CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method and Research Design

3.1.1 Research Method

The method that was used in this research is Poor Experimental Method. The poor experimental or 'weak' method allows the researcher to study within a single group and provides an intervention during the experiment and it is compared to assess the effect of a particular condition or treatment (Fraenkel, Wallen, & Hyun, 2012). This method does not have a control group to compare with the experimental group. In this research, the poor experimental method was used to decide the implementation of design thinking to enhance the problem-solving skills of the student. Therefore, the researcher will know is there any enhancement of students' Problem-Solving skills occurred due to the implementation of the Design Thinking Approach in learning environmental pollution topics.

3.1.2 Research Design

The research design used was the One Group Pretest-Posttest Design. It allows investigating the differences score attained due to the experimental treatment from pre-test and post-test result towards one group. A pretest is given in an experiment before they receive a treatment to assess the prior knowledge or characteristics of the student (Creswell, 2012). While after the treatment the researcher can take another reading that is assessed for the student in an experiment after treatment has done to know the differences (Creswell, 2012). The treatment here is implementing the Design Thinking to the class experiment to enhance the problem-solving skill of students in learning environmental pollution topics. The research design is shown in Table 3.1

Table 3.1
One Group Pretest-Posttest Design

O	**X**	**O**
Pretest	Treatment (Design Thinking)	Posttest

(Fraenkel, Wallen, & Hyun, 2012)

3.2 Research Subjects

The research was conducted in one of the Private Junior High Schools in Bandung. The population of this research is the 7th grade of Junior High School which implements the 2013 Curriculum which has not studied Environmental Pollution Topic yet. The sample was consists of 42 students consists of 26 males and 16 females in ages 13-14 years old from two classes that joining the class from the beginning until the end. In the term of pretest-post-test and learning process, 18 students have participated. The technique to choose the sample in this research is convenience sampling. Convenience sampling means selecting the closest individuals to serve as respondents and continuing the process until those who happen to be available and usable at the time have obtained the appropriate sample size (Cohen, Manion, & Morrison, 2018). According to (Fraenkel, Wallen, & Hyun, 2012) convenience sampling is a comfort sample that consists of a collection of people who are eligible for analysis and available to be studied.

3.3 Operational Definition

To describe and avoid misconceptions about the variable in this research, there is some operational definitions are stated. The research variable as following:

1) The design thinking approach is a learning strategy that human-centered design process. The student that teaches using design thinking is directed to find solutions to problems from the topics taught through 4 stages of design thinking, namely empathy, define, ideate, and prototype. The materials that will be implemented in these learning activities are Environmental Pollution Topic.
2) Problem-solving skills in this research include students' skills in a) understanding the problem; b) planning for problem-solving; c) implementing problem-solving; d) reviewing the solution based on Polya. The problem-solving skill of students will be assessed using objective test consist of 20 multiple-choice questions for pretest and assess students' prior knowledge and posttest to investigate the enhancement and then using a students' worksheet for assessing the process during the treatment applied.

3.4 Hypothesis

The hypothesis tested in this research are as follows:

H_0: There is no difference between students' Problem-Solving skills before and after the implementation Design Thinking Approach in learning environmental pollution topic

H_1: There is a difference between students' Problem-Solving skills before and after the implementation Design Thinking Approach in learning environmental pollution topic

3.5 Research Instrument

In this research, several instruments are used to gather the data of the research such as the objective test and students' worksheets. Those instruments are described below:

3.5.1 Objective Test

The objective test was used to measure the problem-solving skills of the student. The objective test that to be tested was consist of 25 multiple choice questions that cover all aspects of problem-solving skills on the student in the environmental pollution materials. There are four aspects of Problem-Solving skills which are understanding the problem, planning for Problem-Solving, implementing the Problem-Solving, and reviewing the solution. Those aspects are tested through every question in the test item. The test item was judged by the experts and tested on the students who have learned Environmental Pollution Topic. The data gain was analyzed by using ANATEST V4 in terms of validity, reliability, level of difficulty, and discriminating power. This objective test is tested in the pretest to know students' prior knowledge and posttest to know the enhancement after implementation of the Design Thinking approach. The blueprint of the objective test is given in **Table 3.2.**

Table 3.2

Problem-Solving skills blueprint question

No	Polya's Aspect of Problem-Solving	Sub Topics			Total
		Water Pollution	Air Pollution	Soil Pollution	
1	Understanding the problem	13,15,16	8,9,11,12	1,2,3,4,5,6	13
2	Planning for Problem-Solving	7	10	18	3

3	Implementing the Problem-Solving	14	19,21		3
4	Reviewing the solution		23	17,20,22,24, 25	6

3.5.1.1 Validity

A validity test is used to check the ability of the test item to measure students' problem-solving skills by using ANATEST. For checking the test item using the ANATEST the test item will be tested by the higher level of the student that will be treated which is 8th grade and the student result will be assess using ANATEST to know the validity of the test item. The formula used to measure the validity is:

$$rxy = \frac{n\sum xt - \{(\sum x)(\sum y)\}}{\sqrt{\{n\sum x^2 - (\sum x)^2\{n\sum y^2 - (\sum y)^2\}}}$$

Where:

r_{xy} = items correlation coefficient

x = items scores

y = total score of each student

n = amount of subject

$\sum x$ = total score of all students for each question item

$\sum y$ = total score of all students for the whole test

The interpretation of the validity score is shown in **Table 3.3**

Table 3.3
Validity interpretation

r Value	Interpretation
0.80 < r ≤ 1.00	Very High
0.60 < r ≤ 0.80	High
0.40 < r ≤ 0.60	Enough
0.20 < r ≤ 0.40	Low
0.00 < r ≤ 0.20	Very Low

3.5.1.2 Reliability

Reliability refers to the consistency of scores from one administration of an instrument or one set of items to another (Fraenkel, Wallen, Hyun, 2012). This reliability formula used was discovered by Kuder-Richardson. The formula can be defined as follows:

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

Where:

K = Number of items on the test

M = Mean of the set of test scores

SD = Standard Deviation of the test score

The interpretation of the r-value of reliability can be defined as in **Table 3.4**

Table 3.4
Reliability interpretation

r Value	Interpretation
0.80 < r ≤ 1.00	Very High
0.60 < r ≤ 0.80	High
0.40 < r ≤ 0.60	Moderate
0.20 < r ≤ 0.40	Low
0.00 < r ≤ 0.20	Very Low

3.5.1.3 Difficulty Level

In this research, difficulty level refers to the degree of difficulty for the student in answering the question. The formula used is defined as follows:

$$DL = \frac{Ru + R_1}{Nu + N_1}$$

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

N_1 = Number of students in the upper

The category of the difficulty level can be defined in **Table 3.5**

Table 3.5
Difficulty level interpretation

Value of difficulty index	Interpretation
0.00-0.30	Difficult
0.30-0.70	Moderate
0.70-1.00	Easy

3.5.1.4 Discriminating Power

Discriminating power function to identify items for which high-scoring examines have a high probability of answering correctly and low-scoring examines have a low probability of answering correctly. To measuring the discriminating power, the following equation is used:

$$D = \frac{A - B}{0.5N}$$

Where:

D = Discriminating power

A = The number of correct scores from the high scoring group

B = The number of correct scores from the low scoring group

N = The total number of students in the two groups

The interpretation of the discriminating power is shown in Table 3.6

Table 3.6
Discriminating power interpretation

r-value	Interpretation
$0.71 < D \leq 1.00$	Excellent
$0.41 < D \leq 0.70$	Good
$0.21 < D \leq 0.40$	Satisfactory
$0.00 < D \leq 0.20$	Poor
Negatives	Not appropriate

The resulted validation score from students then analyzed using ANATES V4 to find out its validity, reliability, difficulty level, discriminating power, and distractor. The validity of test items is represented in the correlation between item score and total score. After being analyzed, it has resulted that the item reliability score is 0.59 which is categorized as moderate reliability. The recapitulation of test item analysis is tabulated in the following of **Table 3.7**

Table 3.7
Recapitulation of test item analysis

Number of Test Item	Validity	Level of Difficulty	Discriminating Power	Acceptance
1	-0.127 (Low)	Easy	-0.11 (not appropriate)	Rejected
2	0.587 (Average)	Very easy	0.33 (Satisfactory)	Revised
3	0.593 (Average)	Medium	0.67 (Good)	Accepted
4	0.546 (Average)	Easy	0.33 (Satisfactory)	Accepted
5	0.009 (Very Low)	Difficult	-0.11 (not appropriate)	Rejected
6	0.267 (Low)	Medium	0.44 (Good)	Accepted
7	0.239 (Low)	Medium	0.33 (Satisfactory)	Accepted
8	0.387 (Low)	Easy	0.56 (Good)	Accepted
9	0.230 (Low)	Medium	0.78 (Excellent)	Accepted
10	0.407 (Average)	Medium	0.44 (Good)	Accepted

Number of Test Item	Validity	Level of Difficulty	Discriminating Power	Acceptance
11	0.593 (Average)	Medium	0.56 (Good)	Accepted
12	0.758 (High)	Very easy	0.78 (Excellent)	Revised
13	0.518 (Average)	Medium	0.44 (Good)	Accepted
14	0.429 (Average)	Easy	0.56 (Good)	Accepted
15	0.597 (Average)	Easy	0.33 (Satisfactory)	Accepted
16	0.305 (Low)	Medium	0.44 (Good)	Accepted
17	0.065 (Very Low)	Medium	0.00 (Poor)	Rejected
18	0.156 (Very Low)	Medium	0.11 (Poor)	Accepted
19	0.536 (Average)	Medium	0.56 (Good)	Accepted
20	0.049 (Very Low)	Medium	0.00 (Poor)	Rejected
21	0.359 (Low)	Medium	0.44 (Good)	Accepted
22	0.321 (Low)	Medium	0.44 (Good)	Accepted
23	0.576 (Average)	Medium	0.56 (Good)	Accepted
24	0.043 (Very Low)	Medium	0.22 (Satisfactory)	Rejected
25	0.351 (Low)	Difficult	0.11 (Poor)	Accepted

The revised ones are thought to be employed based on expert recommendations, competency domains, and subtopic distributions. The final test items were reduced to 20 multiple choice questions with recapitulation as follows

Table 3.8
Test item blueprint after revision

No	Polya's Aspect of Problem-Solving	Sub Topics			Total
		Water Pollution	Air Pollution	Soil Pollution	
1	Understanding the problem	1,3,7,11,13,14	6,9,10	2,4	11
2	Planning for Problem-Solving	5	8,12	15	4
3	Implementing the Problem-Solving		16,17		2
4	Reviewing the solution		19	18,20	3

3.5.2 Students' Worksheet

The students' worksheet is used to measure student problem-solving skills' during the process of design thinking approach implementation. The students' worksheet is used to assess the behavior and skills of students during the process of the treatment. The students' worksheet consists of several aspects of problem-solving skills such as 1) understanding the problem, 2) planning for problem-solving, 3) implementing the Problem-Solving, and 4) reviewing the solution (Havill & Havill, 2020). In the implementation stage of the research, the researcher doing the treatment for three meetings, and each meeting the researcher using a different worksheet to assess student Problem-Solving skills through a design thinking approach. The construction process of the students' worksheet is explained in Figure 3.1.

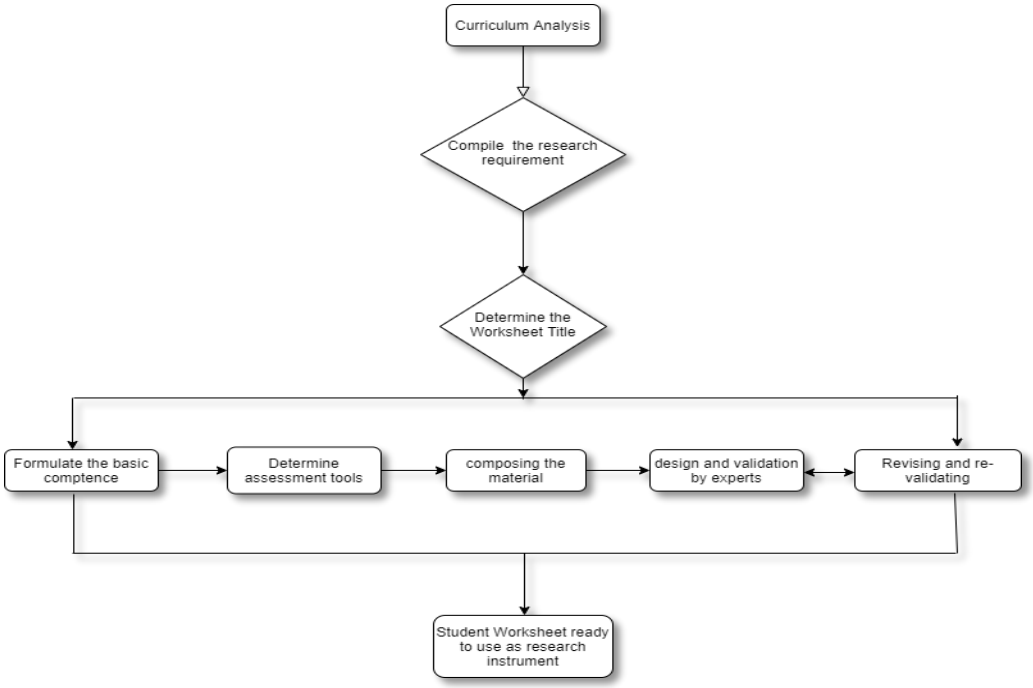


Figure 3.1 Students' Worksheet Construction Process

Expert judgment aims to determine the feasibility of the student worksheet as an instrument from the material aspect, language aspect, and suitability for problem-based learning. The blueprint of the student worksheet as followed with design details of the used student worksheet is attached on Appendix B.2

Table 3.9
Blueprint of student worksheets (Before revision)

Work sheet	Learning goals	Design Thinking Stage/PBL	Contents
1	explain and communicate the problem of environmental pollution around students after making observations	Empathy / Student Orientation to the problem	1. student observe their environment 2. analyze water, air, and soil conditions 3. students conclude environmental problems
2	explain and communicate the biggest problems that are felt in the surrounding	Define / Organize Students	1. grouping 2. categorize environmental problems

Work sheet	Learning goals	Design Thinking Stage/PBL	Contents
	environment after discussing		3. choose a problem that can be solved 4. state the reasons why the problem can be solved
3	planning possible solutions to environmental problems around students after discussing	Individual and group research guide	1. watch environmental pollution project videos 2. planning solutions for environmental pollution around students within the group 3. select and determine community groups 4. choose a project solution for environmental problems
4	make a prototype project of environmental problems around students after observation	Prototype / Develop and Present the Work	1. group work 2. write down tools and materials for making projects 3. write down the steps to create a project 4. make a storyboard 5. receive project storyboard feedback
5	communicating the project of environmental pollution problems around students after having a discussion	Test / Analyze and Evaluate the Problem-Solving Process	1. group work 2. communicating the prototype project

Work sheet	Learning goals	Design Thinking Stage/PBL	Contents
			3. target community achievement 4. ask the community's response

To be a proper instrument, student worksheets go through the expert judgments to validate the contents, design, and also the goals of the learning whether the worksheet has covered the learning goals or not. As seen in Figure 3.1 there are several steps in making student worksheets, such as curriculum analysis, compile the research requirement, determine the worksheet title, formulate the basic competence based on the 2013 Curriculum, determine assessment tools, composing the material, design, and validation by experts, revising and revalidating, until the student worksheets were ready to be an instrument. The student worksheet is reviewed by a specialty with relevant backgrounds in education, notably in science education, to ensure that it is appropriate for implementation. This worksheet judge by three experts to review and validate the concept, design, and contents. The blueprint of the student worksheet as followed with details of the used student worksheet is attached on Appendix B.4.

Table 3.10
Statement revision from expert judgment

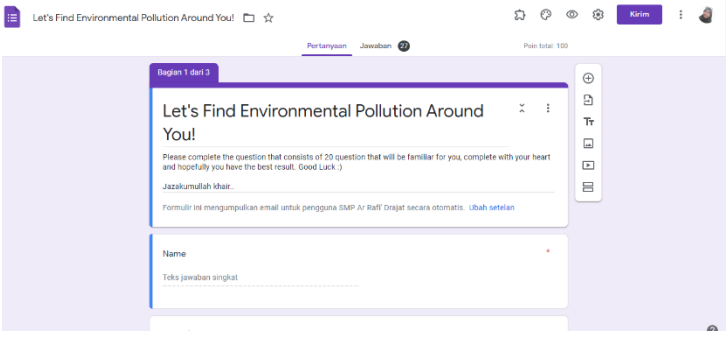
Judgment	Revision
Expert 1	1. Add core competence and basic competence 2. Consistency using English and Bahasa and term ‘student’ 3. Learning objective using the formula ABCD
Expert 2	1. Identify some problems that can relate to the content. 2. Add more questions related to content. 3. Design the worksheet will give the best appearance.
Expert 3	1. Just follow the school standard to achieving the curriculum standard.

	2. The design of the worksheet needs to be improved. Put some colors or designs so that they become more interesting for the students.

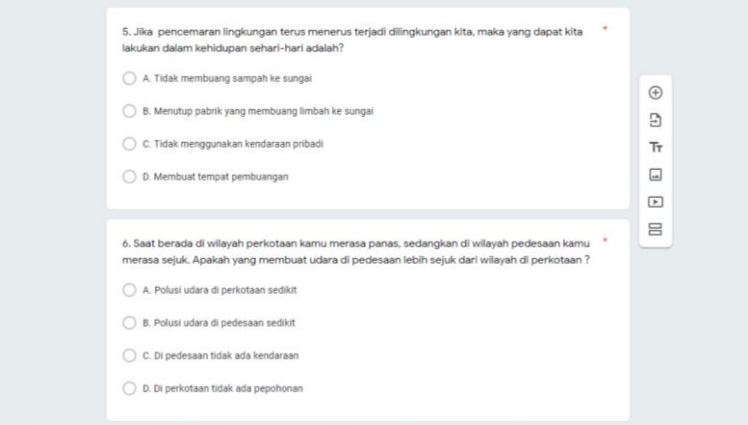
Table 3.10 explains that the revision needed to be done towards the student worksheets. From the learning objective, the expert asked not to use two verbs in one learning objective and to follow the ABCD formula, namely A (audience), B (behavior), C (condition), and D (degree). Then from an additional aspect, the experts were asked to make the interesting design in student worksheets and also consistency in using language. Another aspect to be added is about consideration of the Problem Based Learning step in the worksheet. The details of the instruments' judgments are attached in Appendix B.4.

3.6 Data Collection

Problem-Solving skill data of students in "X" Junior High School were collected through an online form. For students' Problem-Solving skills in terms of competency and knowledge domains have been covered in the objective test while the learning process and the students' experience towards design thinking are covered in the student worksheets and students interview. Moreover, the learning process and the students' experience towards design thinking finished by online zoom meeting conference and google classroom. Because students' ability to understand the questions and statements is better in Bahasa Indonesia than in English, Problem-Solving skills objective tests, student worksheets, and interview questions directed to students have been translated to Bahasa Indonesia. The displays of the objective test online form are shown in Figure 3.2.



(a)



(b)

Figure 3.2 (a) The Display of Objective Test Pretest (b) The Display of Posttest of Objective Test

Furthermore, the student learning process of design thinking is covered in student worksheets, and the worksheet is shared in google classroom as a learning management system used by the school. The student worksheets are given in Figure 3.3

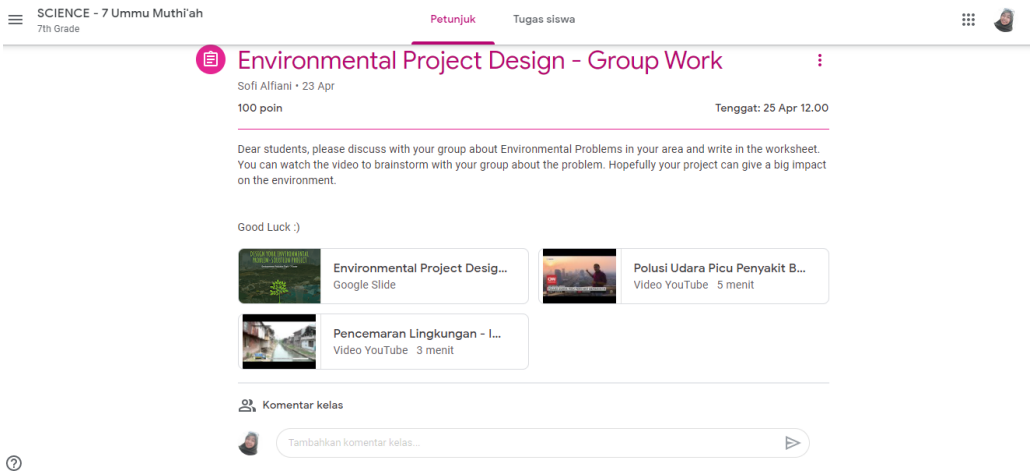


Figure 3.3 Students' Worksheet in Google Classroom

Figure 3.3 displays one of the student worksheets as an instrument to cover the learning process on the design thinking approach in learning environmental pollution. The worksheet is shared in each meeting in google classroom. After students are all completing the worksheet they should present their work in a group.

Moreover, researchers want to know the student experience toward the design thinking approach, because the design thinking approach is one of the learning strategies that new for students. The students experience data obtained by interviewing students and asked what they gather in the learning process of design thinking. The student interview is seen in Figure 3.4

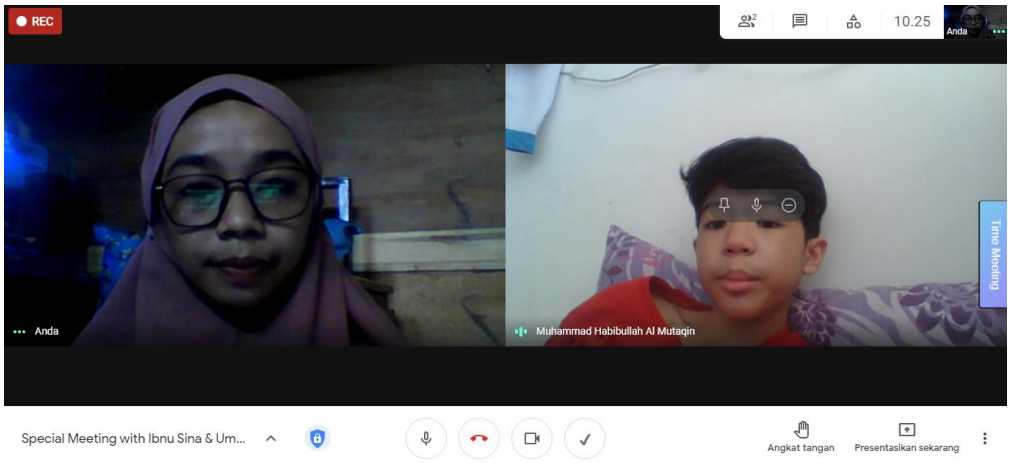


Figure 3.4 The Student Interview

Figure 3.4 shown the student interview to know the student experience toward design thinking in learning environmental pollution. The researcher interview six student representative to know their impression of the implemented new learning strategy and know the difficulties encountered during the implementation of design thinking in learning the materials. The interview is carrying out using google meeting conference one by one student.

3.7 Data Analysis

The data present in this study is primary data where researchers will take data directly in the field and also secondary data taken from previous research that obtain consist of quantitative data. The data is analyzed through simple statistical tests using SPSS 25 Version so that it can be presented through numbers the identification of problem-solving skills and test the hypothesis is carried out by comprehension are described below:

3.7.1 Statistical Data Processing

Students' Problem-Solving Skills pretest and posttest were given a score to see the difference between before and after the treatment in the form of the objective test using 20 questions as quantitative data. To know further investigate how Design Thinking Approach affects the problem-solving skills of students, a statistical approach will be used to measure the

data derive from the pretest and the posttest of students. The statistical analysis used the program SPSS software, and the processing of the data as follows:

3.7.1.1 Normality Test

To determine that the data result is distributed normally or not, the normality test was completed. The normality data is essential because it shows how the sample data represents the population when it comes from a normal distribution. The researcher used the Shapiro-Wilk test with SPSS 25 to determine normality. The Shapiro-Wilk test is a normality check for samples with less than 50 samples. The significant value (α) = 0.05 indicates that the data is normal. Testing of data normality is conducted by the rules as follows:

a. If the value of the significant level is bigger than 0.05 so that the data distribution is normal.
b. If the value of the significant level is smaller than 0.05 so that the data distribution is not normal.

3.7.1.2 Homogeneity Test

The homogeneity test is conducted to determine the variance of the pretest and posttest data. The homogeneity test in this study used the One Way Anova formula by using SPSS 25 Version with a significance level of $\alpha = 0.05$. The homogeneity test is carried out if the data has normally distributed. There is certainty in concluding a homogeneity testing, as follows:

a. If the value of significance (Sig.) > 0.05 the data is homogenous.
b. If the value of significance (Sig.) < 0.05 the data is homogenous.

3.7.1.3 Paired Sample t-Test

To compare the means of two samples of related data, the paired t-test is utilized. The related data used are Pretest and Post-test data. The paired t-test compares the values' mean difference to zero. The number of cases, the mean difference, and the standard deviation of the differences all have a role (Samuels, 2015). Paired sample t-test is used to determine whether a hypothesis is rejected or accepted. Therefore various assumptions also need to be made. The hypothesis should be null and alternative.

The null hypothesis is:

H_0: There is no difference in mean Pretest and Post-test scores

And the alternative hypothesis is:

H_1: There is a difference in mean Pretest and Post-test scores

3.7.1.4 Calculation of Normalized Gain Score

The Normalized Gain (N-Gain) score firstly introduces by Hake 1998 which analyzes student learning gains of the Force Concept Inventory across 62 different introductory physics courses (Setiawan, 2020). The N-Gain score is used to measure the effectiveness of certain learning strategies implied to the student from the gap between post-test and pretest scores. According to Hake (1999), to measuring the N-Gain Score, it can use the formula as follows:

$$\frac{Spost - Spre}{Smax - Spre}$$

When,

S post: post-test score

S pre: pretest score

S max: maximum score of the test

3.7.2 Descriptive Analysis

Descriptive analysis is used to analyze the Design Thinking in the teaching process used worksheet as a research instrument. The analysis is displayed to describe how learning process running using design thinking approach and how students' worksheet works. The descriptive analysis describes the result of students' interviews as well to know the students' experience on design thinking implementation.

3.8 Research Procedure

To make this research well arranged in terms of systematic, the research procedure is dividing into three main stages. The three main stages are the preparation stage, implementation stage, and completion stage that will be elaborated as follows:

3.8.1 Preparation Stage

The preparation stage includes the relevant search from various sources related to Problem-Solving skills, design thinking, and the project of the environmental pollution problem. Then the topic focus is determined to maximize the experiment implementation of the design thinking approach in the learning process. In addition, the instruments used to assist students' attainment are considered with the objective test and student worksheets which are then judged by the expert and validated before given to the students. For additional information, the researcher interviews the student and validate by the supervisor.

3.8.2 Implementation Stage

The implementation of an experiment was conducted to obtain the data from student achievement. The details and complete learning activities can be seen in Appendix 1. The learning process was taken place online in Google Classroom and Zoom meeting for the instructions, then for the additional information and discussion the student make the group in WhatsApp. The following table presents the steps in experimenting as shown in Table 3.11

Table 3.11
Design thinking implementation

Meeting	Learning Activity
1st meeting	1. The teacher shows the video and photos about environmental pollution that occurs in our country 2. The teacher asks the student to identify and mention the environmental pollution that happened around the students' environment 3. The teacher divided the class into 4-6 groups to work collaboratively making a prototype project 4. Students are given the instructions to observe their environment (the water, air, and soil condition)

Meeting	Learning Activity
	5. Teacher give student worksheet to fill by the student to know how their competencies in understanding the problem (an aspect of Problem-Solving)
2nd meeting	1. The students work within their groups and the student discuss their problem of environmental pollution 2. Students are given the instructions to present their findings in the meeting conference 3. Students are given instructions to arrange the problem into several categories and choose the most important and biggest problem to solved and students creating the persona mapping 4. After student choosing the most important and biggest problem, student offer their solution to overcome that problem with their group 5. Students describe the target society in platform *makemypersona.com*
3rd meeting	1. Student begin to collect or create the design of their solution planning using a worksheet that provides by the teacher 2. Student present their prototype planning in a video conference to their friends 3. Other students give a comment and feedback on what should they improve 4. Students present the final prototype of their solution to their environmental problem in front of the class 5. Teacher give student worksheet to observe their ability to evaluate or reviewing the solution (an aspect of Problem-Solving)

Meeting	Learning Activity
	6. Students conclude the materials of environmental pollution and review by the post-test 7. Students are instructed to collect the final prototype project

3.8.3 Completion Stage

During the final stage, the obtained data are then analyzed and reported in a research paper. The data are analyzed statistically and the result is then discussed with the research supervisors and the paper is completed. The whole process of the research is summarized into the flowchart as seen in Figure 3.5

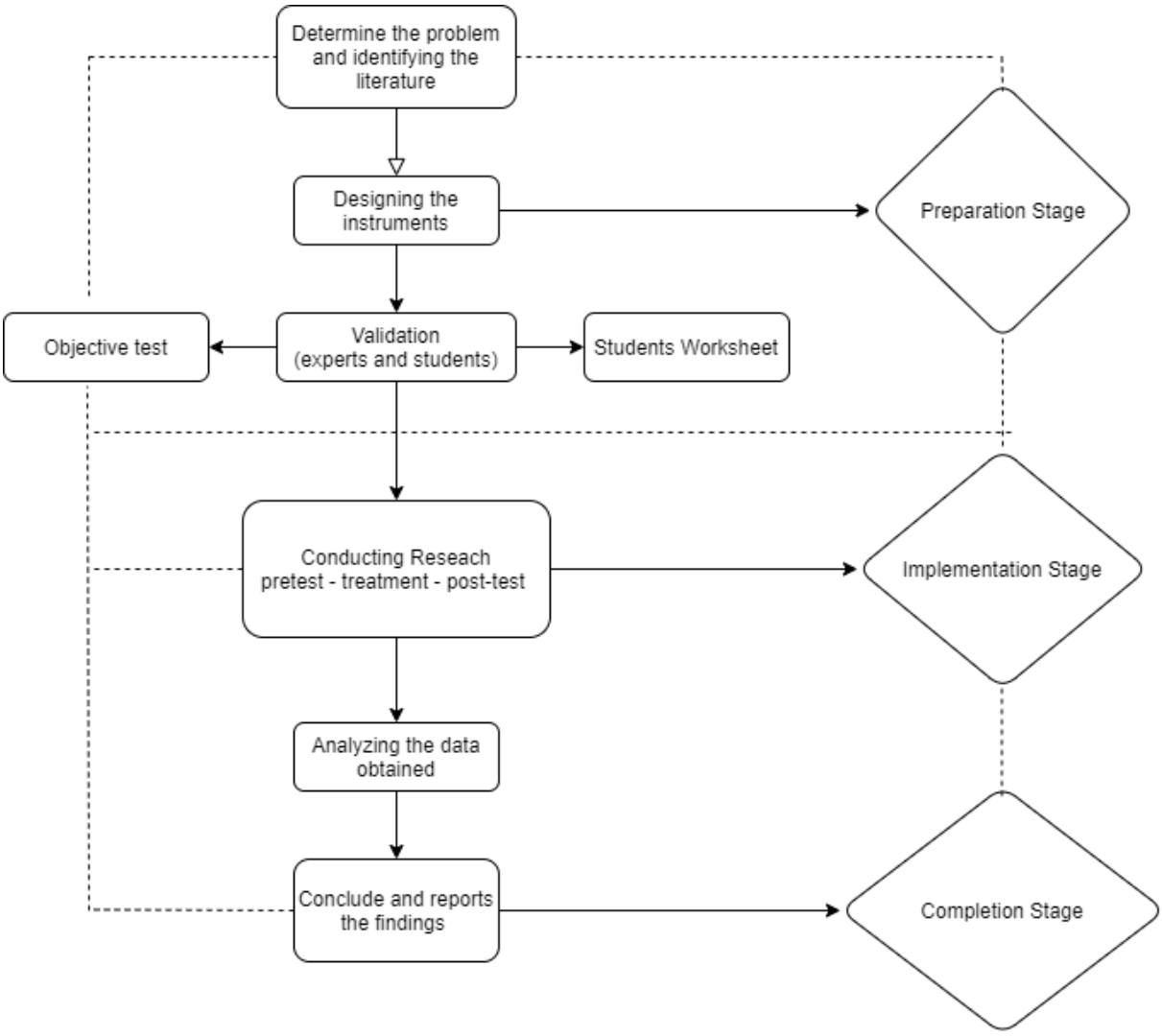


Figure 3.5 Research Procedure