CHAPTER III
RESEARCH METHODOLOGY

A. Research Method and Research Design

In order to conduct a proper research, method and design are required to be well arranged accordingly and systematically valid as the foundation of the research itself. Research method and design in this research are explained as follows.

1. Research Method

In order to conduct the research, an appropriate ways of doing the research is crucial especially the method of doing the research. The method used in this research were quasi-experimental method because this research did not involve any experimental treatment and only using one group as it is exposed to some internal validity thus classified into quasi-experimental design (Gravetter & Forzano, 2012). Quantitative data and statistical analyses is used as the main data of the research. This method makes the results most reliable to investigate the findings of the comparative non-experimental comparative research.

2. Research Design

The design that was employed in this research is one shot case study design which only use one sample group and all the participant in the sample group receive all conditions served with no control or comparison group (Gravetter & Forzano, 2012). The Paper-Based Test is prompted in advance because it was the common for the students while Science Virtual Test is the non-common one just. Furthermore, information required to fill both of the test are provided on the test item so that it is based on students' conceptual understanding and prior knowledge which are the same for both test.

Table 3.1 One Shot Case Study Design

Sample Group	Paper-Based Test	(Time Period)	Science Virtual Test

(Adapted from: Gravetter & Forzano, 2012)

B. Population and Sample

The location of this research is a Public Secondary School "X" West Bandung District. This school using National Curriculum of 2013 and include in one of the most standardized school and also one of school with most complete facilities. The population in this research are all 7th grade students of the ten classes at Public Secondary School "X" West Bandung District. The samples are two classes of 7th grade students in Public Secondary School "X" West Bandung Districts. The sample is 71 students which are consists of 33 male and 38 female students. The sampling technique that is used is purposive sampling. Fraenkle, Wallen and Hyun (2012) describe that purposive sampling is obtaining sample by a non-probability sampling that the sample selected based on characteristics of a population and the objective of the study. Regarding the objective of the research we must consider the condition of the school authorization that it is impossible to re-arrange the class as it need to be conducted as the research objectives need.

C. Operational Definition

a. Science Virtual Test in this research is developed by Maulida, Firman and Rusyati (2017) based on six element of critical thinking by Inch (2006). Science Virtual Test in this research conducted in form of multiple choices questions made by using Adobe Flash Player software. The test items contain certain information provided in interactive media type like; audio-narrative, picture, or video.

b. Paper Based Test used in this research is the converted Science Virtual Test into text-narrated test on printed paper. The information and content is exactly the same with Science Virtual Test but in the form of full traditional text and image version.

c. Students' Critical Thinking are described by Inch (2006). He stated that critical thinking has eight interrelated components namely: (1) question at issue (2) purpose (3) information, (4) concepts, (5) assumptions (6) points of view, (7) interpretation and inference, and (8) implications and consequences. Students' critical thinking then measured by Science Virtual Test that developed based on critical thinking elements by Inch (2006) and Paper-based Test based on the Science Virtual Test itself. .

d. Students' Multiple Intelligence based on Gardner (2011) is the human cognitive competence that is better described in terms of a set of abilities, talents, or mental skills, which is call "intelligences" where all normal individuals possess each of these skills to some extent; individuals differ in the degree of skill and in the nature of their combination. Students' Multiple Intelligence tested using McKenzie's Multiple Intelligence Survey (1999).

e. Gender is classified as male and female as well as behavioral and psychological aspects on education as described by Bleidorn (2015).

f. Students' attitude as the described by Mangaoang-Boado (2013) that refer attitude as the students' perceptions and respond on something that is interpreted into some positivity in psychological aspects.

g. Teachers' perspectives in this research used as described by Diethelm et. al. (2012) that explain teachers' perspectives as logical abstraction of their perception on educational settings that may be influence the educational setting in school.

D. Assumption

The assumption as the foundation of this study as follow.

1. Students will learn better using multimedia on learning and increase their higher order thinking include critical and logical thinking (Chen, 2014)

2. Critical thinking relates with personality and it can affect the elements of the critical thinking so that it can also affects their learning (Petress, 2004)

3. The theory of multiple intelligences has broad implications for team teaching. In a school committed to developing students' multiple intelligences, the ideal teaching team or curriculum planning committee includes expertise in all eight intelligences; that is, each students possesses a high level of competence in a specific intelligence (Armstrong, 2009).

4. In term of ability, male and female has difference in any aspects that it could be possible to become a research study that may also highly influenced the setting in education (Mangaoang-Boado, 2012)

5. The willingness to learn of students when they have some positive respond on something will increase their motivation into learning that is as described as positive attitudes towards learning (Driscoll, 2005)

6. Teachers are often called upon to recommend children for a variety of services in schools that their perspectives playing the big role in education where they actively and directly involved to the students (McBee, 2010)

E. Hypotheses

The statistical hypotheses tested in this study are described as follows:

Null hypothesis 1: there is no significance difference between science virtual and paper-based test based on the tests' score.

Null hypothesis 2: there are no significance differences between science virtual and paper-based test based on test item's type.

Null hypothesis 3: there are no significance differences between science virtual and paper-based test based on critical thinking elements' score.

Null hypothesis 4: there are no significance differences between science virtual and paper-based tests' score based on students' Multiple Intelligences.

Null hypothesis 5: there are no significance differences between science virtual and paper-based test on critical thinking elements' score based on students' Multiple Intelligences.

Null hypothesis 6: there is no significance difference between science virtual and paper based tests' score based on students' gender.

Null hypothesis 7: there are no significance differences between science virtual and paper-based test on critical thinking elements' score based on students' gender.

F. Research Instrument

In this research, instrument is crucially needed to be used for obtaining data. There are four instruments that are used in this research which are two objective tests, Multiple Intelligence Inventory by McKenzie (1999), and students' attitude questionaire. The objective tests are Science Virtual and paper-based test for measuring students' critical thinking (Firman & Rusyati, 2016).

1. Objective Test

Objective test is a test that require a user to choose or provide an answer to a question which correct answer is pre-determined (McKenna and Bull, 1999). In using objective test, some steps are needed for further process to make the instrument can be used on a research, those steps are described as follow.

a. Science Virtual Test

According to Rosyidah, Firman and Rusyati (2017), they described that science virtual test is a test that using digital media constructed to measure students critical thinking based on eight elements of critical thinking by Inch (2006). The development of science virtual test is developed by Maulida, Firman and Rusyati (2017) which has been through further process of validation and has been used on one research to profile seventh grade students' critical thinking.

Maulida, Firman and Rusyati (2017) describe more detail that science virtual test is ready to use with high reliability (Cronbanch's Alpha 0.651), and moderate difficulty level. It contains 28 multiple choice test items that comprised eight elements critical thinking skill by Inch (2006) which are: generates purpose, raises question at issue, makes assumption, embodies point of view, uses information, utilizes concept, makes interpretation and inferences, and generates implication and consequences. Furthermore, science virtual test items' layout are described on Table 3.2.

Table 3.2 Distribution of Science Virtual Tests' Items

No.	Critical Thinking Elements	Topic's Number (Total)						Total
		Characteristics of Living Things	Diversity	Energy Supply	Ecosystem	Pollutions	Global Warming	
1.	**Purpose** a. Clearly stated objectives. b. Differentiating main objectives with other goals. c. Stated goals on target. d. Stated objective of a significant and realistic	1 (Vid)	2, 7 (Vid)	3 (Vid)	8 (Vid)	4, 5 (Vid)	6 (Vid)	8
2.	**Question at issue** a. Stating questions clearly and precisely the problem b. Asking questions with some way to explaining the meaning and scope of the problem. c. Stating sub questions. d. Identifying the problem question	10 (Pict)		9 (Vid)	13 (Vid)	11,12 (vid)		5
3.	**Assumption** a. Identifying assumptions and determine whether the assumption is correct. b. b. Considering that the proposed assumption could form the viewpoint of the problem.				14 (Vid)			1
4.	**Point of View** a. Identify viewpoints. b. Identify the strengths and weaknesses of viewpoints. c. To be fair in assessing all perspectives.		15 (Vid)			16 (Art)		2
5.	**Information** a. Expressed support based on facts.	18 (Vid)	19 (Vid)			16 (Art)	17 (Vid)	4

No.	Critical Thinking Elements	Topic's Number (Total)						
		Characteristics of Living Things	Diversity	Energy Supply	Ecosystem	Pollutions	Global Warming	Total
	b. Looking for information opposing and supporting arguments. c. Using the information that is clear, accurate, and relevant to the problem question. d. Gather enough information							
6.	**Concepts** a. Identify key concepts and stated clearly. b. Stating alternative concept or definition of alternative concepts. c. Using the concept carefully and thoroughly.	22 (Pict)			21 (Vid)		23 (Pict)	3
7.	**Interpretation and Inference** a. Conclude based on the evidence. b. Examine the consistency of conclusions. c. Identify assumptions which may lead to a conclusion.				25 (Vid)	2 (Vid)		2
8.	Implication and Consequences a. Discover the implications and the consequences that follow an argument. b. Stating positive and negative implications. c. Considering all the possible consequences.					26, 27, (Pict) 28 (Vid)		3

Note: Vid = Video, Pict = Picture =, Art = Article   (Maulida, Firman & Rusyati, 2016)

b. Paper-Based Test

After Science Virtual Test converted into Paper-based Test, the test should be processed through some steps in order to use it on research. Fraenkel, Wallen and Hyun (2012) describe that validity is the aspects of appropriateness,

meaningfulness, correctness, and usefulness of the inferences a researcher makes in a test items. PISA (2014) describe that on doing validation on transforming or converting an assessment/test items, it needs to had the same test construct, means that both of the test will become equal. So that all the information from science virtual test should be equal to all information on the paper-based test. The validity itself is judged by some experts based on the topics and based on assessment expertise. Furthermore, the detail of paper-based tests' items layout are described on the table below.

Table 3.3 Distribution of Paper-Based Tests' Items

| No. | Critical Thinking Elements | Topic's Number (Total) | | | | | | Total |
		Characteristics of Living Things	Diversity	Energy Supply	Ecosystem	Pollutions	Global Warming	
1.	**Purpose** a. Clearly stated objectives. b. Differentiating main objectives with other goals. c. Stated goals on target. d. Stated objective of a significant and realistic	1 (Nar)	2, 7 (Nar)	3 (Nar)	8 (Nar)	4, 5 (Nar)	6 (Pict)	8
2.	**Question at issue** a. Stating questions clearly and precisely the problem b. Asking questions with some way to explaining the meaning and scope of the problem. c. Stating sub questions. d. Identifying the problem question	10* (Pict)		9 (Nar)	13 (Nar)	11,12 (Nar)		5
3.	**Assumption** a. Identifying assumptions and determine whether the assumption is correct. c. b. Considering that the proposed assumption could form the viewpoint of the problem.				14 (Nar)			1
4.	**Point of View** a. Identify viewpoints.		15 (Nar)			16* (Art)		3

No.	Critical Thinking Elements	Topic's Number (Total)						Total
		Characteristics of Living Things	Diversity	Energy Supply	Ecosystem	Pollutions	Global Warming	
	d. Identify the strengths and weaknesses of viewpoints. e. To be fair in assessing all perspectives.							
5.	**Information** a. Expressed support based on facts. b. Looking for information opposing and supporting arguments. c. Using the information that is clear, accurate, and relevant to the problem question. d. Gather enough information	18 (Nar)	19 (Nar)			16* (Art)	17* (Pict)	3
6.	**Concepts** a. Identify key concepts and stated clearly. b. Stating alternative concept or definition of alternative concepts. c. Using the concept carefully and thoroughly.	22* (Pict)			21 (Nar)		23* (Pict)	3
7.	**Interpretation and Inference** a. Conclude based on the evidence. b. Examine the consistency of conclusions. c. Identify assumptions which may lead to a conclusion.				25 (Nar)	2 (Nar)		2
8.	Implication and Consequences a. Discover the implications and the consequences that follow an argument.					26*, 27*, (Pict) 28		3

No.	Critical Thinking Elements	Topic's Number (Total)						Total
		Characteristics of Living Things	Diversity	Energy Supply	Ecosystem	Pollutions	Global Warming	
	b. Stating positive and negative implications. c. Considering all the possible consequences.					(Nar)		

Note: Nar = Narration Text, Pict = Picture, Art = Article, * = exactly same as SVT

2. McKenzie Multiple Intelligence Inventory

Gardner (1983) initially proposed his theory of Multiple intelligences (MI) that encompasses seven different areas of intelligence (verbal-linguistic, logical-mathematical, musical-rhythmic, visual-spatial, bodily-kinesthetic, interpersonal, and intrapersonal), and later on added the eighth and ninth areas (naturalist and existential) in 1999. Based on the theory of Multiple Intelligences (MI), a person may be viewed as intelligent in any of these areas, and the identification of the dominant intelligence type has proven to have pedagogic implications. McKenzie's MI questionnaire is one of the established tools to identify the typology of intelligence. Multiple Inventory (questionnaire) proposed by McKenzie (1999) provides an objective measure of MI that has through validation by Hajhashemi and Eng (2010) that involved 173 pre-university students of both genders in Tehran. The findings of the study indicate that overall, the questionnaire has a high reliability (Cronbach's alpha 0.90). The original English version is translated into Indonesian language to ensure that the individuals could easily understand the items as well as to avoid any difficulty related to their students' lack of foreign language proficiency (PISA, 2014).

3. Students' Attitude Questionnaire

Questionnaire on students' attitude will be constructed to find out whether students have positive or negative attitudes towards Science Virtual Test and also find out some aspects as comparison to paper-based test. Students' attitude questionnaire is constructed with four aspects which are experience, preference, technical, and media.

4. Interview of Teachers' Perspectives

Interview is also conducted as additional data to support this research to becoming more eligible as source of local information from the teacher that are involved in this research. The interview form is constructed based on some guidelines which are acceptance, perspectives, and preference regarding computer, Science Virtual, and paper-based test.

G. Research Procedure

In order to make this research become more systematic and well-structured, the procedure of this research are composed of three stages which are preparation stage, implementation stage, and completion stage as its explained below.

1. Preparation stage

This stage is the step before conducting data collection. The preparation stage of this research is described as below.

a. Providing Science Virtual Test

b. Convert Science Virtual Test into paper-based test

c. Validating the language conversion of Multiple Intelligences Inventory

d. Validating the students' attitude questionnaire

e. Preparing form of judgments

f. Readability test

g. Expert judgment

h. Revising test items into fix test item that will be used for data collection

i. School authorization

j. Sampling and making time schedule of data collection

2. Implementation stage

On this stage, the data collection are conducted. The implementation stage of this research is described as follow.

a. Fulfilling Multiple Intelligences Inventory

b. Result socialization of MI Inventory

c. Conducting Paper-based Test

d. Two weeks' time period

e. Conducting Science Virtual Test

f. Fulfilling Students' attitude questionnaire

g. Data administration

3. Completion stage

After implementation stage, the data obtained will be analyzed mainly on this stage. The completion stage of this research is described as follow.

a. Analyzing data using Statistical analysis using SPSS

b. Exporting result into research paper

c. Drawing conclusion

H. Data Analysis

After the data obtained, data analysis is the important step required to continue the research. In this research, due to the quantitative methodology, statistical analyses are mainly used to analyze the data. In more detail, comparative statistical analyses are used because this research objectives are to compare between two modes of assessment tool. As well as other statistical analyses, the analyses is then divided into parametric and non-parametric tests, which is accordance to the normality and homogeneity of the data. After defining its normality and

homogeneity, when the data are assumed to be normally and distributed, then parametric test will be applied, but when it is not as described, then non-parametric test will be used, since it doesn't require the properties of the parametric test (Arikunto, 2006). The main variable that is involved in this research is the score from both test modes. According to the research design that only using one group for both test, paired-samples is used to analyzed the data (Arikunto, 2006). Mainly, paired-samples *t test* is used to analyze the parametric data while Wilcoxon signed rank test is used to analyzed the data that doesn't meet the requirement to do the parametric test. The data beside of the score such as questionnaire and interview are analyzed differently due to the entirely different properties of the data. The statistical test is done using SPSS 23.0 software.

1. Paired-Samples *t* Test

Paired-samples *t* tests are comparative statistic based on *t* values which are derived from processing the means. The *t* values are the test statistic that is a standardized value which is calculated from sample data during a hypothesis test. The *t* then compared to the *t* table and then the null hypothesis is rejected if *t* calculated > *t* table. The formula used to find the *t* value is:

$$t = \frac{\left(\overline{X}_1 - \overline{X}_2\right) - \left(\mu_1 - \mu_2\right)}{s_{\overline{X}_1 - \overline{X}_2}}$$

(Minium, 1993, p. 327)

Description:

t	: t value (t calculated)
$\overline{X}_1 - \overline{X}_2$	: Sample mean difference
$\mu_1 - \mu_2$	: Hypothesized mean difference
$s_{\overline{X}_1 - \overline{X}_2}$	: Standard deviation of the sample differences

2. Wilcoxon Signed Rank Test

Wilcoxon signed rank test can be used in place of the *t* test for dependent samples. The test statistic is using the *z* value to inference the data. The null hypothesis is rejected if *z* value > *z* table.

$$z = \frac{w_s - \dfrac{n(n+1)}{4}}{\sqrt{\dfrac{n(n+1)(2n+1)}{24}}}$$

(Minium, 1993, p. 489)

Description:
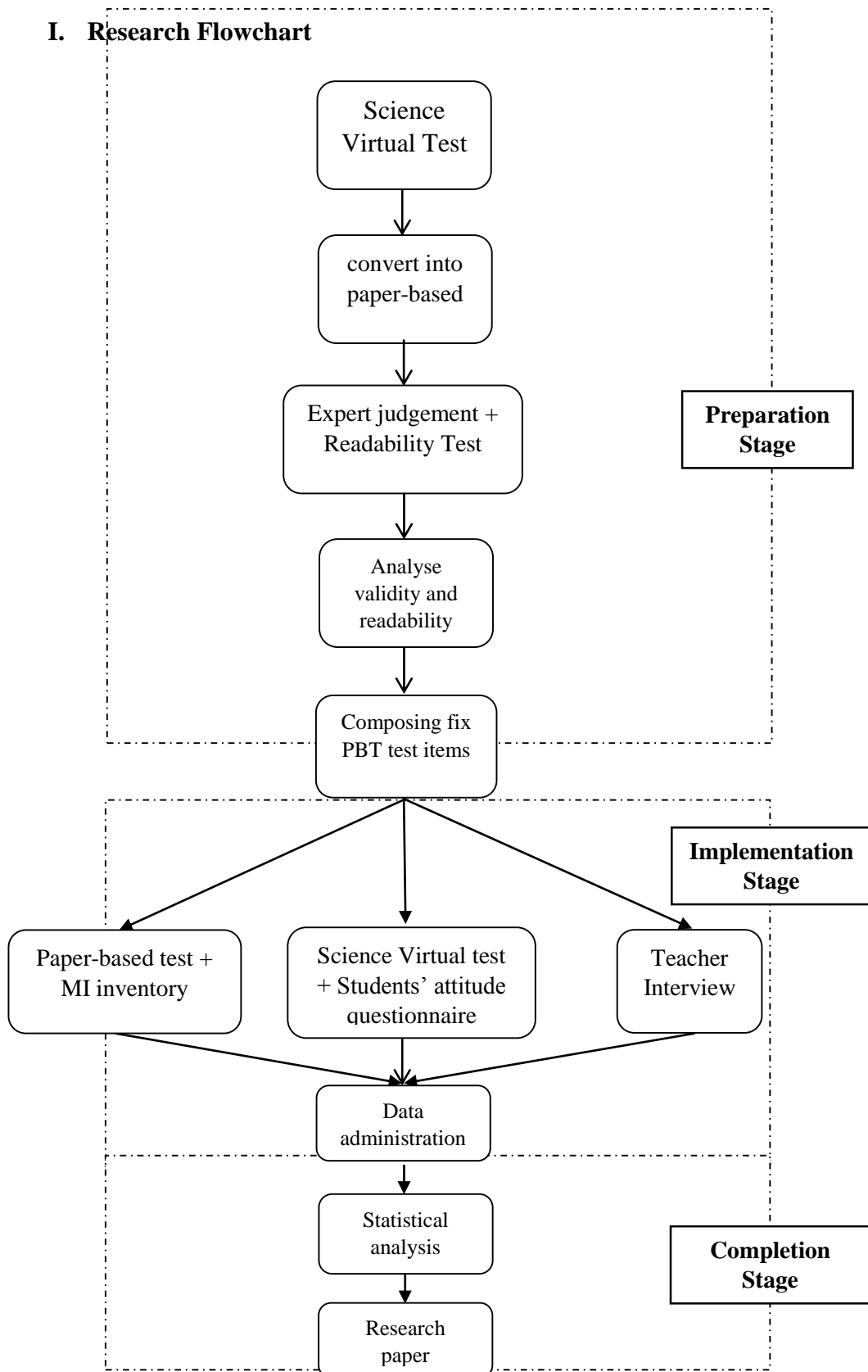
z   : *z* value (*z* calculated)

n   : number of pairs where the difference is not zero

w_s : smallest of absolute values of the sums

3. Analysis of Questionnaire

The students' attitude questionnaire are consist of 15 statements in 4 aspects. Four-point Likert-type scale of agreement (4 = strongly agree, 3 = agree, 2 = disagree, and 4 = strongly disagree) were used on the questionnaire. The data of students' attitude questionnaire is investigated simply by examine its average of the Likert-scale's score as the research that has been done by Dammas (2016) that investigated students' attitude towards computer-based assessment. Then the interpretation of the average is divided as; 1 – 2 as negative, 2.1 – 3, and 3.1 – 4 as positive.

I. Research Flowchart


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┌─────────────────┐
│ Science         │
│ Virtual Test    │
└─────────────────┘
        ↓
┌─────────────────┐
│ convert into    │
│ paper-based     │
└─────────────────┘
        ↓
┌─────────────────┐
│ Expert judgement + │      ┌──────────────┐
│ Readability Test   │      │ Preparation  │
└─────────────────┘         │ Stage        │
        ↓                   └──────────────┘
┌─────────────────┐
│ Analyse         │
│ validity and    │
│ readability     │
└─────────────────┘
        ↓
┌─────────────────┐
│ Composing fix   │
│ PBT test items  │
└─────────────────┘
```

Preparation Stage

Implementation Stage

Paper-based test + MI inventory

Science Virtual test + Students' attitude questionnaire

Teacher Interview

Data administration

Statistical analysis

Completion Stage

Research paper

Figure 3.1 Research Flowchart