CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method

A pre-experimental research method was applied in this research. It is a type of research design which involves a within group procedure in which a single group are studied (Creswell, 2014).

3.2 Research Design

The research design used in the research was one-group pretest-posttest design. A single group is observed before and after being exposed to a treatment (Fraenkel., Wallen., Hyun, 2012). The one group pretest-posttest design is represented as on Table 3.1 below.

Table 3.1

Research Design of One Group Pre-test and Post-test

Pre-Test	Experiment	Post-Test
O_1	X	O_2

(Fraenkel., Wallen., Hyun, 2012)

O_1 : Pretest of students' Achievement Test

X : Implementation of Multiple Intelligence based Learning

O_2 : Posttest of Students' Achievement Test

In this research, students are given the pre-test in the form of questions typed multiple choice that consists of 24 numbers of questions. Afterwards, treatments are given using multiple intelligence based learning to the experimental group only. Finally, students are given the post-test in the same form and number of questions as in the pre-test.

3.3 Population and Sample

The population of this research was 8th grade of Junior High School students. The samples chosen using convenience sampling technique which were 8th grade students from three classes of Private School in Bandung. Two classes were the lower achiever class consists of 19 female students and 22 male students, and other one class was the higher achiever class with 8 female students and 17 male students. This class categorization (higher and lower achiever class) was based on the school privacy itself considering students' achievement once they registered the school at the beginning. Those three classes were all acted as an experimental group

3.4 Operational Definition

1) Multiple intelligence based learning is learning activities that refer to multiple intelligences theory. Those multiple intelligences theory has nine types: visual-spatial, verbal-linguistic, logical-mathematical, music-rhythm, bodily-kinesthetic, intrapersonal, interpersonal, naturalist and existential intelligence. The theory was obtained from reading some relevant literatures. Observation sheet is used to measure the implementation of multiple intelligence based learning.
2) Students' Understanding is the students' competence that covers levels of six cognitive process dimensions based on Bloom's Taxonomy Revision. Students' concept mastery data was gained by using the achievement test consisting of 24 multiple choice questions with implementing only in Remembering (C1), Understanding (C2), Applying (C3) and Analyzing (C4) of cognitive level.
3) Students' Science Learning Motivation is a students' motivation level in learning science. The data was taken from a Likert-scale questionnaire made by Tuan, Chin, and Shieh (2005) consisting of

six aspects: students' self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation.

4) Electrical Circuit Topic is the teaching and learning materials based on Cambridge Curriculum. These materials were dominantly explaining about Series and Parallel Circuit and were taught by using multiple intelligence based learning.

3.5 Assumption

The assumptions as the foundation of this research is as follow:

1) Students' understanding significantly improves after implementing the multiple intelligence based learning.
2) Students' motivation in science learning is in higher level after implementing the multiple intelligence based learning.

3.6 Hypothesis

H_0: The implementation of multiple intelligence based learning has no significant effect towards students' understanding on electrical circuit topic.

H_1: The implementation of multiple intelligence based learning has a significant effect towards students' understanding on electrical circuit topic.

H_0: The implementation of multiple intelligence based learning has no significant effect towards students' motivation on electrical circuit topic.

H_1: The implementation of multiple intelligence based learning has a significant effect towards students' motivation on electrical circuit topic.

3.7 Research Instrument

The instruments used for gaining data of the research are summarized in Table 3.2.

Table 3.2

Research Instrument

No.	Data Needed	Instruments
1	Implementation of multiple intelligence based learning	Observation Sheet
2	Students' understanding	Achievement Test
3	Students' science learning motivation	Likert-Scale Questionnaire

According to the table above, these are the complete description of how the data could be achieved and how the instrument was taken and adopted.

3.7.1 Observation Sheet

Observation sheet in the research contains activities which refer to the multiple intelligence based learning that consists of eight types of multiple intelligences. These eight intelligences were implemented to the concept of science learning especially in electrical circuit topic. Below is the blueprint of multiple intelligence based learning implemented in the research, depicted in Table 3.3.

Table 3.3

Blueprint of Observation Sheet

Type of Intelligence	Concept	Activities
	Electric Charge, Ohm's Law	Paying attention to power point presentation about Electric Charge and Ohm's Law.

Type of Intelligence	Concept	Activities
Visual-Spatial Intelligence	Electrical Circuit Symbols	Drawing the symbols of eight electrical components.
	Circuit Diagram	Drawing circuit diagrams containing sources, switches, resistors and lamps.
	Electric Charge Equation	Calculating the electric charge passing through the lamps using the formula of Q = I.t.
	Ohm's Law Graphic	Drawing the graph of Ohm's Law based on its equation.
Logical-Mathematical Intelligence	Ohm's Law Equation	Calculating the current, voltage and resistance using the Ohm's Law equation.
	Resistance	Finding out the resistance and combined resistance in given circuit diagram.
	Electric Charge, Ohm's Law and Resistance Exercises	Calculating about Electric Charge, Ohm's Law, and Resistance.
	Resistance in Resistor	Doing a virtual experiment to check the magnitude of resistance in a resistor using PhET simulation software.
Bodily-Kinesthetic Intelligence	Series Circuit	Doing a virtual experiment to construct the series circuit using PhET simulation software as the

Type of Intelligence	Concept	Activities
		picture attached in the worksheet.
	Parallel Circuit	Doing a virtual experiment to construct the parallel circuit using PhET simulation software as the picture attached in the worksheet.
	Electric Eel	Watching a video on Youtube about Electric Eel.
Naturalist Intelligence	Fruit Battery	Watching the video given about fruit battery.
Musical-Rhythm Intelligence	Electrical Circuit	Watching a Song Lyric on Youtube about Electrical Circuit.
Intrapersonal Intelligence	Electrical Circuit	Writing the essence of what is explained on the video.
	Connecting Ammeter and	Reading the article given and explained directly by teacher about
Verbal-Linguistic	Voltmeter in Circuit	the way of connecting ammeter and voltmeter in electrical circuit.
Intelligence	Series and Parallel Circuit	Paying attention to teacher's presentation using power point about series and parallel circuit.
Interpersonal Intelligence	Electrical Circuit	Answering some questions regarding the topic delivered.

Table 3.3 shows the activities done during the treatment for 6 meetings in 6 weeks. The intention of this observation sheet was to make sure that researcher has the appropriate activities of implementing the multiple intelligence based learning to students along teaching and learning process.

3.7.2 Achievement Test

In this research, researcher made the questions according to the Bloom's Taxonomy Revision which includes only four cognitive process dimensions: Remembering (C1), Understanding (C2), Applying (C3) and Analyzing (C4). The pre-test and post-test is the time which this achievement test is conducted. Below is Table 3.4, representing the blueprint of achievement test of electrical circuit topic.

Table 3.4

Blueprint of Achievement Test

No.	Sub-topic	C1	C2	C3	C4	Total
1	Open and Closed Circuit	1	2	3	4	4
2	Simple Circuit	5	6	7	8	4
3	Ammeter Reading	9	10	11	12	4
4	Voltmeter Reading	13	14	15	16	4
5	Characteristics of Series Circuit	17	18	19	20	4
6	Characteristics of Parallel Circuit	21	22	23	24	4
	Total	6	5	6	6	24

Table 3.4 shows clearly about the blueprint of achievement test that consists of six sub-topic usually found and be the crucial parts on electrical circuit topic. Here is the process or steps to make the achievement test valid to implement.

1) Validity

Validity is the important thing to consider in research instrumentation. Validity shows that instruments used by researcher achieve the purpose (Fraenkel, 2012). Currently, validity refers to the correctness, appropriateness, meaningfulness,

even usefulness to process the data that researcher obtain from the research. According to Cohen (2007), validity is the key to determine whether the research conducted by researcher is worthy or worthless. Below is the formula for measuring the validity of test items.

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}}$$

Where:

$\sum X$ = Total score of all students in that item

$\sum Y$ = Total score of all students in the test

N = number of students

X = Score of each students in that item

Y = Total score of each students

r_{xy} = Item validity

The following Table 3.5 is used for interpreting the validity of each item.

Table 3.5

Validity Interpretation

Validity value	Interpretation
0.80 – 1.00	Very High
0.60 – 0.79	High
0.40 – 0.59	Prosperous
0.20 – 0.39	Low
0.00 – 0.19	Very Low

(Kaplan & Saccuzzo, 2013)

2) Reliability

Reliability is a measure of consistency over time and over similar samples (Cohen, 2007). Meanwhile, according to Fraenkel (2012), reliability is the consistency of the scores obtained. The researcher uses the Kuder-Richardson formula to measure the reliability of test item. The formula is depicted as follow:

$$KR_{21} = \left[\frac{K}{K-1}\right]\left[1 - \frac{M\,(K-M)}{K\,(SD^2)}\right]$$

Where:

K = Number of items on the test

M = Mean of the set of test scores

SD = Standard Deviation of the test scores set

The interpretation of reliability gained using the formula mentioned above is depicted in Table 3.6 below.

Table 3.6

Reliability Interpretation

Gained r value	Interpretation
0.80 – 1.00	Very High
0.60 – 0.79	High
0.40 – 0.59	Prosperous
0.20 – 0.39	Low
0.00 – 0.19	Very Low

(Fraenkel, 2012)

3) Difficulty Level

Difficulty level in the research that is applied the test refers to the degree of students' difficulty in answering the questions. The

formula to determine the difficulty level of test item in the research is:

$$DL = \frac{R_U + R_1}{N_U + N_1}$$

Where:

R_U = The number of students in the upper group who answer correctly

R_1 = The number of students in the lower group who answer correctly

N_U = Number of students in the upper group

N_1 = Number of students in the lower group

Table 3.7 represents the interpretation of difficulty level in test items.

Table 3.7

Interpretation of Difficulty Level

Difficulty Index Value	Category
0.00 – 0.30	Difficult
0.31 – 0.70	Moderate
0.71 – 1.00	Easy

(Boopathiraj, 2013)

4) Discriminating Power

Discriminating power is defined as degree to which success or failure a test item indicates possession of the ability being measured. The formula used to measure the discriminating power is:

$$D = \frac{R_U - R_1}{\frac{1}{2}(N_U + N_1)}$$

Where:

R_U = The number of students in the upper group who answer Correctly

R_1 = The number of students in the lower group who answer Correctly

N_U = Number of students in the upper group

N_1 = Number of students in the lower group

The representation of discriminating power in test items is depicted in Table 3.8 below.

Table 3.8

Interpretation of Discriminating Power

D value	Quality	Recommendation
00.00 – 0.20	Poor	Discard/ review in depth
0.21 – 0.40	Fair	Need to check / review
0.41 – 0.70	Good	Possibilities for improvement
0.71 – 1.00	Very Good	Retain

(Boopathiraj, 2013)

5) Distractor

Distractor is incorrect option of answer which is provided in a multiple choice questions type. Here is the formula of distractor:

$$\text{corrected score} = R - \frac{W}{n-1}$$

Where:

R = Number of right answer

W = Number of wrong answer

n = Number of choice in each item

(Kaplan & Saccuzo, 2012)

3.7.3 Likert-Scale Questionnaire

The questionnaire of the research is posed to measure students' science learning motivation which was adopted from Tuan, Chin, & Shieh, (2005) that consists of six aspects to measure students' science learning motivation. Those six aspects are including to the students' self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation gathered into 35 items. Below is Table 3.9 representing the blueprint of students' science learning motivation in the form of Liker-scale questionnaire.

Table 3.9

Aspects in Students' Motivation Questionnaire

No.	Aspects	Quantity	Details numbers
1	Self-efficacy	7	1 – 7
2	Active Learning Strategies	8	8 – 15
3	Science Learning Value	5	16 – 20
4	Performance Goal	4	21 – 24
5	Achievement Goal	5	25 – 29
6	Learning Environment Stimulation	6	30 – 35

(Tuan, Chin, & Shieh, 2005)

There are five statements of Likert-scale of the questionnaire which includes to the Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5).

3.8 Instrument Analysis Result

1) Recapitulation of Achievement Test Instrument

Table 3.10 and 3.11 below shows the instrument analysis result which has been tested to 9th grade students of the same school which the research samples were taken and who have learnt about electrical circuit topic when they were in grade 8. The result was including to its validity, reliability, discriminating power and difficulty level. Here is the recapitulation of achievement test instrument analysis result, depicted in Table 3.10 and 3.11 below.

Table 3.10

Reliability of Achievement Test Instrument

Aspect	Value
Mean	16.10
Standard Deviation	3.33
Correlation	0.50
Reliability Test	0.67
Category	High

From Table 3.10 it can be seen that the achievement test has high level of reliability with the value of 0.67. Meanwhile, the validity of the achievement test is depicted in Table 3.11 below.

Table 3.11

Analysis Result of Achievement Test Instrument

DP	Category	DL	Category	Validity	Category	Decision
9.09	Poor	97.50	Very Easy	0.588	Pros-perous	Used
9.09	Poor	82.50	Easy	0.154	Very Low	Revised

DP	Category	DL	Category	Validity	Category	Decision
9.09	Poor	2.50	Very Difficult	0.190	Very Low	Revised
27.27	Fair	92.50	Very Easy	0.729	High	Used
27.27	Fair	55.00	Medium	0.333	Low	Revised
27.27	Fair	82.50	Easy	0.374	Low	Revised
27.27	Fair	65.00	Medium	0.309	Low	Revised
9.09	Poor	80.00	Easy	0.186	Very Low	Revised
18.18	Poor	90.00	Very Easy	0.466	Pros perous	Used
36.36	Fair	85.00	Easy	0.438	Pros perous	Used
27.27	Fair	55.00	Medium	0.226	Low	Revised
45.45	Good	80.00	Easy	0.585	Prospero us	Used
45.45	Good	87.50	Very Easy	0.700	High	Used
0.00	Poor	77.50	Easy	0.089	Very Low	Revised
63.64	Good	42.50	Medium	0.511	Pros perous	Used
36.36	Fair	67.50	Medium	0.216	Low	Revised
63.64	Good	72.50	Easy	0.512	Pros perous	Used
9.09	Poor	25.00	Difficult	-0.088	-	Revised
63.64	Good	60.00	Medium	0.505	Pros perous	Used
54.55	Good	67.50	Medium	0.378	Low	Revised

DP	Category	DL	Category	Validity	Category	Decision
27.27	Fair	75.00	Easy	0.263	Low	Revised
36.36	Fair	87.50	Very Easy	0.494	Pros perous	Used
27.27	Fair	22.50	Difficult	0.202	Low	Revised
27.27	Fair	57.50	Medium	0.303	Low	Revised

From Table 3.11 it shows that there is only one rejected item. However, all items are used with revision consideration.

2) Instrument Non-Test Requirement

Another instrument of this research was including to the non-test requirement which was students' science learning motivation questionnaire. The students' science learning questionnaire was adopted from Tuan (2005) and validated by three experts. This instrument was distributed to students before and after being taught Electrical Circuit Topic with implementing multiple intelligence based learning during the teaching and learning process.

3.9 Data Processing Technique

There are two types of data have to be collected in this research, which were quantitative data that were obtained from pre-test and post-test of achievement test, and the other one was data obtained from questionnaire response.

1) Students' Understanding Measurement

The steps of calculating the data of students understanding measurement was explained clearly as follow:

a) Scoring of Test Items

Scoring of test item was calculated using Microsoft Excel to determine the score of both pre-test and post-test of achievement test that consists of 23 questions.

b) Calculation of Gain Score and Normalized Gain

After scoring test items, the data was then processed to gain the gain score and normalized gain. Gain score is obtained from the difference between post-test and pore-test result. To determine the gain score, Hake (2009) suggested the formula below:

$$G = S_f - S_i$$

Description:

G = Gain Score

S_f = Post-test Score

S_i = Pre-test Score

(Hake, 2009)

The effect of implementing multiple intelligence based learning towards students' understanding on electrical circuit topic was determined from the result of normalized gain. The formula used to calculate and obtain normalized gain is depicted on the details below:

$$< g > = \frac{\%<G>}{\%<G>max} = \frac{(\%<S_f> - \%<S_i>)}{(100 - \%<S_i>)}$$

Description:

<g> = Normalized Gain

<G> = Actual Gain

<G> max = Maximum gain possible

$< S_f >$ = Average of post-test score

$< S_i >$ = Average of pre-test score

The value of normalized gain has been obtained is interpreted using the table 3.12.

Table 3.12

Interpretation of Normalized Gain

Value	Classification
$-1.0 < g < 0.0$	Decrease
$g = 0.0$	Stable
$0.0 < g < 0.3$	Low
$0.3 < g < 0.7$	Average
$0.7 < g < 1.0$	High

(Hake, 2009)

c) Normality and Homogeneity Test

Normality test is used to see whether the sample is normally distributed. In this research, SPSS 23 was used to conduct normality and homogeneity test. The normal distribution is determined by referring to the significant value of Kolmogorov-Smirnov which has been approved for its effectiveness in measuring normality for a sample ($N = \geq 50$). If the significance level is ≥ 0.05, then H_1 is accepted. H_0 would be rejected if the significance level is ≤ 0.05. Homogeneity test also is obtained from analysis result through IBM SPSS 23. The data is considered as homogenous if the significance value is ≥ 0.05.

d) Wilcoxon Test

Based on the previous analysis of normality and homogeneity test, the data was homogenous but not normally distributed. Hence, the Wilcoxon Test in SPSS 23 was used to replace Paired Sample T-Test as it should be when the data meets normal distribution. H_0 is accepted if the significance level is ≤ 0.05 while it is rejected if its significance level is ≥ 0.05.

2) Students Science Learning Questionnaire Measurement

The secondary data in this research was obtained from the students' science learning questionnaire. The analysis of this

questionnaire was done by converting the raw score into percentage using the following formula:

$$P = \frac{f}{n} \times 100\%$$

Where:

P = Percentage

F = Frequency of Answer

n = Total of Response

After calculating the percentage using the formula above, the result is then categorized into level as shown in Table 3.13.

Table 3.13

Interpretation of Students' Motivation Level

Percentage	Level
0 % – 20 %	Very Low
21 % – 40 %	Low
41 % – 60 %	Medium
61 % – 80 %	High
81 % – 100 %	Very High

(Sugiyono, 2011)

3.10 Research Procedure

To be systematically arranged, this research has several steps to do such as preparation, implementation and completion stage. Each stage is explained below.

1) Preparation Stage

In this stage, the researcher conducts several steps as follow:

a) Formulating problem that is going to be investigated.

b) Determine the focus of variable research.
c) Conduct literature review about Multiple Intelligences Theory on students' understanding and motivation. Others literature review also have been read, such as students' understanding and motivational aspects.
d) Arrange the research proposal to be presented in the proposal seminar.
e) Consultation with experts.
f) Present the research proposal in seminar proposals.
g) Revise research proposal after having some suggestions and critics from lecturers.
h) Arrange research instrument and ask for expert judgment to judge it.
i) Revise the research instrument has been judged.
j) Try out research instrument has been revised.
k) Revise research instrument analyzed based on trial previously.

2) Implementation Stage

In this stage, the data gathering process is included. The steps are explained as follow:

a) Determination of experimental group. Three classes existed as samples in this research acted as experimental group.
b) Conduct the pre-test to the experimental group, in order to find out the initial condition. The pre-test is an achievement test consists of 24 electrical circuit topic questions. Thereafter, students' science learning motivation questionnaire in the form of Likert-scale that consist of 35 statements of six aspects are also administered.
c) Analyze the pre-test results. The pre-test is analyzed using Wilcoxon test in SPSS 23. Meanwhile, the questionnaire is analyzed using the formula proposed by other researcher.

d) Conduct the research activity by implementing multiple intelligence based learning as a treatment. The treatment conducted during 6 meetings in 6 weeks. The implementation of the treatment was online due to the condition adjustment of covid-19 outbreak. In those 6 meetings, students learned the materials of electrical circuit topic through Google Classroom and Zoom Apps. In this case students did not gather in the same profile of multiple intelligences they have since they also did not take any test that generated them to recognize their profile. So they only gathered in the same arrangements of existed condition in class. In each meeting students had experienced learning activities related to several multiple intelligence based learning in integrated way. So in the complete meeting, students experienced all types of multiple intelligence based learning.

e) Conduct post-test to the experimental group to find out students' response towards implementation of multiple intelligence based learning. The post-test questions and questionnaire, and the analysis process were also the same as in the pre-test.

3) Completion Stage

This stage is a final stage where the researcher analyzes the collected data obtained during the implementation stage. The steps are as follow:

a) Analyze the overall results. The result from the implementation stage was analyzed comprehensively. Students understanding and motivation were analyzed based on their class types: higher achiever class, lower achiever class, and all participants. It was also analyzed based on the Bloom's Taxonomy Revision from C1 (Remembering) until C4 (Analyzing).

b) Discuss and conclude the data analysis results. The discussion and conclusion also explained the same way as in point a. the cause and effect of result also presented in this part.
c) Arrange of research report. Research report was made based on the real result obtained in this research. There was no manipulation to gain better result, it was originally resulted, discussed, and concluded.

3.11 Research Flowchart

Below is the steps in every stages used as a guideline to conduct the research resumed in Figure 3.1 on the next page.

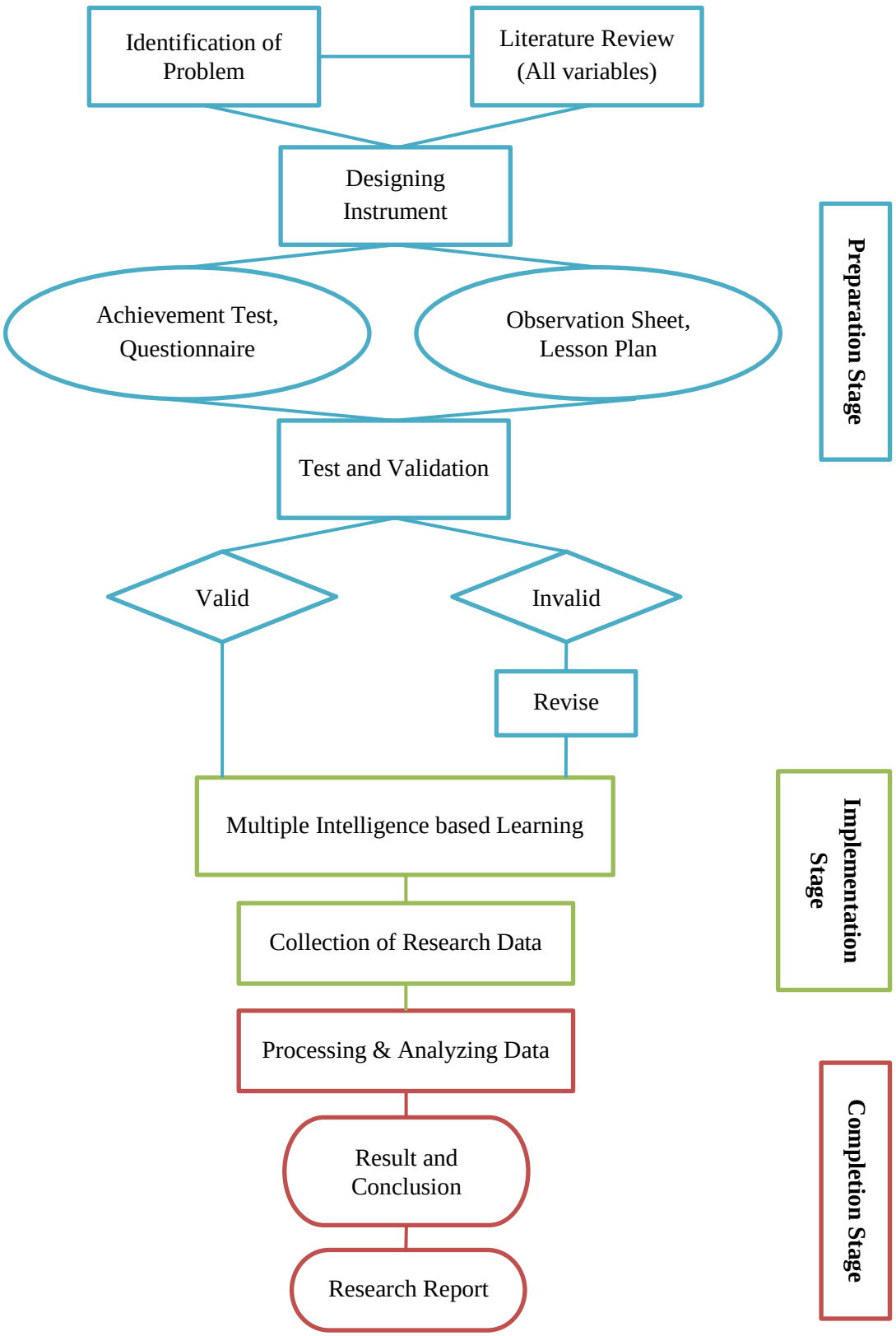

Figure 3.1 Research Flowchart