CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method and Research Design

3.1.1 Research Method

Quasi-experimental method is used in this research to collect and obtain data in the field. Researcher uses this experimental research to test the effect of problem solving model on students' concept mastery. According to Fraenkel, experimental research has often been hailed as the most powerful method for studying cause and effect (Fraenkel et.al., 2011). In this method, research carried out on two experimental groups of 7^{th} grader students which are girl class and boy class.

3.1.2 Research Design

Pre-test and post-test design definition from Cresswell (2012) provides a measure on some attribute or characteristic that is assessed for participants in an experiment before they receive a treatment. Post-test can be used to assess participant in experiment after a treatment. The research design is illustrated in Table 3.1

Table 3.1 Research Design: Two Group Pre-Test Post-Test Design

O_1	X	O_2
O_3	X	O_4

(Source: Cresswell, 2012)

O_1 = Pre-test for girl class

O_2 = Post-test for girl class

O_3 = Pre-test for boy class

O_4 = Post-test for boy class

X = Treatment using Problem Solving Model

3.2 Population and Sample

The location of this research is taken in one of Billingual School in Bandung. This school is one of the Pasiad partner school which use Kurikulum 2013 along with Zambak modular system. This school named as bilingual school because it uses Bahasa and English as its instructions language. This school is appropriate for this research because it has a different system of class division. The class of girl and boy students are separated.

The population in this research is 7^{th} grade students at Billingual Junior High School in Bandung. The sample is taken from two classes of the 7^{th} grades. There are 7 A and 7 B as different based on gender classes. 7 A is boys' class and 7 B is girls' class, both of classes are given the same treatment.

Sampling are selected by purposive sampling technique according to Fraenkel et.al., (2011). The sampling consideration is based on the specific purpose which is compare the cognitive achievement between girl and boy students, therefore researcher choose sample from based gender classes (Fraenkel et.al., 2011). The total samplings are 32 students of 7^{th} grader, with 16 girl students and 16 boy students.

3.3 Assumptions

Based on some literature review and experts, the assumption as the foundation of this study as follow:

1. Problem solving will help students to improve students' concept mastery in learning physics especially heat topic based on correlate journal that researcher has read.
2. Researchers who worked on problem solving agree that a problem occurs only when someone is confronted with a difficulty for which an immediate answer is not available. It can help students to solve the problems and enhance students' understanding.
3. The main problem on the science instruction is boring instruction, so that, students will leak of motivation in learning

science especially physics. Students' motivation will increase within this model of instructions.

3.4 Hyphothesis

Using of parametric statistic has a deal with assumption that each variable in this research that will be analyzed form a normal distribution. If, the data is abnormal, the homogeneity variant test cannot be done or the parametric technique cannot be used. Meanwhile if the data is normal and homogen, the parametric technique can be used. Normality test is to know whether the sample comes from population that has normal distribution or not. In this research, Normality test uses statistic test from SPSS 20, ***Kolmogorov-Smirnov*** with significancy level (α) is 0,05. When significance value > 0,05, H_0 will be accepted and H_0 will be rejected or denied if significance value < 0,05 The hypotheses are:

H_0 : There is no difference in boy and girl students' concept mastery and motivation in learning heat.

H_1 : There is difference in boy and girl students' concept mastery and motivation in learning heat.

The homogeneity test is also uses statistic test from SPSS 20, with significance level (α) is 0,05. When significance value ≥0,05, the data is considered as homogeny (Sarwono, 2012).

3.5 Operational Definition

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

a. Problem-Solving is a model which includes problem identification, problem definition, strategy formulation, organization of information, allocation of resources, monitoring and evaluation (Yahya, 2014). The problem-solving model is assessed by the observational sheet that is

assessed by other teacher in school while the author is implementing problem-solving model and collecting data.

b. Students' Concept Mastery in this research is the competence of students that covers the level concept mastery such as remembering (C1), understanding (C2), applying (C3), analyzing (C4) and evaluating (C5). The indicators are heat chapter in physics subject. This competence is measured by using multiple choice questions (pre-test and post-test).

c. Students' Motivation consists of the amount of effort a person is willing to exert in pursuit of a goal (Keller, 2006). For this research, instruction is designed to enhance four learner motivation categories, i.e, attention, Relevance, Confidence and Satisfaction. Students' motivation towards this problem-solving model are measured by distributing questionnaire that covers students' attention and satisfaction after learning heat within this model. By distributing questionnaire also students' problem within learning this topic can be discovered.

3.6 Research Instrument

In this research, instrument is necessary to be read for gaining data. These are two types instrument that are used in this research. Those instruments are described below.

a. Objective Test

Objective test is used to measure students' cognitive before and after problem-solving model is conducted. Multiple-choices question are type of the objective test that is used in this research that is contributed to the students in the pre-test and post-test. There are 25 multiple-choices about heat concept that is used in this research.

1) Validity

Arikunto (2012) stated a good assessment of data should accordance to the reality. Validity defined as the appropriateness,

correctness, meaningfulness of the evidence that supports any inferences from the scores (Fraenkel and Wallen, 2012). The instrument of research should be valid in order to get valid result. Validity that will be used is content validity. Content validity is used to measure the particular purpose which is parallel with material given. Formula that will be used is correlation product moment equation.

$$r_{xy} = \frac{n\sum xy - [(\sum x)(\sum y)]}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Explanation:

r_{xy} = items correlation coefficient.

X = items scores

N = amount of subject

(Source: Minium et al., 1993)

According to Minium et al (1993) interpretation about correlation coefficient between x and y variable is divided into different categories as shown on the Table 3.2.

Table 3.2 Interpretation of Validity

***r* Value**	**Interpretation**
$0{,}80 < r \leq 1{,}00$	Very High
$0{,}60 < r \leq 0{,}80$	High
$0{,}40 < r \leq 0{,}60$	Enough
$0{,}20 < r \leq 0{,}40$	Low
$0{,}00 < r \leq 0{,}20$	Very Low

(Source: Minium et al., 1993)

2) Reliability

Reliability is the extent to which a measuring device is consistent in measuring whatever it measures (Ary, Jacobs and

Razavich, 1979). Anderson (2001) stated that validity and reliability are important. In this case, validity is more important and reliability is required to support the formation of validity. According to Arikunto (2013) reliability of an evaluation instrument is intended as a tool that gives the same results if the measurement is given on the same subject although done by different people, at different times, and different places. According to Arikunto (2013), the value of reliability is determined based on coefficient value which is gained by Alpha formula (Arikunto, 2013), as follows

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

Explanation:

r_{11} : reliability coefficient

$s_i{}^2$: score variant each test item

n : amount of test item

s_t^2 : total score variant

(Source: Arikunto, 2013)

3) Difficulty Level

The assumption that used to determine the good problem is by balancing the difficulties of problem. The ability of student in answering the difficult question is not seen from the teacher perspective. Basic considerations in determining the proportion of categories of problems are easy, medium and difficult. The first consideration is the balance, which is about the same amount for all of three categories, the number of questions which easy, medium, and hard numbers scores. The second consideration for approximately three categories based on the proportion of the normal curve. Means, most of the problems are in the medium category, some are included in the category of easy and difficult with balanced proportions (Arikunto, 2012).

Difficulty test should be a good test if it has a balance composition between easy and difficult questions that given to the students. It means researcher should give optional answer that can be chosen by students and not far by the key answer (Ebel and Frisbie, 1991).

The formula which is used in this research to determine the level of difficulty of the problems can be shown as follows.

$$P = \frac{B}{N} \times 100\%$$

Explanation:

P = Difficulty Level

B = Number of Students who answer correctly

N = Total number of students

(Source: Cohen et al., 2007)

The number which indicates the difficulty and how easy a certain question is called as difficulty index (Arikunto, 2013). The range of difficulty index is start from 0,00 until 1, 00. The difficulty index criteria are shown in the Table 3.3

Table 3.3 Difficulty Index

Value	**Criteria**
0,00 – 0,30	Difficult
0,31 – 0,70	Middle
0,71 – 1,00	Easy

(Source: Arikunto, 2013)

3) Distractor

Based on Mkrtchyan (2014), distractors play a vital role for the process of multiple-choice testing, in that good quality distractors ensure that the outcome of the tests provides more credible and objective picture of the knowledge of the tested involved. On the other hand, poor distractors would not contribute much to the accuracy of

the assessment as obvious or too easy distractors will pose no challenge to the students and as a result, will not be able to distinguish high performing from low performing learners. According to Arikunto (2013) distractor which is not chosen at all means that the distractor is not good or bad. Oppositely, the distractor is impressed has good function, if that distractor has big attraction to participants who are not really mastering the concept. A certain distraction can be treated with these three following methods.

1) accepted, because it has been good
2) rejected, because it is bad
3) rewritten, because it is not really good.

b. Questionnaire

Students' motivation can be measured by distributing the questionnaire. This instrument is distributed to students in the end of the lesson. The form of likert scale is used to calculate students' response. The questionnaire is divided into positive statements and negative statements. The blueprint of students' motivation questionnaire is illustrated as in the Table 3.4

Table 3.4 Blueprint of Students' Motivation Questionnaire

Indicators	Category and Number	
	Positive Statement	Negative Statement
Students Response toward Learning Leisure in Using Problem-Solving Model	1, 3	2, 4
Students Response toward The Usefulness of Problem-Solving Model	5, 7, 9	6, 8
Students Response of Motivation towards this Learning Method	11, 13, 15	10, 12, 14

Indicators	Category and Number	
	Positive Statement	Negative Statement
Preference		

3.6 Data analysis

In this research, the data is processed in both quantitatively and supported by qualitative data. Quantitative data processing is used for measuring cognitive aspect (pre-test and post-test), meanwhile qualitative data processing is used for knowing the students impression towards this learning method.

3.6.1 Data Analysis Toward Student Concept Mastery

3.6.1.1 Quantitative Data Analysis

Quantitative data analysis is done by Microsoft excel and SPSS calculation, in order to determine the score of pre-test and post-test. Then the result of the data will be processes as the following explanation.

1) Scoring test items

The first step to process data is scoring the test items. The test items are provided in 25 number of questions. All of questions are provided in the form of multiple choices. The result will be scoring, and the scores are processed using Microsoft excel.

2) Calculation of Gain Score and Normalized Gain

After obtaining data score of the test item, the data is proceed through gain score and normalized gain score. According to Hake, gain score is obtained from the differences between pre-test and post-test. It is assumed as the effect of the treatment itself. Normalized gain test itself is to determine the categories of student's achievement improvement. According to Hake (1999) here is the formula to get the gain score:

$$G = S_f - S_i$$

G = Gain score

S_f = Post-test score

S_i = Pre-test score

(Source: Hake, 1999)

The effectiveness of problem-solving model in learning heat can be determined in the result of gain score, whether it gives a significant positive impact or not. For calculating the Normalized-gain and its interpretation is used the calculation as below (Hake, 1999).

$$< g > = \frac{G}{Gmax} = \frac{Sf - Si}{100 - Si}$$

Explanation:

<g> = Normalized gain

G = Actual gain

G max = Maximum gain possible

S_f = Post-test score

S_i = Pre-test score

(Source: Hake, 1999)

The normalized gain which already obtained is categorized according to N-gain classification. The classification of n-gain provided in Table 3.5

Table 3.5 Normalized Gain score classification

Value	Category
<g> ≥ 0,7	High
0,7 > <g> ≥ 0,3	Medium
<g> < 0,3	Low

(Source: Hake, 1999)

3) Normality test

Parametric statistic assume that each variable in this data of research form a normal distribution. Normality test is use to know whether the sample comes from population that has

normal distribution or not. In this research, Normality test is used statistic test from SPSS 20, ***Kolmogorov-Smirnov*** with significancy level (α) is 0,05. This data is normally distributed then it continues with the Homogeneity and Average difference test (Sarwono, 2012).

The criteria of the parametric statistic: when the significance value > 0.05. Hence, H_0 will be accepted and H_0 will be rejected or denied if significance value < 0.05 (Sarwono, 2012).

4) Homogeneity test

Homogeneity test is used for determine a sample from population that is originated from two classes that is homogeny. This test is done with Test of Homogeneity of Variance in SPSS 20 by ***Levene's*** test, and the Significance level (α) is 0,05.

Criteria of this test when significance value > 0.05 so, H_0 will be accepted and H_0 will be rejected or denied if significance value < 0.05 (Sarwono, 2012).

5) Hypothesis test

This research is used t-test to check the hypothesis. These hypotheses determine differences of average score between girls and boys result. This test can be used because of the sample has to be distributed normally and each group is homogeny (Sarwono, 2012). This test are using ***Levene*** test in SPSS 20.

3.7 Non Test Data Analysis

3.7.1 Qualitative Data Analysis

a. Data Analysis of Students Motivation Scaling

The *Likert-scale* of this research is done in order to obtain the data which really can represent the students' response of the statement given, so that the researcher is able to give five alternatives answer. This *Likert-scale* divided into two statements, positive and negative. Each of statement is given five answer choices, there are; strongly

agree, slightly agree, doubtful, slightly disagree, and strongly disagree. For each statement is given score as the Table 3.6.

Table 3.6 Scoring Guideline of *Likert-Scale*

Statement	Strongly disagree	Slightly disagree	Doubtful	Slightly agree	Strongly agree
Positive Statement	1	2	3	4	5
Negative statement	5	4	3	2	1

4. Data Interpretations

Likert-scale is interpreted to know how the problem-solving model affects students' motivation. The score is turn to the percentage by using this following formula.

$$\boldsymbol{P = \frac{f}{n} \text{ x } 100\%}$$

Explanation:

P = Percentage

f = Score from the frequency of the answer

n = score from response of the answer

(Source: Suherman, 2001)

The percentage is used to see how many students who gives response of strongly agree, slightly agree, strongly disagree, and slightly disagree. Finally after the data has been obtained, the data is needed to interpret by making the average of the total score of the student or of any category.

The average score of the questionnaire results of more than 3, it means that students respond positively. Meanwhile, if the average scores of students in the focus groups is smaller than 3, meaning that students responded negatively (Suherman, 2001).

5. Observational sheet

Table 3.7 Observational Sheet

No.	Statements	Yes	No
1.	Teacher states the problems clearly (about concept related to the problem)		
2.	Teacher helps students define problems in daily life that related to students		
3.	Teacher guides students to construct strategy to solve problems		
4.	Teacher guides students to use their prior knowledge for solving problems		
5.	Teacher ensures students communicate their findings within the group and the other group		
6.	Teacher gives real activity which is related to students' daily life		
7.	Teacher evaluate the findings		

3.8 Instrument Analysis Result

3.8.1 Recapitulation of Students' Mastery Concept Instrument

The instrument for measuring students' cognitive achievement is by giving an objective test in a form of 25 questions. The instrument should be tested in terms of validity, reliability, discriminating power, and difficulty level as explained before. The test was given to 30 students which have learned about the chapter that will be learned for the research. The recapitulation of test item analysis is shown in the following table.

Test item recapitulation:

Reliability test : 0.91 (Medium degree)

Table 3.8 Recapitulation of test item for students' mastery concept

Questions Number	Discriminating Power	Validity	Difficulty Level	Status
1	Fair	Very Low	Very Easy	Revised
2	Good	Medium	Medium	Accepted
3	Very Good	High	Easy	Revised
4	Very Good	High	Medium	Accepted
5	Good	Medium	Medium	Accepted
6	Very Good	High	Easy	Accepted
7	Good	Medium	Medium	Accepted
8	Good	Medium	Medium	Accepted
9	Good	Medium	Medium	Accepted
10	Good	Medium	Medium	Accepted
11	Very Good	High	Medium	Revised
12	Fair	Low	Difficult	Revised
13	Fair	Medium	Medium	Revised
14	Fair	Medium	Medium	Revised
15	Good	Low	Difficult	Revised
16	Fair	Medium	Medium	Revised
17	Fair	Medium	Medium	Revised
18	Very Good	High	Medium	Accepted
19	Very Good	Medium	Medium	Accepted
20	Very Good	High	Medium	Accepted
21	Good	Low	Difficult	Revised
22	Very Good	Medium	Medium	Accepted
23	Very Good	High	Medium	Accepted
24	Very Good	Medium	Medium	Accepted
25	Good	Low	Difficult	Revised

2) Instrument Non-Test Requirements

a. Questionnaire

Unstructured questionnaire is used to know the response of the students motivation towards the implementation of problem-solving model in learning heat. This data obtained from students' answer from 15 questions given in the end of the lesson.

3.9 Research Procedure

In order to make this research arranged systematically, there are three stages of procedure that had been conducted in this research, including preparation stage, implementation stage, and completion stage.

a. Preparation Stage

This stage is focusing on all of the preparation to conduct and support the research. Here are the steps of preparation stage.

a) Analyzing and determine all variable
b) Literature review for Problem-Solving Model, Students' Concept Mastery, Students' Motivation, Gender and Heat
c) Designing Instruments
d) Designing Objective Test, Questionnaire and Observational Sheet
e) Conduct the expert judgment, limitation test and make some revision based on suggestions for objective test
f) Conduct expert judgment and make some revision based on suggestions for questionnaire and observational sheet

b. Implementation Stage

This is the process of data collecting in the school, when the treatments to students' are implemented.

a) Determine girl and boy classes

b) Give pre-test to girl and boy classes to recognize the initial condition and prior knowledge.
c) Process pre-test result
d) Conduct research activity by implementing problem-solving model in learning heat
e) Give post-test in the experimental class to recognize the improvement of students' concept mastery about heat
f) Distributing questionnaire to determine the students' motivation towards implementation of problem-solving model.

c. Completion Stage

This is the final stage of research design, the step that is conducted in this stage is explained as the following steps.

a) Process and analyze data result of the research implementation.
b) Discuss and concluded the data analysis result.
c) Arrange the report of the research.

Scheme of research is a view how will the research be conducted. From preparation stage, implementation stage, analysis and conclusion stage. Detailed of the research scheme will be shown as in the next page.

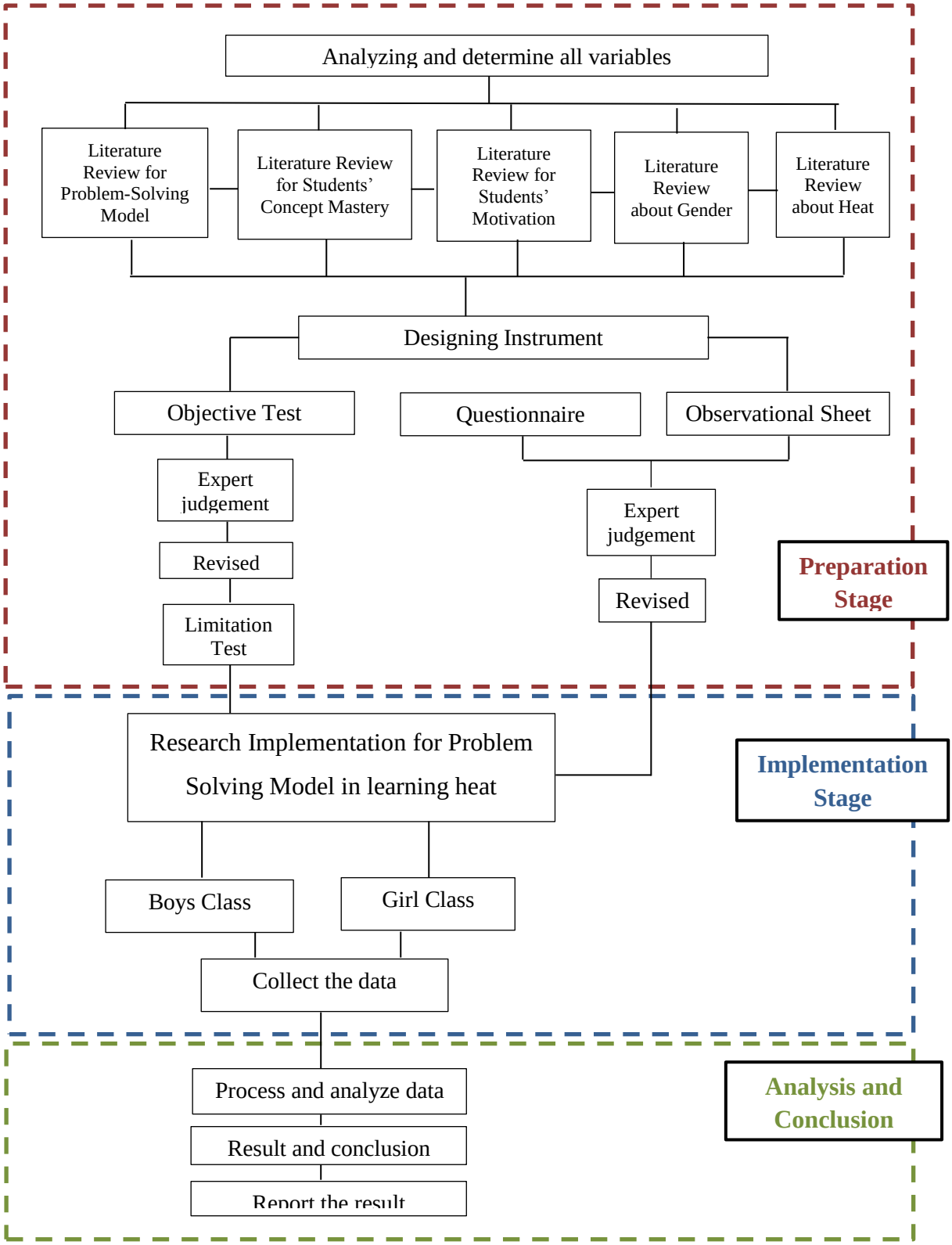

Figure 3.1 Research Plot