

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Method

Experimental research is used as the method of this research. Pre – Experimental Design is chosen as one of the experimental research method to discover a causal relationship only by involving one group of subject. In other words, this method is used when there is no control group or extraneous factors which can influence internal validity (Fraenkel, Wallen, & Hyun, 2011). Extraneous factors are any influences in selecting participants, the producers, the statistics, or the design likely to affect the outcome and provide an alternative explanation for the result than what its expected (Creswell, 2012). In this research, pre – experimental design was used to discover the effect of STEM Learning approach implemented by the researcher to students' STEM Literacy. Therefore, the researcher will know whether any change occurred due to the implementation of STEM Learning approach in learning electricity.

3.2 Research Design

The design of this research was One- Group Pretest-Posttest Design. A pretest was used to measure some attribute or characteristic of participants in an experiment before receiving treatment. While posttest was used to measure some attribute or characteristic of participants in an experiment after receiving treatment (Creswell, 2012). In this research design the ability of students' STEM Literacy were measured before and after implementation of STEM learning. A diagram of this design was explained in the Table 3.1:

Table 3.1 One- Group-Pretest-Posttest Design

O ₁	X	O ₂
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Where,

O₁ : STEM Literacy -Based Electricity Pretest

X : Implementation of STEM learning

O₂ : STEM Literacy -Based Electricity Posttest

(Fraenkel, Wallen, & Hyun, 2011)

3.3 Population and Sample

The location of this research was one of the Private Junior High School which located in Bogor, West Java. Because this school applied IGCSE curriculum in the teaching learning activity.

The population of this research would be all 8th students. The samples in this research was one class which consist of 16 students from 8th grade in X Private Junior High School. This class consisted of 7 female and 9 male students who were 15 years old. According to index of student's achievement from school, this class consisted of students who categorized as medium achiever from other two classes.

The sampling technique used was cluster random sampling. According to Fraenkel, Wallen and Hyun (2011), cluster random sampling is the selection of random samples from individual groups. Cluster random sampling can be used when the condition are difficult or impossible to pick samples from individuals randomly. The selection of samples with CRS is very suitable to be applied in schools because in schools usually individuals are already in the form of groups or classes so it is very difficult to randomize them individually. The method is also easier and suitable for researches done in school (Fraenkel, Wallen, & Hyun, 2011).

3.4 Operational Definition

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

3.4.1 STEM

Science, Technology, Engineering and Mathematics (STEM) is an approach used to teach scientific and mathematics applications through engineering activities that involve the development of technology. STEM approach is the independent variable in this research which implement in the class. The STEM approach which

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implemented in learning electricity is described in lesson plan that have been arranged. STEM Learning implementation in this research is investigated through observation sheet.

3.4.2 STEM Literacy

STEM Literacy is the ability to identify, apply, and integrate concept from science, technology, engineering, and mathematics to understand complex problems and to innovate to solve them. STEM literacy is the dependent variable in this research which the result is depend on the implementation of STEM approach in learning electricity. In this research STEM Literacy of the students is investigated through STEM Literacy instrument test.

3.5 Assumption

The assumption that used as the foundation of this study are:

3.5.1 STEM education approaches not only increase students' interest but also improves their thinking and practical skill in learning magnetism, electricity and electrical energy (Anwari, et al., 2015).

3.5.2 Engaging students in STEM learning activity can increase students' achievement in assessment of knowledge and skills of science and math (Kennedy & Odell, 2014).

3.6 Hypothesis

Hypothesis that is tested in this study stated as follow:

H_0 : There is no significant difference on students' STEM Literacy in learning electricity after applying STEM Learning.

H_1 : There is significant difference of students' STEM Literacy in learning electricity after applying STEM Learning.

3.7 Research Instrument

In this research, instrument is necessary to gain the data. There are several types of research instrument used in this research. Those instruments are described as follow:

3.7.1 Observation Sheet

Observation sheet was used to measure the implementation of STEM learning in the class. The observation sheet contained the steps which conduct by the researcher and the students that will be assessed whether it is implemented appropriately or not.

3.7.2 Objective test

The objective test is the instrument which used to test students' STEM Literacy. In this research, STEM Literacy based test which covers the four aspect such as Science, Technology, Engineering and Mathematics in electricity topic used as objective test. This test was used in both pretest and posttest. Pretest were given before conducting the treatment to know STEM Literacy basic of students. While posttest were given to know the improvement of students' STEM Literacy. The type of question of pretest and posttest was multiple choice, which contained 27 questions. The multiple choice questions was constructed based on the four strands of STEM Literacy from Allan Zollman (2012). The Table 3.2 is the blue print of objective test before being analyzed and revised.

No.	Aspects of STEM Literacy	Item Test	Total	Percentage
1.	Science Literacy	1, 2, 3, 4, 5, 6, 8, 9	8	30%
2.	Technology Literacy	7, 10, 11, 12, 13	5	28%

3.	Eligible Blue Print of STEM Literacy-Based Test			
4.	Mathematics Literacy	18, 19, 20, 21, 22, 23, 24, 25, 26, 27	10	37%
Total			27	100%

All the test item were judged by the experts and tested to the students who have learned about electricity, afterwards students' answer was analyzed by using a statistical software, namely ANATES (The result of the analysis is attached in appendix). The result of ANATES was used to eliminate or select the test items. The new blue print of objective test item was arranged and used as fix research instrument. From 27 test items, there are 25 test items used. The new blue print of objective test items after being analyzed and revised was shown in Table 4.8.

3.8 Instrument Development and Analysis

The objective test used in this research was tested before it was used as pretest and posttest. The instrument developed started by analyzing the four STEM aspects and indicators which suitable with the concept of electricity. Then the researcher formulated and arranged the objective test. In the preparation stage the objective test was validated and tested to the students who have learned about electricity, which is 10th grade students. The analysis of objective test which used in this research consisted of the discriminating power, distractor, and level of difficulty, validity and reliability.

3.8.1 Difficulty level

Difficulty level is defined as the proportion of examines that responded to the item correctly. The result of students' achievement in the test is used to define the quality of difficulty level (Sabri, 2013). The formula to determine difficulty level is shown as follow:

$$Difficulty\ Level = \frac{R_U + R_1}{N_U + N_1}$$

Where:

R_U = the number of the students in the upper group who responded correctly

R_1 = the number of the students in the lower group who responded correctly

N_U = number of students in the upper group

N_1 = number of students in the lower group

(Boopathiraj & Chellamani, 2013)

The result of difficulty level can be interpreted through the Table 3.3.

Table 3.3 Interpretation of Difficulty Level

Difficulty Value	Criteria
0,00 – 0,30	Hard
0,31 – 0,70	Fair
0,71 – 1,00	Easy

(Arikunto, 2013)

3.8.2 Discriminating Power

Discriminating power of test items refers to the degree to which success or failure on an item indicates possession of the ability being measured. The result of discriminating power will define the students who had high score / higher achiever and the students who had lower score / lower achiever (Boopathiraj & Chellamani, 2013). The formulae for measuring discrimination power is:

$$\text{Discriminating Power} = \frac{R_U - R_1}{\frac{1}{2}(N_U - N_1)}$$

Where:

R_U = the number of the students in the upper group who

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responded correctly

R_1 = the number of the students in the lower group who
responded correctly

N_U = number of students in the upper group

N_1 = number of students in the lower group

(Boopathiraj & Chellamani, 2013)

The result of discriminating power can be interpreted through the Table 3.4.

Table 3.4 Interpretation of Discriminating Power

Discriminating Power Value	Criteria
0,00 – 0,20	Poor
0,21 – 0,40	Fair
0,41 – 0,70	Good
0,71 – 1,00	Very Good

(Arikunto, 2013)

3.8.3 Distractors

Distractors are determined as the incorrect answer in a multiple-choice question. The analysis of distractor is needed to determine the effectiveness of each answer provided and its influence to students' performance (Sabri, 2013). According to Brame (2013), the characteristic of a good distractor or incorrect alternative are:

- It should be plausible to be chosen by lower achiever students
- It should be stated clearly and concisely.
- It should be mutually exclusive and homogeneous in content

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- d. It should be free from clues about which response is correct
- e. The sentences of “all of the above” and “none of the above” should not be used.
- f. It should be presented in a logical order.
- g. The number of incorrect alternatives can vary among items as long as all alternatives are plausible.

3.8.4 Validity

Validity can be stated as the agreement between test score and the quality which believed to be measured. The newest standard underlined that validity is the unity of concept which characterize all of the evidence that support the purposed interpretation of a measure (Kaplan & Saccuzzo, 2008). The formulae can be used to determine test item validity is described as follow:

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

Where:

r_{xy} = items correlation coefficient

$\sum X$ = items scores

N = amount of subject

(Minium, King, & Rosopa, 1993)

To interpret the validity, the researcher used reference as shown in Table 3.5.

The Value of r	Interpretation
0.80 < r ≤ 1.00	Very High
0.60 < r ≤ 0.80	High
0.40 ≤ r ≤ 0.60	Enough

Table 3.5 Interpretation of Validity Value	
$0.20 < r \leq 0.40$	Low
$0.00 < r \leq 0.20$	Very Low

(Minium, King, & Rosopa, 1993)

3.8.5 Reliability

Based on the theory, reliability is the result of the ratio of true score variance to determine score variance (Kaplan & Saccuzzo, 2008). This ratio can be determined using a variety of correlation methods, in this research the method was used is Kuder-Richardson. The formulae described 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 the test scores
- SD = standard deviation of the set of test scores

(Fraenkel, Wallen, & Hyun, 2012)

To interpret the reability, the researcher used reference as shown in Table 3.6.

Table 3.6 Interpretation of Reability

Reability Coefficient	Criteria
$0,80 < r \leq 1,00$	Very High
$0,60 < r \leq 0,80$	High
$0,40 < r \leq 0,60$	Medium
$0,20 < r \leq 0,40$	Low
$0,00 < r \leq 0,20$	Very Low

(Minium, Rosopa, King, & 1993)

3.9 Instrument Analysis Result

The instrument draft for measuring students' STEM Literacy were made into 27 questions. After constructing the questions, then it was tried toward 10th grade of Private Senior High School students in Bogor Regency, the reason is because they have learnt about the concept of electricity. The result of the test is tested by difficulty level, discriminating power, validity and reability. The analysis of recapitulation of each test item is shown in the Table 3.7:

Reability test : 0,50 (Medium Level of Reability)

Table 3.7 Recapitulation of Test Item for Students' STEM Literacy

No	DP	Category	DL	Category	Validity	Category	Decision
1	45,45	Good	69,05	Medium	0,295	Low	Revised
2	63,64	Good	61,90	Medium	0,434	Medium	Used
3	9,09	Poor	97,62	Easy	0,302	Low	Revised
4	18,18	Poor	45,24	Medium	0,128	Very Low	Revised
5	27,27	Fair	40,48	Medium	0,216	Low	Revised
6	63,64	Good	59,52	Medium	0,509	Medium	Used

No	DP	Category	DL	Category	Validity	Category	Decision
7	9,09	Poor	95,24	Easy	0,165	Very Low	Revised
8	63,64	Good	64,29	Medium	0,537	Medium	Used
9	54,55	Good	50,00	Medium	0,412	Medium	Used
10	27,27	Fair	45,24	Medium	0,185	Very Low	Revised
11	9,09	Poor	14,29	Hard	0,064	Very Low	Revised
12	36,36	Fair	85,71	Easy	0,383	Very Low	Used
13	-9,09	Poor	19,05	Hard	-0,069	Very Low	Dropped
14	9,09	Poor	35,71	Medium	0,146	Very Low	Revised
15	-27,27	Poor	66, 67	Medium	-0,111	Very Low	Dropped
16	9,09	Poor	26,19	Hard	0,206	Low	Revised
17	63, 64	Good	47,62	Medium	0,463	Medium	Used
18	0.00	Poor	35,71	Medium	0,117	Very Low	Revised
19	-18,18	Poor	26,19	Hard	-0,166	Very Low	Revised
20	18,18	Poor	92,86	Easy	0,260	Low	Dropped
21	0,00	Poor	7,14	Hard	0,071	Very Low	Revised
22	81,82	Very Good	45,24	Medium	0,642	High	Used
23	81,82	Very Good	47,62	Medium	0,562	Medium	Used
24	27,27	Fair	28,10	Medium	0,255	Low	Used

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No	DP	Category	DL	Category	Validity	Category	Decision
25	81,82	Very Good	40,48	Medium	0,593	Medium	Revised
26	63, 64	Good	69,05	Medium	0,465	Medium	Used
27	36,36	Fair	21,43	Hard	0,428	Medium	Used

3.10 Data Processing Technique

There are quantitative and qualitative data in this research. Quantitative data was obtained through objective test in pre-test and post-test. While qualitative data was obtained through rubric of observation sheet. The data processing technique was done as follow:

3.10.1 Quantitative Data Processing

a. Score of Item Test

The score of test item for measuring the improvement of students' STEM Literacy are obtained from the set of test item which consist of 25 questions. Each questions have one score if the students answer it correctly, and zero for their wrong answer.

b. Calculation of Gain Score and Normalize Gain

The gain score was calculated by using normalized gain $\langle \bar{g} \rangle$. It will measure the fraction of the available improvement that is obtained. Gained score can be determined through the formulae as follow:

$$\langle G \rangle = \langle S_f \rangle - \langle S_i \rangle$$

Where:

$\langle G \rangle$ = actual average gain

$\langle S_f \rangle$ = final (post) class average

$\langle S_i \rangle$ = initial (post) class average

(Hake, 2002)

Then, the formulae to measure the normalize gain is shown as follow:

$$\langle \bar{g} \rangle = \frac{\% \langle G \rangle}{\% \langle G \rangle_{max}} = \frac{(\% \langle S_f \rangle - \% \langle S_i \rangle)}{(100 - \% \langle S_i \rangle)}$$

Where:

$\langle \bar{g} \rangle$ = average normalized gain

$\langle G \rangle$ = actual average gain

$\langle S_f \rangle$ = final (post) class average

$\langle S_i \rangle$ = initial (post) class average

(Hake, 2002)

The result of normalize gain score can be interpret through Table 3.8.

Table 3.8 Interpretation of Normalize Gain Score

Normalized Gain Score / $\langle \bar{g} \rangle$	Criteria
$\langle \bar{g} \rangle > 0,7$	High
$0,7 \geq \langle \bar{g} \rangle \geq 0,3$	Fair
$\langle \bar{g} \rangle < 0,3$	Low

(Hake,
2002)

3.10.2 Qualitative Data Processing

Qualitative data processing is used to gain the data from rubric of observation sheet. In this research, the author calculate the result of observation sheet rubric by

converting the result into percentage scale. The following formulae is used to convert raw score into percentage scale:

$$P = \frac{R}{MS} \times 100\%$$

Where:

P = percentage

R = Raw score

MS = Maximum Score

(Arikunto, 2013)

Then the Table 3.9 is used to interpret the percentage result.

Table 3.9 Interpretation of Percentage

Percentage (%)	Criteria
80 – 100	Very Good
66 – 79	Good
56 – 65	Moderate
40 – 55	Lack
< 40	Very Lack

(Arikunto, 2013)

3.11 Research Procedure

The research procedure of this research as shown in Figure 3.1 described the steps in implementing the research design. The research procedure consist of preparation, implementation and completion stage which explained in detail as follow:

3.11.1 Preparation Stage

- a. Formulating STEM problem to be investigated and research objective determined.
- b. Determine a specific topic to be conducted in this research.

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- c. Conducting analysis of several aspects which strengthen the foundation of this research and explain it in the literature review, such as:
 1. The problem raised in teaching and learning process, especially in electricity topic.
 2. The curriculum which used at school, to make sure that the topic of electricity which take in this research is appropriate.
 3. STEM learning which possible to implement in the subject class as independent variable.
 4. The use of Android Game in electricity topic.
 5. The use of *Arduino –Uno* project in electricity topic.
 6. STEM Literacy which will be used as parameter of students' achievement / dependent variable.
- d. Finding the possible school to conduct this research.
- e. Designing hypothesis of experiment.
- f. Designing research instrument which used in this research such as objective test, lesson plan, worksheet and observation sheet.
- g. Validate the objective test to the expert or lecturer.
- h. Revisions of research instrument after receiving suggestion from the expert or lecturer.
- i. Try the objective test to the students, and test the result by difficulty level, discriminating power, distractor, validity and reliability.
- j. Validate the rest of instrument such as lesson plan, worksheet and observation sheet before going to use in this research.

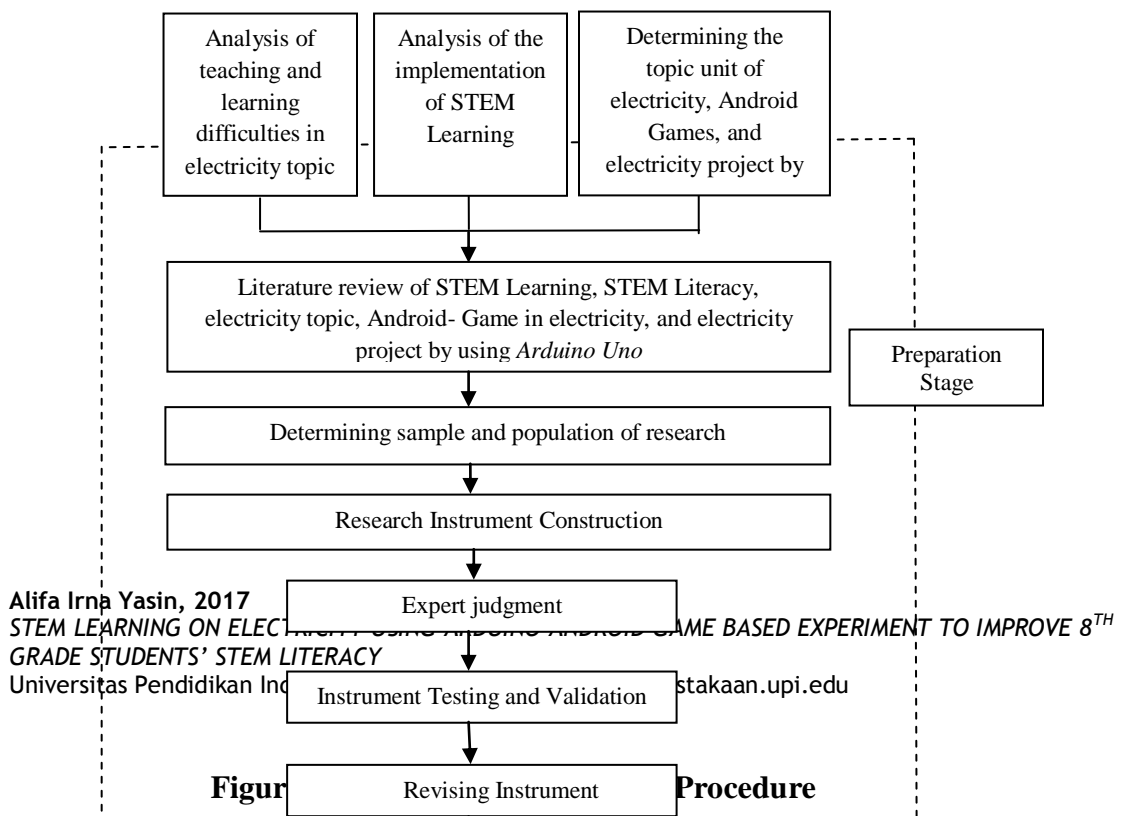
3.11.2 Implementation Stage

- a. Analyzing students previous test score, it can be from previous formative or quiz, to know the composition of higher and lower achiever before grouping the students.
- b. Distribute pre-test question to know the basic STEM Literacy of the students.

- c. Conducting STEM Learning as the treatment in the class for three meetings.
- d. Distributing post-test question to know the effect of STEM Learning in the topic of electricity in students' STEM Literacy.
- e. Collect the result from data gained to be analyzed in the next stage.

3.11.3 Completion Stage

- a. Analyze the result from the instrument which have been used.
- b. Interpreting the result.
- c. Make discussion regarding the result of analysis with supervisors.
- d. Draw conclusion from the research.
- e. Completing the research report.



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