

## CHAPTER III RESEARCH METHODOLOGY

### 3.1 Research Design

The research method used in this study is the pre-experimental method which use one group pre-test without any control group assigned. Pre-experimental used a single group then offer the intervention to them (Creswell, 2012). This is aligned with the aim of this research to investigate the effect of socio-scientific issue-based learning (SSI-BL) supported by Lucidchart toward students' argumentation skills and attitudes toward science by using Lucidchart in learning energy resource topic. Besides, this method appropriate due to the learning activity was conducted in online. Thus, it is effectively to implement pre-experiment for this research.

The research design in this study use one group pre-posttest design. It allows investigating the differences between pretest-posttest due to the treatment (Creswell, 2012). It means that the investigation is not observed and measured after the treatment given, but also before the treatment applied. Therefore, it is possible to compare the result of the pre-test and to determine the prior knowledge and the post-test which is the result after the treatment. The treatment itself is given by implementing SSI-BL supported by Lucidchart. As for the representation of the design shown in Table 3.1

Table 3.1

The table of representation of research design

Pretest	Treatment	Posttest
O <sub>1</sub>	X	O <sub>2</sub>

(Creswell, 2012).

Where:

O<sub>1</sub>: Pre-test to measure students' argumentation skill and attitude toward science before treatment

X: Student was treated by implementing SSI-BL with Lucidchart

O<sub>2</sub>: Post-test to measure students' argumentation skill and attitude toward science after treatment

### 3.2 Population and Sample

The population of this research is 7<sup>th</sup> grade students in one of junior high school in Bandung, Indonesia. The students haven't learned the energy resource topic for the level junior high school student. The school's curriculum was adjusted in 2013 (Kurtilas), and the sequence of science topics was rearranged from the original sequence to meet the school's needs. The science curriculum, especially for the 7th grade, was based on the Cambridge curriculum. Bahasa Indonesia is utilized as an intermediate language in the teaching-learning process.

In this research, the sample was chosen by convenience technique. It is because the students are willing and available to be investigated in this research. This is aligned with (Creswell, 2012) wherein convenience sampling means the chosen samples are willing and able to be examined. So, there are 32 samples (16 females and 16 males) with an average 12-13 years old. The sample distribution can be seen in Table 3.2.

Table 3.2

Data of the sample

Population	Sample	Percentage (%)	Total (%)
7 <sup>th</sup> Grade	Male	16	50
	Female	16	50
			100

### 3.3 Research Instrument

The instrument needed to be used to obtain the data for this research. There are several types of instrument have been used. Those instruments are described below.

#### 3.3.1 Argumentation Skill

The written test essay has been used to test the students' argumentation skill in this research. The same written essay test was given to the students as for pre-test and post-test. The data of pre-test and post-test was compared to determine the improvement of students' argumentation skills. There are two question that for each consist of six component of argumentation skills based on (Toulmin, 2003) which are claim, data, warrant, backing, qualifier, and rebuttal. The phrase used to make questions was adopted to (Heng et al., 2014) in order to fit in the questions with the component of argumentation skills. The blueprint of the written essay test before expert judgment and validation is shown in the Table 3.3.

Table 3.3

Sub-Topic	Argumentation Component	Number of Question
Energy resources	Claim	1a, 2a
	Data	1b, 2b
	Warrant	1c, 2c
	Backing	1d, 2d
	Qualifier	1e, 2e
	Rebuttal	1f, 2f

### 3.3.2 Instrument development and analysis

Before the written essay test was being used to measure students' argumentation skill, there are some processes required. The first one is constructing the written test based on energy resource topic. In order to make all the question fit in with the component, the questions were adopted from the study (Lin & Mintzes, 2010). After that, the written essay test sent to the expert to be analyzed and judged. Furthermore, the written essay test was revised based on the expert's suggestion. The written essay test was then administered to 22 of 9<sup>th</sup>-grade students who had studied energy resource subjects. The result then will be analyzed in the terms of validity, reliability, difficulty level, and discriminating power.

#### a. Validity

According to (Fraenkel et al., 2012) validity includes the process to collect and analyze evidence to provision inferences the researcher made which definitely about the specific uses of an instrument. In this research, a validity test is used to check the ability of the assay to measure student's argumentation skills. The calculation of validity was measured by ANATEST 4.0. Furthermore, the interpretation of the validity can be defined in Table 3.4.

Table 3.4

Correlation Coefficient	Criteria
$0.90 \leq r \leq 1.00$	Very High
$0.70 \leq r \leq 0.90$	High
$0.40 \leq r \leq 0.70$	Enough
$0.20 \leq r \leq 0.40$	Low

Correlation Coefficient	Criteria
$0.00 \leq r \leq 0.20$	Very Low
$r < 0.20$	Invalid

(Source: (Cohen et al., 2018))

#### b. Reliability

Reliability is the stability and consistency of a test result. However, reliability and validity are in line and always dependent on the context of an instrument being used for research (Fraenkel et al., 2012). The reliability calculated by using ANATEST 4.0. The interpretation of the r-value of reliability can be defined as in Table 7.

Table 3.5

The interpretation of the r-value of reliability

Correlation Coefficient	Criteria
$0.80 < r \leq 1.00$	Very High
$0.60 < r \leq 0.80$	High
$0.40 < r \leq 0.60$	Prosperous
$0.20 < r \leq 0.40$	Low
$0.00 < r \leq 0.20$	Very Low

(source: (Fraenkel et al., 2012))

#### c. Difficulty Level

In this research, the difficulty level refers to the degree of difficulty for the students in answering the question. The calculation use ANATEST 4.0 and interpret formula the difficulty can be defined as in Table 3.6

Table 3.6

The interpretation of the difficulty index

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

(Source: (Boopathiraj & Chellamani, 2013))

#### d. Discriminating power

In order to determine which high-scoring examinees have a high likelihood of answering correctly and which low-scoring examinees have a low probability of answering correctly, discriminating power was used. Furthermore, to measure the

discriminating power, it was used ANATEST 4.0 and interpret of discriminating power as shown in Table 3.7.

Table 3.7

The interpretation of the discriminating power

Value of difficulty index	Interpretation
0.70 – 1.00	Excellent
0.40 – 0.80	Good
0.20 – 0.60	Satisfactory
$\leq 0.20$	Poor

(Source: Croker et al., 2008)

### 3.3.2 Instrument development and analysis result

The essay written test has been validated by two experts and followed by the revision for some phrases for the question. Furthermore, the result of validating by 22 of 9<sup>th</sup> grade students has been analyzed by using several tests including the validity, reliability, difficulty level (DL), and discriminating power (DP). The calculation of the tests item analysis helped by ANATEST 4.0. As the result, the reliability score of written test essay is 0.84 which categorized as very high. As for the recapitulation of written test essay analysis is shown in Table 3.8.

Table 3. 8

The Recapitulation of Written Essay Test Analysis

Number	Validity	DL	DP	Acceptance
1a	0.288 (Low)	0.500 (Moderate)	0.222 (Satisfactory)	Revised
2a	0.538 (Enough)	0.694 (Moderate)	0.611 (Good)	Used
3a	0.671 (High)	0.472 (Moderate)	0.722 (Excellent)	Used
4a	0.781 (Very high)	0.667 (Moderate)	0.667 (Good)	Used
5a	0.707 (High)	0.528 (Moderate)	0.500 (Good)	Used
6a	0.356 (Enough)	0.361 (Moderate)	0.278 (Satisfactory)	Revised
1b	0.582 (Enough)	0.528 (Moderate)	0.389 (Satisfactory)	Used

Number	Validity	DL	DP	Acceptance
2b	0.790 (High)	0.528 (Moderate)	0.944 (Excellent)	Used
3b	0.819 (Very high)	0.583 (Moderate)	0.722 (Excellent)	Used
4b	0.673 (High)	0.556 (Moderate)	0.556 (Good)	Used
5b	0.582 (Enough)	0.417 (Moderate)	0.389 (Satisfactory)	Used
6b	0.376 (Low)	0.389 (Moderate)	0.333 (Satisfactory)	Revised

Based on Table 3.8 there are ten question accepted and three questions need to revised. As consequences, all the question of written test essay was used after considering the distribution of the argumentation component. So, the two question was revised then included as the instrument with other 10 question of written test essay. In other word the blue print of the written essay test after expert judgment and validation is the same as shown in the Table 3.3. As for the detailed of the instrument used is attached on Appendix B2.

### 3.3.2 Attitude toward Science

In this research, the questionnaire developed by SITASI was adopted to determine students' attitude toward science. The questionnaire is made up of 32 statements in the form of Likert scale. There are five scales where 5 stands for 'strongly agree,' 4 stands for 'agree,' 3 for 'neutral,' 2 for 'disagree,' and 1 for 'disagree.' Meanwhile, for the negative statement, the arrangement was vice versa. The 32 statements covered five sub-scales of the attitude toward science including attitude, unfavorable outlook, control beliefs, behavioral beliefs, and intention. The blue print of the ATSQ sub-scale is shown in Table 3.9

Table 3.9

The Blueprint of ATSQ Sub-scale

Attitude toward Science Questionnaire Sub-Scale	Questions	Total	Percentage (%)
Attitude	1,3,8,9,11,15,16,21,24	9	28.12
Unfavorable Outlook	2,6,7,10,12,25,27,30,31	9	28.12
Control Beliefs	5,18	2	6.25
Behavioral Beliefs	13,19,22,26,28,32	6	18.75

Attitude toward Science Questionnaire Sub-Scale	Questions	Total	Percentage (%)
Intention	4,14,17,20,23,29	6	18.75
Total		32	100

Even though, the questionnaire used was adopted from the previous study, the questionnaire also validated by two experts. The revision for the phrases of the statements followed the expert judgment. As the result, the questionnaire of attitude toward science is shown in Table 3.10.

Table 3.10

## The Statements of Attitude toward Science Questionnaire

No.	Question	SD	D	N	A	SA
1.	I really enjoy science lessons					
2.	Learning science is not essential for my future success					
3.	We do a lot of exciting activities in science class					
4.	I will study science if I get into a university					
5.	I am sure I can do well on a science test					
6.	Scientific discoveries do more harm than good					
7.	I usually give up when I do not understand a science concept					
8.	Science is one of the most exciting school subjects					
9.	My science teachers are excellent					
10.	I will not pursue a science-related career in the future					
11.	I like to watch TV programs about science					
12.	I cannot understand science even if I try hard					
13.	Science is helpful in solving everyday life problems					
14.	I will become a scientist in the future					
15.	I look forward to science activities in class					
16.	I really enjoy science lessons					
17.	I will continue studying science after I leave school					
18.	I am confident that I can understand the science					
19.	We live in a better world because of science					
20.	I would enjoy working in a science-related career					

No.	Question	SD	D	N	A	SA
21.	I will miss studying science when I leave school					
22.	Knowing science can help me make better choices about my health					
23.	My family encourages me to have a science-related career					
24.	I really like science					
25.	If I could choose, I would not take any more science in school					
26.	Knowledge of science helps me protect the environment					
27.	Scientific work is only valuable for scientists					
28.	Science will help me understand the world around me					
29.	I will take additional science courses in the future					
30.	Science lessons are a waste of time					
31.	Scientists do not have enough time for fun					
32.	People with science-related careers have an everyday family life					

(Source: Abd-El-Khalick, Summers, Said, Wang, & Culbertson, 2015)

### 3.4 Research Procedure

Research procedures in this study will be carried out in three stages. The stages are preparation; implementation; and the completion stage. The three stages will be explained as follows:

#### 3.4.1. Preparation Stage

In the preparation stage, the researcher focuses on defining the problem and finding more references. The activity in the preparation stage is explained below:

- 1) Problem investigation by reading journals and articles related to socio-scientific issue-based learning, argumentation skills, and attitude toward science.
- 2) Selecting the specific topic to be addressed in this research by considering several components will improve the strength of the research such as:
  - a. The curriculum used in the targeted school and the topic chosen must be appropriate for the variables being investigated.
  - b. Learning instruments that are appropriate to be applied to the students that are based on literature reviews on argumentation skills and attitude toward science.



- c. Teaching schedules in the school to plan the lessons that need to be integrated with the treatment.
- 3) Finding many studies as literature review which have the same variable such as about SSI-BL, argumentation skills, attitudes toward science, and the topic. The form of literature mostly from article or journal, but there is some book also to strengthen the argument
- 4) Construct the instrument as tools to gather data. There are written essay test and questionnaire to obtain the for the pre-test and post-test.
- 5) Construct the lesson plan that used as the instructional tools to help the implementation of the treatment.
- 6) Instruments are judged by experts.
- 7) Revise research instruments based on experts' judgments.
- 8) The objective test on the validity, reliability, difficulty level, and discriminating power of the. The trial test is taken by students that have previously learned the energy resource topic.
- 9) Revise the written essay test based on the result of the trial test

### **3.4.2. Implementation Stage**

The implementation of SSI-BL with Lucidchart is conducted in online due to the pandemic COVID-19. The implementation was conducted in two meeting. The first meeting focus on the students' understanding in energy resource and skills training to make argumentation map by using Lucidchart. As for the second meeting focus on presentation of argumentation map. The complete lesson activity can be seen in the lesson plan in the Appendix A1. The pre-test given before the first meeting conducted, while the post-test given after the second meeting has been done. Both pre and posttest were distributed online by giving the link of the test. Overall, the implementation stage aims to get the data for the research and observe the learning situation.

### **3.4.3. Completion Stage**

This stage explains the completion phase after the data are all obtained and gathered, those details are as followed:

- 1) Analyze the data that has been gathered statistically depending on the type of instrument
- 2) Generating the discussion to elaborate on the findings of the study with the theory
- 3) Construct conclusion and recommendation based on the result and discussion

As indicated in Figure 3.1, the researcher created a flowchart to develop the study method systemically.

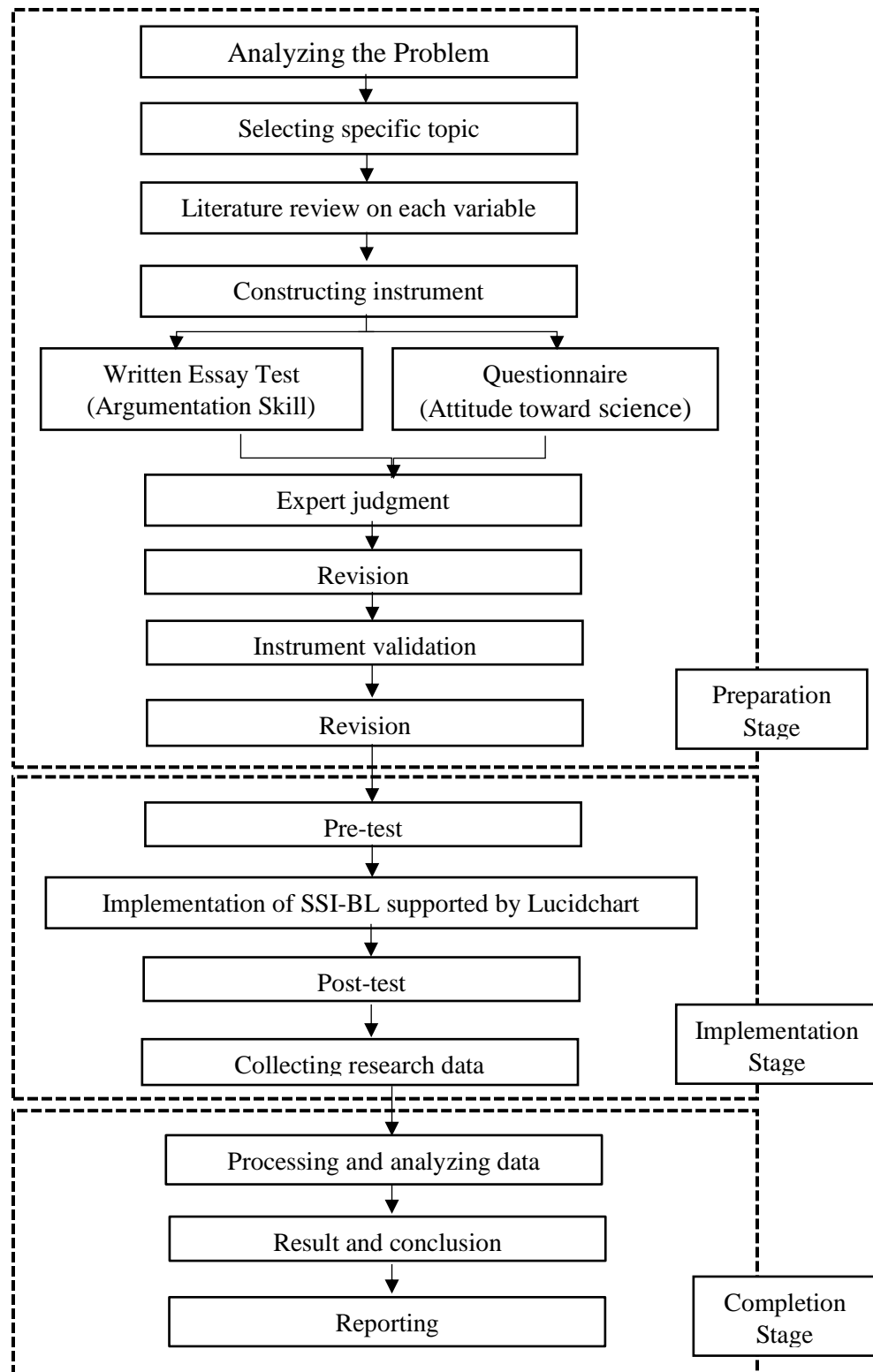


Figure 3.1

## The Flow Chart of The Research Procedure

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### 3.5 Data Analysis

Based on the research question, the data result from pre-test and post-test were obtained quantitatively. The findings revealed that following intervention toward students' argumentation skills and attitude toward science. The steps in processing data from students' argumentation skill and attitude toward science are described below.

#### 3.5.1 Argumentation Skill

The data gained for argumentation skill are quantitative data. After the data was acquired from the written exam essay, it was processed and analyzed using IBM's Statistic Product and Service Solution (SPSS) version 25, which can assist in the accurate processing of statistical data. The following is an explanation of the data processing technique.

##### a. Scoring of the test

To measure students' improvement in argumentation skills, the data gained from the written essay test. The rubric of the argumentation written test used for scoring the argumentation written test for each question. The rubric was adopted from (Chen et al., 2016) by adding two-component of argumentation which are backing and qualifier. As the detailed of the scoring rubric attached in the Appendix B.3 The range of the score used is 0-3, within the score 0 is represents an irrelevant applicable/no answer provided and 3 represents a high level with clear and complete components of argumentation quality.

After scoring of the question has been done, the total score was calculated. The total correct score divided by the maximal score which is 36, then multiplied by 100. Thus, the perfect score will be 100, and the smallest score is 0. Every sample's score was calculated.

##### b. Normality test

The normality test was measured to determine the following data calculation. When the sig. value is greater than 0.05, the data is said to be regularly distributed. A parametric test will be used to assess the data if both the pre-test and post-test data are normally distributed. Meanwhile, a non-parametric test will be employed if the data is not regularly distributed.

### c. Homogeneity test

In order to determine the data is homogeneous or not, a homogeneity test was performed. When the sig. value is greater than 0.05, the data is homogeneous.

### d. Mean difference test

The difference in mean scores between pre- and post-test data can be examined using the mean difference test. The T-Test can be used to test homogenous and evenly distributed data (paired-sample t-test). When the data is not normally distributed but homogeneous, the Wilcoxon signed-rank test can be used.

### e. Calculation of normalized gain score

The N-gain score was calculated to see how the treatment affected students' reasoning skills and attitudes toward science. The difference between the pre-test and post-test can be used to calculate the gain score (Hake, 1998). The normalized increase was then calculated to determine the category in which students' reasoning skills and attitudes toward science improved. According to (Hake, 1998), the formula to calculate the gain score was as follows.

$$N - gain = \frac{Post - test\ score - Pre - test\ score}{Maximal\ score - Pre - test\ score}$$

The N-Gain score was calculated the categorized. Table 3.11 describe the interpretation of the N-Gain score.

Table 3. 11

#### Interpretation of Normalized Gain Value Interpretation

Value	Interpretation
>0.70	High
0.70 - 0.30	Medium
<0.30	Low

(Hake, 1998)

### 3.5.2 Attitude toward science

The Attitude toward science questionnaire (ATSQ) was used to obtain the data from pre-test and post-test. As followed the collection of data, it was processed and analyzed using IBM's Statistic Product and Service Solution (SPSS) version 25, which can assist

in the appropriate processing of statistical data. The following is an explanation of the data processing technique.

**a. Scoring of the test**

Considering the questionnaire using the Likert Scale, the score is in lined with the stand. The score of 5 stands for ‘strongly agree,’ 4 stands for ‘agree,’ 3 for ‘neutral,’ 2 for ‘disagree,’ and 1 for ‘disagree.’ Meanwhile, for the negative statement that is in unfavorable outlook sub-scales, the arrangement of the score was vice versa. As for the maximal score is 5 which multiplied by the number of the statement, which is 160. The score of the students will determined by divided the total score for all statement have been choose with the maximal score, then multiplied by 100. Thus, the perfect score will be 100, and the smallest score is 0.

**b. Normality test**

The normality test was measured to determine the following data calculation. Data can be called normally distributed when it meets the requirement of the sig. value is more than 0.05. A parametric test will be used to assess the data if both the pre-test and post-test data are normally distributed. Meanwhile, a non-parametric test will be employed if the data is not regularly distributed.

**c. Homogeneity test**

A homogeneity test was conducted in order to determine whether the data is homogeneous or not. The data is homogeneous when the sig. value is more than 0.05.

**d. Mean difference test**

The mean score difference between pre-test and post-test data can be investigated using the mean difference test. A parametric test, the paired sample t-test, can be used to test data that are homogeneous and regularly distributed. Meanwhile, a non-parametric test, the Wilcoxon signed-rank test, can be employed when the data are not normally distributed but are homogeneous. In addition, the result of mean score could be categorized in order to the determine the category of the data. According to (Riduwan form Rockyane & Sukartiningsih, 2018) the interpretation of the percentage formulation. Then, the result from percentage calculation is categorized into certain category as shown in Table 3.12.

Table 3.12

Interpretation of Percentage Formulation	
Percentage (100%)	Category
0 – 20	Very Not Good
21 – 40	Not Good
41 – 60	Moderate
61 – 80	Good
81 – 100	Very good

(Source: Riduwan from Rockyane & Sukartiningsih, 2018)

e. Calculation the normalized gain (N-Gain) score

In order to investigate the effect of the treatment on students' argumentation skill and attitude toward science, the gain of both of the data was calculated. The gain score can be obtained from the differences between pre-test and post-test (Hake, 1998). The normalized gain was then calculated to determine the category of students' improvement in argumentation skill and attitude toward science. According to (Hake, 1998) the formula to calculate the gain score was as follows.

$$N - gain = \frac{Post - test\ score - Pre - test\ score}{Maximal\ score - Pre - test\ score}$$

The N-Gain score was calculated the categorized. Table 3.13 describe the interpretation of the N-Gain score.

Table 3.13

Interpretation of Normalized Gain Value Interpretation

Value	Interpretation
>0.70	High
0.70 - 0.30	Medium
<30	Low

(Hake, 1998)

### 3.6 Assumption

The assumption that can be defined as the basis of this research includes the following:

- a. Socio-scientific issue based-learning has a common feature, including complex, socially relevant issue, and engage learners in higher thinking process (Sadler et al., 2016). Moreover, in science learning, it presents the issue in the daily problem which is not structured and complex that leads to the multi-perspective problem

that providing student to evaluate, discussion, and encourage representation that will support the claim so that a good argument is formed (Purwati et al., 2019). Besides, facilitating students' in making scientific argumentation, and let them relate with the issue in multiple perspective that makes them engage to the learning process supports the students' attitudes toward science (Hsu et al., 2019). Thus, it is an effective implementation to increase students' argumentation quality and attitude toward science (Atabey et al., 2017)

- b. Lucidchart helps the student in improving student argumentation to reach rebuttal aspect through making argument map since it is a propriety tool and which provided argumentation elements by corresponding shapes, arrows, and definition (Hsu et al., 2018).
- c. Argumentation skill involved students in meaningful learning as it allows learners to give more justification on their understanding and being able to argue scientifically by providing data, and evidence to develop and evaluate the claim or giving the reason for a problem (Erika & Prahani, 2017). Thus, students able to make-decision, ethical considerations, assessing a claim, and more develop their critical thinking skills by delivering the problems related to scientific issues.
- d. Attitudes toward science might influenced by the student's perceptions as it connected between the science and society (Pelch & McConnell, 2017). As students obtained the multiple perspective, it makes students' easy to relate with the context of sustainability.

### **3.7 Hypothesis**

The hypothesis that would be tested in this study are as following:

- a.  $H_0$ : There is no improvement in students' argumentation skills after implementing SSI-BL by using Lucidchart in energy resource topics.  
 $H_1$ : There is improvement in students' argumentation skills after implementing SSI-BL by using Lucidchart in energy resource topics.
- b.  $H_0$ : There is no improvement in students' argumentation skills after implementing SSI-BL by using Lucidchart in energy resource topics.



H<sub>1</sub>: There is improvement in students' argumentation skills after implementing SSI-BL by using Lucidchart in energy resource topics.

### 3.8 Operational Definition

To summarize and avoid any misconception about this research, the operational definitions are stated. The following are an operational definition of this research:

- a. Socio-scientific Issue-Based Learning (SSI-BL) is a learning approach in which learning and teaching processes are planned using a variety of real or near-real circumstances containing socio-scientific aspects (Yapıcıoğlu & Kaptan, 2017). The framework of SSI-BL based on (Presley et al., 2013) are implemented. The issues of coal energy in Indonesia becomes the context for opening the class. The issues could help students to identify the problem of energy resource and lead them to decide the alternative energy that would be effectively used in the future. Besides, the students asked to construct and present the argumentation map in order to facilitating the higher order practices that would influence to the students' outcome.
- b. Lucidchart is a website for visual workspace with provided powerful diagramming that will be used to make an argument map. In this research, students provide several features from the website to visualize their argument through the argument map they have made. Therefore, the students have to present their argument map to trained them the desired skill of this research.
- c. Argumentation skill is carried out individually which providing scientific evidence or as a form of communication ideas to conclude multiple alternatives as they visualizing, they argument through argumentation map. In order to determine the improvement of students' argumentation skill, the written test essay that cover six components of argumentation given to the students. There are 12 questions regarding to energy resources that covered six components of argumentation. In other words, each component of argumentation skill is determined by two question.
- d. The word "attitudes toward science" refers to a broad, long-term, positive or negative scientific outlook (Zeidan & Jayosi, 2014). In this research, the positive students' attitude toward science expected to improve due to the learning activity

conducted by the students. In order to determine the improvement, the attitudes towards science questionnaire adopted from (Abd-El-Khalick et al., 2015) used. The students' attitude toward science determine individually. Besides, the students' participation during the treatment of SSI-BL supported by Lucidchart are observe to determine the effect during the treatment.