CHAPTER III
METHODOLOGY

A. Operational Definition

a. Design Based Learning

Design-based learning (DBL) is a form of project-based learning in which students learn what they need to learn in a just-in-time fashion while trying to design something. This kind of learning challenges students to create physical objects that reflect themes, concepts and standards. With these objects students learn basic subjects in an interactive environment that promotes the recall and reuse of information. They learn to make logical connections, identify cause and effect, draw analogies, and think critically at the highest level. Using simplified techniques from the design professions, they learn to plan, experiment, discover, interpret, discriminate, revise and justify their thinking.

b. Creative Thinking Skill

Creative thinking is a cognitive activity that may result in a creative production that groups or individuals perceive as useful and new. Creative thinking skills utilize divergent thinking; thinking that diverges from a single point. The following types of cognitive processes are used here: generating ideas, integrating ideas, or seeing things in new ways. This kind of creative thinking skill will be measured by portfolio documents that are perceived as a new method of assessment.

c. Concept of Electricity (Building Alarm System)

Electricity is a form of energy called electrical energy. It is sometimes called an "unseen" force because the energy itself cannot be seen, heard, touched, or smelled. In another definition, electricity is the set of physical phenomena associated with the presence and flow of electric charge. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and the flow of electrical current. The understanding of student can be measured by conduct the test (pretest and posttest) in the beginning and in the end of lesson.

B. Population and Sample of Research

According to Sudjana (1989), *Population is the totality of all possible values, the results of counting and measurement, quantitative and qualitative characteristics of certain of the set of objects is limited by a certain criteria or restrictions, while the sample is a part of the population.*

In this study examined the population of DBL implementation is the entire students of ninth grade in Junior high school, while the total sample of this research is one science class that are consisting of 9 students and has been existed in designated school. For DBL class has meeting schedule for 1 hour per day, and 2 or 3 days per week.

Class is divided into three groups and students do the lesson collaboratively. Each group consists of 3 persons and built the electrical alarm system through 6 components, there are **P**urpose, **I**nput, **S**olutions, **C**hoice, **O**perations, and **E**valuation (**PISCOE**).

a. Method of Research

This study is part of a comprehensive study aimed at investigating the impact of design-based learning on students' academic achievement, particularly in creative thinking skill. The research method that is used to implement DBL is quantitative descriptive method. The purpose of quantitative descriptive studies is to find inter-relationships between variables. Descriptive research can be either quantitative or qualitative. It can involve collections of quantitative information that can be tabulated along a continuum in numerical form or describe categories of information. Descriptive research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection (Glass & Hopkins, 1984). It often uses visual aids such as graphs and charts to aid the reader in understanding the data distribution. In this method, the writer uses weak experiment design with a single pretest-posttest design. The main data collection that will be implemented more inclined to qualitative data, that is measuring students' creative thinking skill by using portfolio documents and observational sheet. The method will be explained descriptively that aims to describe phenomena that are appeared. This study was not conducted on the manipulation or alteration of independent variables, but it describes a condition as it is (Sukmadinata,

2011). The students' cognitive domain is measured before and after treatment. While the students' creative thinking skill would be measured during learning process occurred.

C. Research Scheme

Research scheme is a view of how the research is conducted. Starting from the preparation phase, the implementation until a conclusion is reached based on the formulation of the issues raised. Detailed the plot of this research is set out in several steps as shown in the next page.

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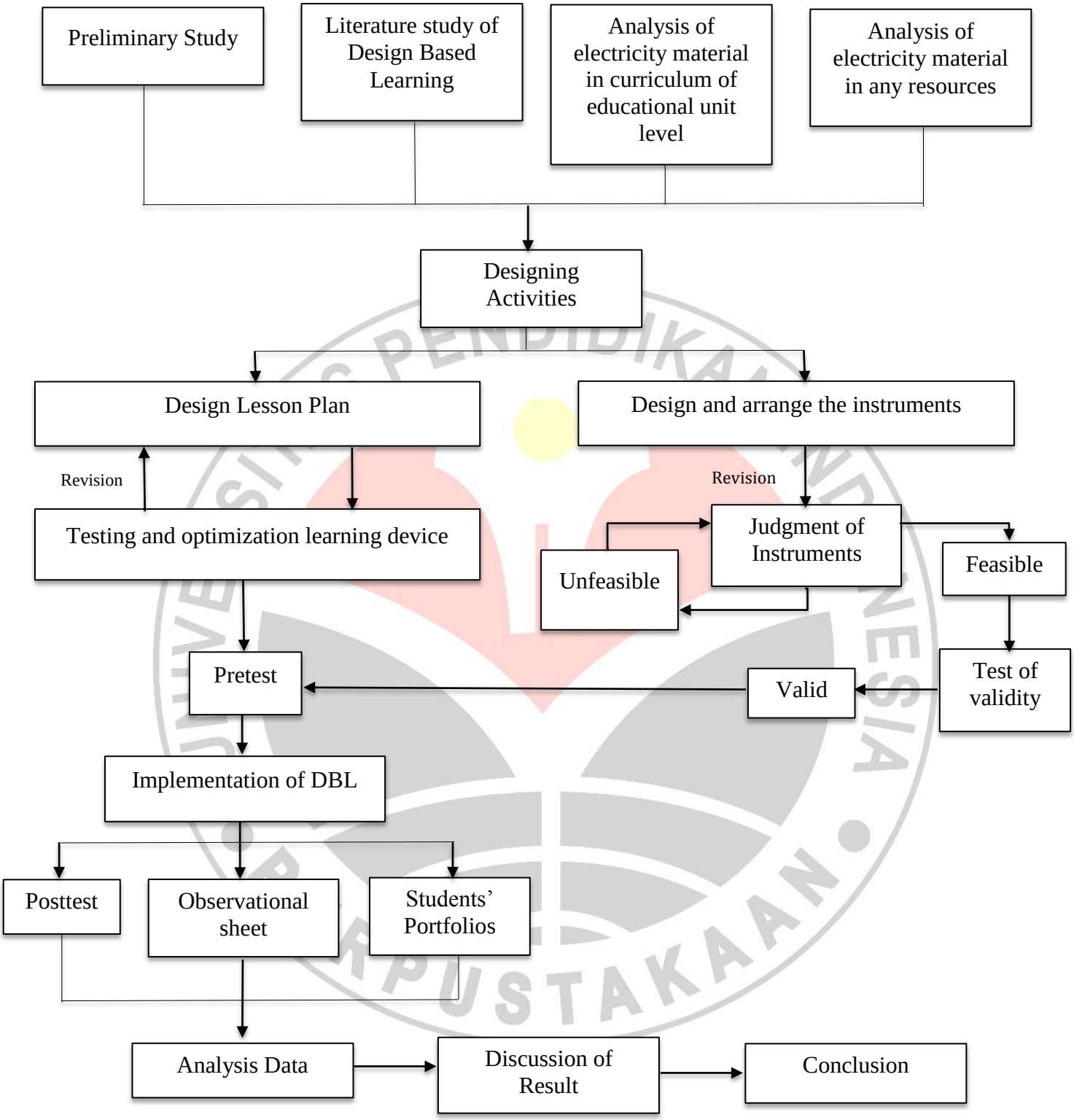

Figure 3.1
Scheme of Research's Plot

D. Procedure of Collecting Data

Procedure of collecting data consist of three phases, there are:

1. Preparation Phase

   The preparation phase is intended to prepare all instruments that is needed in research. Activities that is done in preparation phase are:

   a. Analysis the material of physics in Educational Unit Level Curriculum
   b. Determine the topic or chapter of lesson.
   c. Design lesson plan, learning scenario and activities for Design Based Learning Implementation.

      It is a plan for implementation in the regular science curriculum. The resulting module, Electrical Alarm System: Design, Construction, and Reflection (Doppelt, Mehalik & Schunn, 2004). The framework's components are: **P**urpose, **I**nput, **S**olutions, **C**hoice, **O**perations, and **E**valuation (**PISCOE**).

      The module included modes of design thinking.

      1) Alarm systems - where they can be found, reasons such systems exist, how they work, and how to build such a system;
      2) Technological systems and subsystems
      3) Constructing an alarm system in order to learn how electronic components can applied in developing such a system;
      4) Brainstorming, communicating, documenting, working in teams, and designing technological systems for solving problems;
      5) Developing criteria for assessing the design process;
      6) Evaluating alternative designs as problem solutions; and
      7) Reflecting on the design process.

   d. Making Instruments of research
   e. Testing the validity of Instrument, and test those instruments before doing the *treatment*. *If there are some deficiencies, the revision might be done.*

2. Implementation Phase

   The implementation started with,

   a. Starting the learning model by giving pretest (T_1) in sample class.

b. Do the treatment by applying the Design Based Learning.
c. At the time of treatment, also would be done the observation of learning process by teacher.
d. When the implementation has finished, all of students' documents (pictures, design, ideas, etc.) would be collected by the teacher as their portfolios.
e. Ended the learning by giving a posttest (T_2) to know the development of their conceptual knowledge before and after treatment.

3. Analysis Phase
   a. Process the data from pre-test, post-test, and student portfolios
   b. Analyze and discuss research findings
   c. Deduce a conclusion

E. Data Collection

a. Knowledge Test (KT)

The knowledge test (KT) consists of two sections, there are pre-test and post test. The pre test would be given before any instruction of electricity begun while posttest would be given after all of instruction has been done. Students were given this kind of test to measure the changes of their knowledge about electricity concept.

b. Oral Presentation Assessment

At the final stage of learning module students are obligated to present the entire design and build the process. The presentation include the system purpose, system model, material and apparatus, procedure, project result, strengthens and weaknesses, and idea for the future. A teacher and peer has role in assessing this performance by using peer assessment sheet. peer assessment can help them in learning to evaluate their own learning and in interpreting assessment criteria

c. Analysis of student portfolios

All data or documents during implementation of learning process would be collected. It consists of drafts, sketch, and photos of product and other things that relates with the material of lesson.

Data collection techniques used in this research was conducted through a pretest and post-test, the test results of essay questions contained in the module, and peer assessment. Details of data collection techniques can be seen in the table 3.1.

Table 3.1 Techniques of Data Collection

Meeting	Activities	Types of Data
1st	Electricity Pretest	Pretest (Multiple choice)
2nd	Describe the Current Situation, Describe the Uses and Need of Alarm System	Essay question, reflection
3rd	Choose the Alarm System and Define The General Requirements	Essay question, reflection
4th	Create a System Model, Generate Alternative Solutions	Essay question, reflection
5th	Create a Power Subsystem and Indicator Subsystem	Essay question, reflection
6th	Improving Model of Circuit Design, Adding a Detector Subsystem	Essay question, reflection
7th	Finishing The Project Task	Essay question, reflection
8th	Presentation of Students' Project, Electricity Posttest	Peer Assessment, Post-test (Multiple Choice)

F. Instruments

1. Pre test

Pre test are conducted in the beginning of teaching implementation. It is intended to know the students' prior knowledge to the concept of electricity. In this pre test consist of twelve multiple-choice questions. Those questions only elaborate to the students' cognitive domain. Learning outcomes that will be revealed in this study is about cognitive aspects; there are C1 (remembering), C2 (Understanding), C3 (Applying), C4 (Analyzing), C5 (Evaluating), and C6 (Creating) according to Revised Taxonomy Bloom.

Table 3.2 Details of Cognitive Domain Test

No	Indicator	Cognitive Domain	Question Number
1	Students are able to identify the material of electricity that can travel easily	C1 Recalling	1
2	Students are able to identify the function of an ammeter	C1 Recalling	2
3	Students are able to describe function of electrical components.	C2 Explaining	3
4	Students are able to interpret the diagram series circuit.	C2 Inferring	4
5	Students are able to calculate the amount of electrical quantities in series and parallel circuit.	C3 Executing	5
6	Students are able to differentiate between series and parallel circuit.	C3 Implementing	6
7	Students are able to analyze the principles of opened and closed electric circuits.	C4 Differentiating	7
8	Students are able to determine the diagram of a given circuit.	C4 Attributing	8

9	Students are able to determine the best electrical experiment design	C5 Checking	9
10	Students are able to investigate the principle work of electrical circuit	C5 Checking	10
11	Students are able to create a series of electrical components with a variety of both series and parallel.	C6 Assembling	11
12	Students are able to create a series of electrical components with a variety of both series and parallel.	C6 Planning	12

2. Post Test

Posttest is conducted in the last section of DBL implementation. All questions are same with pre test questions. It is intended to know the improvement of students to the concept of electricity.

3. Observational sheet

Observational sheet is a form that record students' activity. The biggest value of periodic observation is to check on how individuals are doing, looking for their progress and discovering their problems. With this information, the educator can diagnose weaknesses and work with students to find solutions. Recorded observation provides a means to see gaps in lessons or where students have misunderstood essential points. The form will be explained descriptively to describe how the learning process occurred. It divided into three sequences, there are opening activity, core activity, and closing activity.

4. Rubric Scale of Observational Sheet.

Observations are opportunities to observe teacher performance and provide information for the preparation of the evaluation. By observation can enable: (1) informed planning, (2) informed understanding of a student's current competence

levels, (3) reflection on the appropriateness of provision, (4) sharing of information with other parties, (5) assessment of specific children, groups, interactions, the learning environment and staff. (Baltimore, 2012)

In this study, teacher provides observational sheet to be assessed by two observers. Observers will evaluate the ongoing learning process, both of teacher performance or students' activities. To make that evaluation easier, writer makes the rubric of observational sheet. This rubric uses rating scale as the score. Writer divide scales into three parts, they are poor, good, and excellent. Hoped with this rubric could make the evaluation clearly stated and more accurate.

5. Rubric Scale of Portfolios

Assessment rubric is used to assess the tasks or the work of students who serve as portfolio. Assessment rubric works resulting from the manufacture of electrical alarm system with assessment criteria including completeness of the whole process such as Presents the system's purpose, Generates alternative and creative solutions, Analyzes solutions for choosing a design, Explores design stages through planning and constructing, and Conducts reflection on design stages. The range is started from level 1 (Awareness of Thinking) until level 4 (Reflection of Thinking). In making this rubric the writer adapted the existing rubric and developed subsequently revised twice to resulting a maximum rubric.

6. Students Module

A module is the smallest unit of learning programs, which can be learned by the students themselves as individuals (self-instructional) and in groups. After the student has completed one unit in the module, then the student can move forward and learn the next module unit.

This module consists of a variety of discourses, questions, descriptions, tables, images and all other materials that will guide students in making the alarm system. The form of question is essay form to measure students' learning outcomes that will be used as a portfolio assignment. The entire questions were adopted from the previous research, so its validity can be ascertained and no need

for improvement. In addition, this module also guides students in making the entire portfolio of documents that will be collected at the end of the implementation of the DBL.

7. Rubric Scale of Students' Performance

The form of observation sheet is rubric scale. Rubrics contain two separate elements, a set of labels that describe each of the performance levels and an associated set of score.

Students and teacher would fill this rubric. The criteria of performance are: Knowledge of information, entire explanation, use of alarm system model, and use of the transparencies. There is a rubric scale for the performance assessment, from 5 (advanced) to 1 (unsatisfactory).

G. Validity Test of Instruments

Validity test is tests performed on the content of instruments, with the aim to measure the accuracy of the instruments used in a study. So, the data obtained could be relevant / appropriate to the purpose of the measurements. The instruments that will be judged consist of questions of pretest-posttest, the evaluation form of observation sheet, the rubric scale of observation sheet, and rubric of portfolios. The whole instruments were judged by 5 expert persons. Three of them are the lecturers of university, and two of them are the official school teachers of Mutiara Nusantara International School.

H. Data Analysis

1. Descriptive analysis

This research will investigate the secondary students' creative thinking skill through DBL. Most of the results data obtained will be analyzed with genre of analysis descriptive. Below are the description of instruments analysis.

a. Analysis of Observational Sheet

The form will be analyzed and elaborated the process of learning descriptively. It divided into three sequences, there are opening activity, core activity, and closing activity.

b. Analysis of Portfolio

The results are obtained from students' worksheet that will be examined by the teacher during the implementation of design-based learning take place. Rubric scale is used to determine the students' creative thinking level (from scale 1 until 4 as the highest level of creative thinking). The criteria of assessment in the portfolio evaluation are made by the teacher. The causal of the results would be described descriptively.

c. Analysis of Students' Performance

Students' performance is conducted in the end stage of DBL, the evaluation stage. Student will be assessed orally while presenting their project results. Both teacher and students do assessment regarding to the presentation but in the different form. Observation data in the form use rubric scale. Student only judge others group performance while displaying the result of project, but teachers assess the performance, process, and discussion of the entire group.

2. Analysis of Pretest and Posttest

Pre test and posttest are conducted in the beginning and in the end of teaching implementation. It is intended to know the students' prior knowledge and students' improvement to the concept of electricity. Below is the pretest and posttest analysis.

a. Average Normalized Gain

Average normalized gain is a useful method to assess the effectiveness of instruction. The average normalized gain or the **g**-factor has been widely used in assessing students' performance in pre- and post-tests. The average **g**-factor can be calculated using either the average scores of the class or individual student's scores. In general, these two calculations produce different results.

The nature of these two results is explored for several idealized situations. The results suggest that we may be able to utilize the difference between the two results to extract information on how the population may have changed as a result of instruction. Average normalized gain, (g), is defined as the ratio of the average improvement in participant scores from pre-test to post-test with respect to the maximum possible improvement. (g) Can be calculated:

$$g = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}.$$

Figure. 3.2
The Equation of Average Normalized Gain

Hake (1998) argues that the normalized gain is a meaningful measure of how well a course teaches topics in physics to students. Hake considered normalized gains in three categories: "high" for a normalized gain greater than 0.7, "medium" between 0.3 and 0.7, and "low" below 0.3. Traditional courses typically have low. See the table 3.3 below.

Table 3.3
Category of Average Normalized Gain

Normalized Gain	Category
< 0.3	Low
0.3 < x < 0.7	Medium
> 0.7	High