CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method and Research Design

This research used a quantitative approach quasi-experimental method, which allowed the researcher to assess both before and after treatments (Creswell, 2013). This design allowed the researcher to have a not-fully functioned traditional group, as external variables that affect the implementation of the experiment cannot be controlled (Sugiyono, 2013). This method was appropriate for the objective of the research set by the researcher, to analyze the comparison of students' science process skills in dynamic electricity topic through different treatments. There were two different groups needed as the subject of this research.

The design of this research was a two-group pretest-posttest design. In this design, two groups were selected without random assignments. This design was used to compare the changes that occurs within two different groups on some dependent variables (Tikkanen, 2017). A prior test (pretest) was given to both groups to perceive the initial condition before treatment (Sugiyono, 2013). Therefore, a posttest was also given to ascertain students' science process skills after treatment and to compare the overall effectiveness of treatment on students' science process skills. Table 3.1 shows the research design.

Table 3.1

Quasi Experimental Pretest and Posttest Design

Groups	Pretest	Treatment	Posttest
Traditional Group	O_1	X_1 *(Traditional Laboratory Activity)*	O_2
Combined Group	O_3	X_2 *(Combined Laboratory Activity)*	O_4

3.2 Population and Sample

The population in this study was 9th grade students in one of the private junior high schools in Bandung. This school implements curriculum 2013 as the main curriculum. The researcher used two classes where the total number of samples from the two classes was 34 students. Those two classes were assigned as traditional and combined groups respectively. The total number of samples in traditional group was 17 students and the total number of students in combined group was 17 students as well. The sampling technique in this study is convenience sampling as samples are chosen based on those who happen to be available and accessible at the time (Cohen et al., 2010).

3.3 Operational Definition

To avoid any misconception about this research, the operational definitions are stated. The research variables are as followed:

1) Combined laboratory means the laboratory activity that combined traditional laboratory and virtual laboratory in the form of PhET Simulation. PhET Interactive Simulation is a project developed at the University of Colorado Boulder that provides and explorable explanations. Specifically, the PhET Interactive Simulation used in this research is 'Circuit Construction Kit: DC' simulation.

2) Students' process skills are a set of skills used in scientific activities. There are nine measurable science process skills that will be analyzed in this research: (1) observing, (2) interpreting, (3) classifying, (4) predicting, (5) communicating, (6) hypothesizing, (7) planning an experiment, (8) applying the concept, and (9) interpreting data. Assessment of students' process skills were collected through objective test and direct observation rubric.

3) Dynamic electricity is a topic for 9th grade students based on the 2013 National Curriculum. This research focused on Ohm's Law subtopic. The materials were taught with Inquiry Based Learning Approach.

3.4 Assumption

In this research, the assumptions based on literacy study and experts are combined laboratory activity has a tendency to enrich students' science process skills as the interactive display in virtual laboratory can help students recall the materials, summarize and build the concepts. The virtual laboratory will be used in this study, PhET interactive simulation, claimed as a concrete level media because 90% of the students will be actively engage in learning activity.

3.5 Hypothesis

The hypothesis that would be tested in this study is stated as follows:

H_o: There is no significant differences of students' science process skills between combined laboratory and traditional laboratory.

H_1: There is significant differences of students' science process skills between combined laboratory and traditional laboratory.

3.6 Research Instrument

Research instruments are necessary to obtain data. In this research, research used two types of instruments, both are used to assess students' science process skills. Both instruments are described below:

3.6.1 Objective Test

Objective test was used to evaluate students' hypothesizing, interpreting, predicting and communicating skills. The objective test consisted of 15 questions that cover hypothesizing, interpreting, predicting, and communicating skills in the topic dynamic electricity. This objective test was given to students before treatment as a pretest to know students' prior knowledge and science process skills and after treatment as a posttest to determine the effectiveness of the treatment. The raw blueprint of the objective is presented in the Table 3.2.

Table 3.2

Blueprint of test (before validation)

No.	Aspect of Science Process Skills	Number of Question	Total Number
1.	Hypothesizing	1, 6, 13, 17, 22	5
2.	Interpreting	2, 4, 7, 8, 12, 14, 21, 23, 25	9
3.	Predicting	5, 9, 10, 15, 18,	5
4.	Communicating	3, 11, 16, 19, 20, 24	6
Total Number			25

This test item was then judged by three experts as getting validated by testing on students that have already learned about the dynamic electricity concept. The data validation involved 64 students of grade 10 students from a public senior high school in Bandung. The analyses of this instrument consist of analysis of validity, reliability, difficulty level, and discriminating power as explained in following:

1) Validity

The appropriateness, meaningfulness, and usefulness of specific inferences drawn from test scores is referred to as test item validity (McCowan & McCowan, 1999). The formula of validity measurement is:

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

(Kaplan & Saccuzzo, 2013)

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

2) Reliability

Reliability is the extent to which test results are consistent, stable and free of error variance (McCowan & McCowan, 1999). Reliability may be characterized as test results' consistency, reliability or accuracy. According to McCowan et al. (1999), for short test with only 10 to 50 test items, the reliability score should be more than 0.50. The formula of reliability is:

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

where:

K = items correlation coefficient

M = items scores

SD = total score of each student

3) Difficulty Level

Difficulty level refers to the percentage of people who answer the item correctly. Difficulty level shows the characteristic of the item and the sample that takes the test (McCowan & McCowan, 1999). The formula of difficulty level is:

$$DL = \frac{R_u + R_l}{N_u + N_l}$$

where:

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

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

N_u = Number of students in the upper group

N_l = Number of students in the lower group

There is also the interpretation value of difficulty level, which shown in Table 3.3.

Table 3.3

Difficulty Level Interpretation

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

(Cohen et al., 2010)

4) Discriminating Power

Discriminating power refers to the extent to which items discriminate among students in the upper and lower groups. It compares the number of high scores and low scores who answer the item correctly (McCowan & McCowan, 1999). The formula of discrimination power is:

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

where:

D = Discriminating power

A = The number of correct scores from high scoring group

B = The number of correct scores from low scoring group

N = Total number of students in those two groups

The analysis was carried out by using ANATES V4. The result of the analysis is presented in Table 3.4.

Table 3.4

Recapitulation of Test Analysis

Number of Test Item	DP (%)	Difficulty Level	Validity	Conclusion
1	52.94	Medium	0.36 (Invalid)	Rejected
2	11.76	Medium	0.11 (Invalid)	Rejected
3	5.88	Easy	0.19 (Invalid)	Rejected
4	76.47	Medium	0.61 (Valid)	Accepted
5	41.18	Easy	0.47 (Valid)	Accepted
6	35.39	Easy	0.38 (Invalid)	Rejected
7	47.06	Easy	0.39 (Valid)	Accepted
8	64.71	Easy	0.66 (Valid)	Accepted
9	17.65	Difficult	0.16 (Invalid)	Rejected
10	58.82	Medium	0.54 (Valid)	Accepted
11	64.71	Easy	0.62 (Valid)	Accepted
12	5.88	Difficult	0.12 (Invalid)	Rejected
13	52.94	Difficult	0.38 (Valid)	Accepted
14	52.94	Medium	0.45 (Valid)	Accepted
15	58.82	Medium	0.50 (Valid)	Accepted
16	47.06	Easy	0.34 (Invalid)	Rejected
17	52.94	Medium	0.40 (Valid)	Accepted
18	41.18	Medium	0.28 (Invalid)	Rejected
19	76.47	Medium	0.60 (Valid)	Accepted
20	52.94	Medium	0.34 (Invalid)	Rejected

Number of Test Item	DP (%)	Difficulty Level	Validity	Conclusion
21	11.76	Medium	0.18 (Invalid)	Rejected
22	76.47	Easy	0.66 (Valid)	Accepted
23	82.35	Medium	0.64 (Valid)	Accepted
24	41.18	Easy	0.41 (Valid)	Accepted
25	52.94	Easy	0.55 (Valid)	Accepted

As presented in Table 3.4, there are 15 accepted test items and 10 rejected test items. The reliability of the test is 0.81, which categorized as high reliability. After thorough analysis and feedback from expert judgements, the final revision of objective test item is made designed with the blueprint as shown in the Table 3.5.

Table 3.5

Blueprint of Test (after validation)

No.	Aspect of Science Process Skills	Number of Question	Total Number
1.	Hypothesizing	7, 10, 12	3
2.	Interpreting	1, 3, 8, 13, 15	5
3.	Predicting	2, 5, 6	3
4.	Communicating	4, 9, 11, 14	4
Total Number			15

3.6.2 Direct Observation Rubric

Other than objective test, the researcher also created a direct observation rubric to assess students' observing, classifying, planning experiment, applying concept, and asking question skills. The direct observation rubric is designed in the form of analytic rubric with scoring 1 to 3 scale. There is total five aspects to assess with the total checkpoint for each aspect is three checkpoints. The checkpoint for each aspects refer to the characteristic of science process skill stated by Rustaman (2007). This direct observation rubric was used to assess students before treatment as a

pretest to know students' prior science process skills and during treatment as a posttest to determine the effectiveness of the treatment.

3.7 Data Analysis

The data gained in this research was collected through objective test and direct observation rubric. After the data was collected, the data was analyzed further through several stages of analysis using SPSS 24.0 software and Microsoft Excel to answer the research questions. The detail of data analysis stages is explained as follow:

1) Scoring of the Test

As there are two instruments used in this research, the final data of students' science process skills score assess with both instruments is expected to be use the same scaling. The scoring of objective test is obtained by dividing students correct answer by the total number of questions then multiply it by 100. Meanwhile, for the scoring of direct observation rubric, the score is converted into percentage using the formula proposed by Purwanto (2013) (as cited in Kurniaman et al., 2020) which is:

$$NP = \frac{R}{SM}\ x\ 100\%$$

where:

NP = The percent value sought or expected

R = Raw score obtained

SM = Maximum Score

2) Normalized Gain Score

When students' pretest score has significant difference, normalized gain score is required to determine whether or not there is improvement of students' science process skills. N-gain is calculated using the formula as below:

$$N - gain = \frac{Posttest\ score - pretest\ score}{Ideal\ score - pretest\ score}$$

The N-gain score is categorized into three categories. The interpretation of N-gain score is presented in Table 3.6.

Table 3. 6

N-Gain Score Category

N-Gain Score	Category
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

3) Statistical Descriptive Analysis

To organize and summarize the data, descriptive statistics is done. The descriptive analysis of a data includes the number of the data, maximum score, minimum score, mean, standard deviation, etc.

4) Normality Test

Normality test is carried out using SPSS 24.0 software. The goal of normality test is to determine whether or not the data is normally distributed. The normality test in this research refers to the significance value of Shapiro-Wilk. If the significance value is ≥ 0.05, the data is normally distributed. Contrary, if the significance value is < 0.05, the data is not normally distributed.

5) Homogeneity Test

Homogeneity test is carries out using SPSS 24.0 software. The main purpose of homogeneity test is to determine whether or not the data is distributed homogenously. The homogeneity test in this research refers to the significance value of Levene's Test. If the significance value is ≥ 0.05, the data is homogeneously distributed. Contrary, if the significance value is < 0.05, the data is not homogeneously distributed.

6) Mann Whitney Test

The most important stage of this data analysis is the hypothesis testing. To determine to difference between two data, Mann Whitney Test is used. Referring to the Sig. 2-tail value of Mann Whitney Test, if the significance value is ≥ 0.05, H_o is accepted and H_1 is rejected. However, if the significance value is < 0.05, H_o is rejected and H_1 is accepted.

3.8 Research Procedures

This research was done following the arranged procedures, in such manner the research had become systematic research. The arrangements consist of preparation stage, implementation stage and completion stage.

1) Preparation stage

Before the data collecting, several steps should be accomplished in this preparation stage. The stages consist of:

a. Formulating the problem;
b. Determining variables that will become the focus of the research;
c. Collecting and reviewing literature regarding virtual laboratory and students' science process skills;
d. Arranging research proposal;
e. Consulting the research proposal to lecturer and experts;
f. Presenting the research proposal in proposal seminar;
g. Revising research proposal in accordance with lecturers' and experts' suggestion.
h. Arranging research instrument

There were three kinds of instruments made on this stage, lesson plan, student worksheets and science process skill assessment instruments. Lesson plans (see Appendix A.1) were arranged with learning duration of 2 until 3 times 35 minutes and using the same learning model, Inquiry Model, which was recommended by Widodo (2021) as one of the suitable learning models for teaching science process skills. Student worksheets (see Appendix A.2) were also arranged in accordance to the lesson plan. Science process skills assessment instruments were divided into two tests, objective test and direct observation rubric.

i. Consulting the research instrument to the experts

After arranging the research instruments, research instruments were judged by experts to be revised (see appendix B.1, Appendix B.2, Appendix B.3, and Appendix B.4). While the instruments were judged by experts, instrument also went through a validation process. The

validation of research instrument especially science process skills assessment instrument was done by testing out the instrument to 64 Grade 10 Senior Highschool students in one of the public schools in Bandung. The result of validity and reliability of the instrument can be seen in appendix C.1.

2) Implementation stage

In this stage, the research begins to get implemented. The steps are detailed as followed:

a. Organizing school permission;

School permission was organized by sending out the research permission from UPI to sampled school (see appendix E.1).

b. Determining the combined and traditional groups;

The determination of combined and traditional groups was done in accordance to the existing groups provided by the school.

c. Giving pre-test for both groups;

Pre-test for both groups was done in the first meeting of each group. The topic for pre-test was Electric Current and involving 4 extra observers and 17 students for each group.

d. Giving treatment according to the research design;

The treatment for both groups was given in meeting two and meeting three of each group. The topic learnt during treatment process was Ohm's Law (see appendix A.1).

e. Giving posttest for both classes to obtain the data;

Posttest was given to each group in the third meeting after researcher giving the treatment. This post-test involved 4 extra observers and 17 students for each group.

3) Completion stage

After all data are obtained and gathered, the completion stage will be conducted following these stages:

a. Analyzing the research data;

   The data gain from this research was gathered and collected to Microsoft Excel (see appendix D.1 and appendix D.2) then analyzed using SPSS 24.0.

b. Discussing and drawing conclusion from the analysis result;

c. Completing the research paper.

The researcher designs a flow chart that is shown in Figure 3.1 to provide an overview of the procedure.

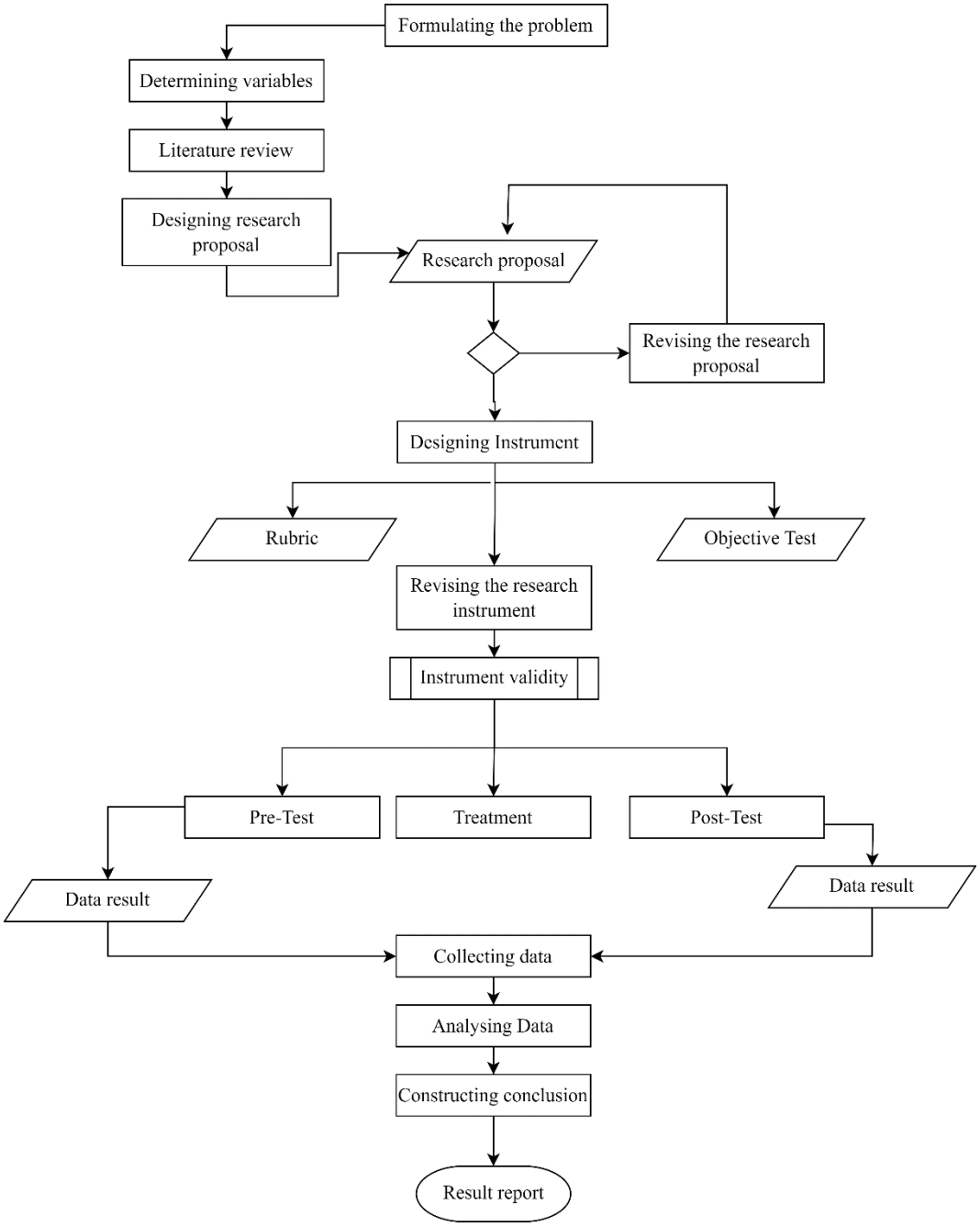

Figure 3.1 Flowchart of Research Procedures