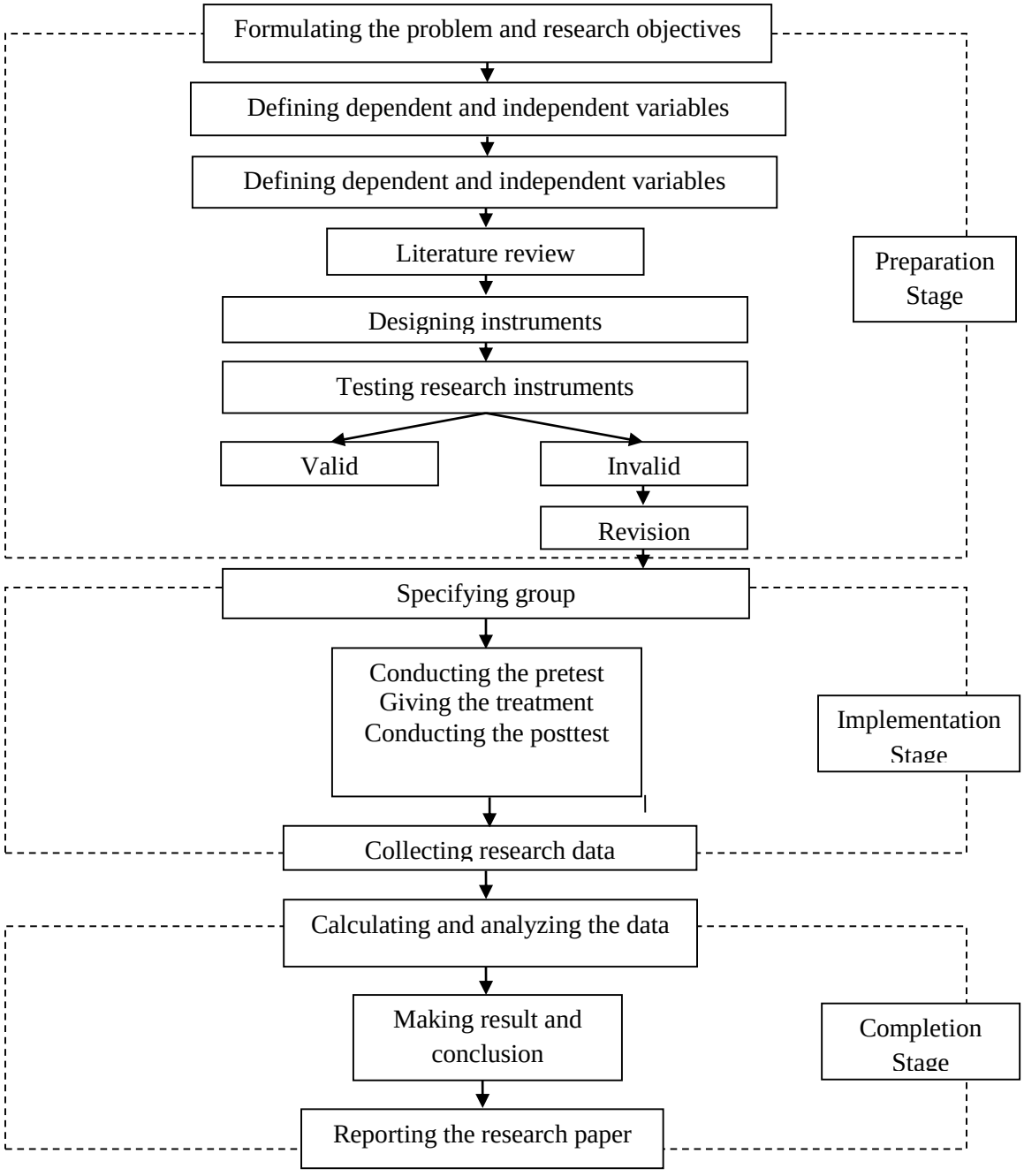

Figure 3.1. Flowchart of Research Procedure

3.5 Data Analysis

3.5.1 Indicators of Conceptual Mastery

1) Generalized N-gain score for each student

The development of students' conceptual mastery in pretest and posttest results was measured by N-gain calculation. According to Hake (1999), pretest and posttest data can be used with equation as follows:

$$g = \frac{(average\ of\ posttest\ score) - (average\ of\ pretest\ score)}{maximum\ score - (average\ of\ pretest\ score)}$$

The data is then interpreted using the criteria shown by Table 3.5.

Table 3.5. Criteria of Indicators of Conceptual Mastery

g	Interpretation
$g \geq 0{,}7$	High
$0{,}3 \leq g < 7$	Fair
$g < 0{,}3$	Low

(Hake, 1999)

2) N-gain score for each aspect of Conceptual Mastery

The N-gain calculation is also done to measure the development of students' conceptual mastery by the aspects. This is done to distinguish whether and how POE affects the development of each aspect of conceptual mastery of the students.

3.5.2 Indicators of Critical Thinking

1) Gain score for aspects of Critical Thinking ability

Aspects of critical thinking ability are also measured using score to determine how POE affects students' critical thinking skills. The score is determined using rubrics as follows.

Table 3.6. Indicators of Aspects of Critical Thinking Ability

Element	Score				
	0	1	2	3	4
Analyzing arguments	The answer is left blank.	The answer is incorrect and the reason is not relevant to the question.	The answer is incorrect but the reason is significant to the question.	The answer is correct but the reason is none or not significant to the question.	The question is answered correctly and the reason is significant to the question.
Making induction and assess induction	The answer is left blank.	The conclusion is incorrect and the statements are not relevant to the question.	The conclusion is not clear or incorrect but the statements are relevant to the question.	The conclusion is correct and clear but the statements are none or not relevant to the question.	The conclusion is correct and clear and the statements are relevant to the question.
Formulating an action	The answer is left blank.	The answer is incorrect and the strategy/formula is not proper/relevant to the question.	The answer is incorrect but the strategy/formula is proper/relevant to the question.	The answer is correct but the strategy/formula is none or not proper/relevant to the question.	The answer is correct and the strategy/formula is proper/relevant to the question.

(adapted from White et al. 2011)

The rubrics will be used to measure students' critical thinking with essay test. After the score is obtained, it will then be interpreted. The criteria for the interpretation are detailed in Table 3.7.

Table 3.7. Interpretation of Indicator of Critical Thinking Ability Aspects

Score	Interpretation
3.51 - 4.0	Master Thinker
3.11 - 3.5	Advanced Thinker
2.41 - 3.10	Practicing Thinker
1.71 - 2.40	Beginning Thinker

1.01	-	1.70	Challenged Thinker
0	-	1.0	Unreflective Thinker

(Paul and Elder, 2009)

3.5.3 Analysis of Students' Answer in POE

In this analysis, students' capability in POE stages is measured using scores and rubrics. The scores are divided into each stage, which include Predict, Observe and Explain. Each stage will also have its ranging score. The details are described in Table 3.8.

Table 3.8. Interpretation of Indicator of Conceptual Mastery

Stages	Score 0	Score 1	Score 2
Predict	Student is unable state their prediction, or prediction is not related to the topic, without acceptable reasoning or with the reason is not related.	Student is able state their prediction, or prediction is related to the topic, but has no related or acceptable reasoning, or vice versa.	Student is able state related prediction with related reasoning.
Observe	Student is unable state their observation, or observation is not related to the topic, without acceptable reasoning or with the reason is not related.	Student is able state their observation, or observation is related to the topic, but has no related or acceptable reasoning, or vice versa.	Student is able state their observation with related reasoning.
Explain	Student is unable to explain why or how their observation is or is not according to their prediction.	Student is able to explain why or how their observation is or is not according to their prediction.	(No score 2, the score ranges from 0 to 1).

(adapted from White et al. 2011)

3.6 Operational Definition

In order to avoid misconception about this research, some operational definitions are explained as follow.

3.6.1 Predict-Observe-Explain learning model in this research is done in three POE stages, which are Predict, Observe and Explain. The learning activities are based on POE learning strategy by Liew (2004).

3.6.2 Students' conceptual mastery in this research refers to the competence of the students that covers the cognitive competences of Bloom's taxonomy as stated by Anderson and Krathwohl (2000), which are remembering (C1), understanding (C2), applying (C3), and Analyzing (C4). This is measured by using a multiple choice questions test in the pre-test and post-test.

3.6.3 Students' critical thinking in this research is measured by using a multiple choices test which consists of in the pre-test and post-test. The test will cover all six indicators of students' critical thinking by Ennis (2014).

3.6.4 Students' abilities in conducting Predict-Observe-Explain (POE) strategy in learning vibration and wave is measured by using worksheet in the teaching-learning process. The worksheet provides activity to measure students' ability in each stage (predict, observe and explain).

3.7 Assumption

The assumptions as the foundation of this research are as follow.

3.7.2 Kala, Yaman and Ayas (2012) stated that using POE strategy, teacher can easily see how many students understand the concept correctly, partially, or wrong. Teacher will also be able to identify any misconception regarding the concept.

3.7.3 Since students construct the new knowledge from their prediction the experience, students should have improvement in their conceptual mastery. According to Anderson and Krathwohl (2000), the students should understand or have good conceptual knowledge when they can build connection between newly obtained knowledge and their prior knowledge.

3.7.4 POE strategy should be beneficial for students in learning, as stated by Kibirige, Osodo and Tlala (2014), that POE strategy can help students to overcome the misconception in learning science.