

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Design

The purpose of the research are to investigate the students' science inquiry skill and students' concept mastery with the implementation of web-based inquiry learning. The study use pre-experimental design with one posttest group design for inquiry skills and pre-posttest design for concept mastery. The aim of pre experimental method is to determine the possible cause and effect of the independent and dependent variables (Creswell, 2012).

When a treatment is implemented (or an independent variable is modified) and then a dependent variable is measured once after the treatment is implemented, it is referred to as a one-group posttest only design (Creswell, 2012). The research design is shown in Table 3.1

Table 3.1 Posttest design only (science inquiry skills)

X	O ₁
Treatment	Post-test

Known:

X: Treatment (implementation of WBIL)

O₂: Condition after treatment (final of students' science inquiry skills)

Meanwhile, in a one-group pretest-posttest design is administered when the dependent variables were measure once before the treatment is implemented and once after it has been implemented (Creswell, 2012). The research design is shown in Table 3.2

Table 3.2 Pre-posttest design (concept mastery)

O ₁	X	O ₂
Pre-test	Treatment	Post-test

Known:

O₁: Condition before treatment (initial of students' concept mastery)

X: Treatment (implementation of WBIL)

O₂: Condition after treatment (final of students' concept mastery)

3.2 Population and Sample

This research was conducted in one private school that is located in Bandung Barat. Since this school using the Cambridge curriculum as their curriculum, and using English as a main instructional language during the teaching-learning processes. The population of this research is from 8th grade.

The sampling technique used in this research is convenience sampling. Convenience sampling is when the participants were selected by the researcher because they were willing and available to be studied (Creswell, 2012). In this case, the individuals cannot be said to be representative of the population, but the participant can provide useful information for answering questions and hypotheses (Creswell, 2012). The number of students involved in this research was 29 samples (11 males and 18 females) with an age average of 13-14 years old. The number of students was gained from three classes with the same treatment. Since the requirement school emphasizes that at the same grade they need to be taught by the same treatment and there are consist of 29 students voluntary actively in this research. The distribution participant is shown in Table 3.3

Table 3.3 Participation Distribution

Population	Gender	Experiment Class	
		Number of Students	Percentage
8 th grade	Male	11	37.94 %
	Female	18	62.06 %
	Total	29	100 %

3.3 Research Instrument

To gain the data needed for this research, several types of research instruments were used. The instruments used in this research to gain the data is shown in Table 3.4

Table 3.4 The Research Instrument Used to Obtain the Data

Data Required	Instrument Used
Students' science inquiry skill	Observation sheet, Web-based Inquiry learning platform, Worksheet, Rubric
Students' concept mastery	Objective test

Each of these instruments has its purpose. **First**, the observation sheet used as an instrument to observe the activity conducted by the researcher was appropriate with the strategies employed, the observer for this activity was observed by the teacher from the school. This instrument is developed through the lesson plan has been designed and the teacher as an observer will check the appropriateness strategies based on the observation sheet. **Second**, WBIL application used as a platform to investigate the students' answers on that website to assess the inquiry skills (formulate question, hypothesis, make conclusion). **Third**, worksheet used as a file to support the WBIL in terms of plan the experiment and analyze the data, this worksheet then need to be uploaded on the WBIL. **Fourth**, the rubric used as a guidance to categorized the students' science inquiry skills that will be interpreted from the highest to the lowest score. **Fifth**, in the students' concept mastery the objective test used as an instrument to investigate the differences before and after the implementation of WIBL which are consists of 25 multiple choices and was conducted using google form.

3.3.1 The Implementation of Web-Based Inquiry Activity

The observation sheet contains several strategies that need to be assessed by the observer. The observer will gave a check mark for the strategy that has been delivered by the researcher during the implementation. The strategy is based on the lesson plan that has been designed by the researcher. This observation sheet is used to ensure that the whole implementation of the learning processes is confirmed to the aspects of WBIL. The summary of observation sheets can be seen in Table 3.4. While the whole of the observation sheet can be seen in the Appendix B.

Table 3.5 The observation sheet of implementing web-based inquiry activity

Step	Learning Experiences	Time Allocation	Acceptance	
			Yes	No
Introduction	<ul style="list-style-type: none"> Teacher and students entering the zoom meeting Teacher open the class by greet the students and say basmalah Teacher check the attendance from zoom meeting 	5 minutes		
Main Activities	<ul style="list-style-type: none"> Teacher inform the students to pay attention and take a notes to the instruction because there will be an introduction of web-based inquiry Teacher give the link of the web and the class code to students. Teacher explain how to use the web-based inquiry. In the middle of introduction, teacher ask the students if there is some question Teacher continue to explain how to use the website until the end. Students sign up their account and joining the class Students are asked to fill the questions in website. The phases of inquiry learning started here. <ol style="list-style-type: none"> Formulating questions: Teacher let the students watched the video on the website, and when it is done, teacher inform to formulate questions in the web Formulate hypothesis: Teacher inform the students to read the sources in the website, after that, students 	50 minutes		

Step	Learning Experiences	Time Allocation	Acceptance	
			Yes	No
	<p>try to formulate the hypothesis. Teacher monitoring in the website</p> <p>3) Planning experiment: Teacher inform the students to open the worksheet in google classroom, and let them to design the experiment that has been mentioned</p> <ul style="list-style-type: none"> Teacher always monitoring the students' work in the website and zoom meeting. 			
Closing	<ul style="list-style-type: none"> Teacher inform the rest of web activity will be conducted into two meetings and inform it as assignment Teacher inform the students to do the live experiment in their home and record the data into worksheet. Teacher ask whether there is some questions Teacher close the meeting by saying hamdalah 	5 minutes		

3.3.2 Science Inquiry Skill Rubric

The Science inquiry skill of the students will be assessed through the rubric adapted from Ješková et al (2018) and Wenning (2007). The instrument used in this research is the WBIL platform and the worksheet given by the researcher. The quality of students' science inquiry skills is limited into five skills, consist of formulating the question, formulating a hypothesis, planning an experiment, analyzing the data, and making conclusion will be categorized based on the

recapitulation score from the rubric has been designed. The rubric for assessing the students' skills is shown in Table 3.6

Table 3.6 Science Inquiry Skill Rubric

Stage of Inquiry	Skills	Score				
		1	2	3	4	5
Research question formulation	Formulate relevant question based on the provided video	Formulate question incorrectly, not really relevant, unclear sentences	Able to formulate question correctly, not really relevant, and unclear sentences	Able to formulate question correctly, not really relevant, and 1-2 words sentences not really clear	Able to formulate question correctly, relevant, but 1-2 words sentences not really clear	Able to formulate question correctly, relevant and use clear sentences
	Formulate relevant hypothesis based on digital reference exploration	Formulate hypothesis incorrectly, not really relevant, unclear sentences	Able to formulate hypothesis correctly, not really relevant, unclear sentences	Able to formulate hypothesis correctly, not really relevant, and 1-2 words sentences not really clear	Able to formulate hypothesis correctly, relevant, but 1-2 words sentences not really clear	Able to formulate hypothesis correctly, relevant, and use clear sentences
Planning Experiment	Design the Procedures of the experiment relevant with the questions and hypothesis that has been formulated	Formulate experiment incorrectly, not really relevant, and all of the steps are missed	Able to formulate experiment correctly, not really relevant, and half of the steps are missed	Able to plan experiment correctly, relevant, but half of the steps are missed	Able to plan experiment correctly, relevant, but 1-2 steps are missed	Able to plan the experiment correctly, relevant, and design with complete steps
Analyzing the data	Collect data from observation and transfer into table	Unable to transfer the data into table, missed the data, incorrect calculation, and does not state the units	Able to transfer the data into table, missed the data, incorrect calculation, and does not state the units	Able to transfer the data into table, complete all the data, incorrect calculation, and does not state the units	Able to transfer the data into table, complete all the data, correct calculation, but does not state the units	Able to transfer the data into table, complete all data, correct calculation, and state the units
	Discuss the result from experiment and observation	Able to explain the result correctly but missed 4 questions, and use unclear sentences	Able to explain the result correctly but missed 3 questions, and use clear sentences	Able to explain the result correctly but missed 2 question, and use clear sentences	Able to explain the result correctly but missed 1 question, and use clear sentences	Able to explain all the result correctly, relevant, and use clear sentences

Stage of Inquiry	Skills	Score				
		1	2	3	4	5
Making conclusion	Conclude the data from observation and measurement	Unable to Conclude the data correctly, not relevant, and use unclear sentences	Able to conclude the data correctly, not really relevant, and unclear sentences	Able to conclude the data correctly, not really relevant with hypothesis, and 1-2 words sentences not really clear	Able to conclude the data correctly, relevant with hypothesis, but 1-2 words sentences not really clear	Able to conclude the data correctly, relevant with hypothesis, and use clear sentences

3.3.2.1 Instrument Development and Analysis

The rubric of students' science inquiry skills was judged by the experts as confirmed in Appendix A, so that the rubric is acceptable and sufficient to be used as the research instrument to analyze the science inquiry skill. The rubric was used to determine the skills through the answer on the WBIL and the worksheet. After the score of the questions is obtained, it will be calculated and interpreted to determine the category level. The minimum score (KKM) that is used is 50 for biology subjects. This minimum score is adapted from the Cambridge curriculum used in this school. This pre-requisite score is used as a reference to make an interval score for the science inquiry skill using WBIL as a media of teaching and learning process. The criteria for the interpretation is shown in Table 3.7

Table 3.7 Score interpretation of Science Inquiry Skill

Interval Score	Interpretation
84-100	High
68-83	Sufficient
52-67	Low

(Al-Irsyad Satya Islamic Report Book Regulation, 2021)

3.3.3 Objective Test

The objective test was used in this research to measure the students' concept mastery on the coordination and response topic. The objective test consists of 25 multiple choices questions, consisting of C1 (Remembering), C2 (Understanding), C3 (evaluation, and C4 (Applying). This cognitive domain was adapted to the core

Cambridge curriculum, and school's regulation. These test items have been judged by several experts who is related to the field as confirmed in Appendix A. The objective test has been tested on students who have learned the topic from another school to see the quality of research instruments in terms of validity, reliability, discriminating power, and difficulty level. After passed the judgment process, the result was accepted, revised, or deleted to get the appropriate objective test for the research. The blueprint of the test item is shown in Table 3.8

Table 3.8 Blueprint of an objective test (before revision)

No	Subtopic of Coordination and Response	C1	C2	C3	C4	Total
1	Describe the CNS and PNS in human nervous system	1,2,3	25			4
2	Describe the voluntary and involuntary action		5		4,6,7	4
3	Describe the sequence of Reflex Arc	9	10,12,13	8,14,24	11,21	9
4	Describe the types of neurons	15,16	17,18,22,23			6
5	Describe the structure of neurons	19	20			2
Total		7	10	3	5	25
Percentage		28%	40%	12%	20%	100%

3.3.3.1 Instruments Development and Analysis

An objective test is used in this study to assess students' concept mastery. To be validated before the pre-test and post-test, some analysis is required. Before being validated and tested on students, the objective test was judged by experts. The validation of instrument analysis consists of validity, reliability, level of difficulty, and discriminating power.

1) Validity

Validity refers to the accuracy, usefulness, appropriateness, and significance of a given result (Fraenkel, 2012). This test was used to test the validity of the objective test to investigate the question capable of measuring the concept mastery or not. In order to determine the validity value, the

software that is used in this research is ANATES. The validity value interpretation are shown in Table 3.9

Table 3. 9 The Interpretation of Validity Value

The amount of r value	Interpretation
$0,80 < r \leq 1,00$	Very high
$0,60 < r \leq 0,80$	High
$0,40 < r \leq 0,60$	Enough
$0,20 < r \leq 0,40$	Low
$0,00 < r \leq 0,20$	Very low

(Minium et al., 1993)

2) Reliability

Reliability may be characterized as a test outcome's stability, reliability or accuracy. The consistency of the respondent in responding question in the test item (Bonett & Wright, 2015). The reliability category interpretation is shown in Table 3.10

Table 3. 10 The interpretation of Reliability Value

Gained r value	Interpretation
0,80-1,00	Very High
0,60-0,79	High
0,40-0,59	Prosperous
0,30-0,39	Low
0,00-0,19	Very low

(Tilastoseura, Finnish, & Society, 2000)

3) Difficulty Level

The difficulty level in this study refer to the degree of difficulty in answering the questions for students, which is not from the viewpoint of the teacher. The difficulty level can be determined by dividing the number of students who are able questions correctly with the total number of students who participate in the test Chauhan & Bhoomika, 2013). The interpretation value of difficulty level is shown in Table 3.11.

Table 3.11 Interpretation Value of Difficulty Level

Value of Difficulty Index	Interpretation
0,00 – 0,30	Difficult
0,30 – 0,70	Medium
0,70 – 1,00	Easy

(Cohen et al., 2008)

4) Discriminating Power

Discriminating power is used to classify things based on how likely high-scoring examiners are to react properly and how unlikely low-scoring examiners are to react properly (Backhoff, Larrazolo & Rosas, 2015). The category of discriminating power are shown in Table 3.12

Table 3.12 Discriminating Power Interpretation

D Value	Interpretation
$0,00 < D \leq 0,20$	Poor
$0,20 < D \leq 0,40$	Satisfactory
$0,40 < D \leq 0,70$	Good
$0,70 < D \leq 1,00$	Excellent
D = Negative	Question is deleted

(Exhcoba & Reyna, 2015)

5) Distractor

Distractor is part of the option which offer the incorrect alternative option to distract the students with the wrong option. To find out the number of distractor in every question can be done by measure the number of students who select the wrong answer.

3.3.3.2 Instrument Development and Analysis Result

The objective test was built in several stages, starting with the adaptation of the school curriculum, followed by expert judgment and validation. Further, the validity, reliability, difficulty level (DL), discriminating power (DP), distractor power of the objective test were all used to analyze it. The reliability for this test item gain 0.8 (very high) and the recapitulation of objective test analysis shown in Table 3.13

Table 3.13 The recapitulation of Objective Test Analysis

Number	Validity	DL	DP	Acceptance
1	High	Easy	0,66 (Good)	Used
2	High	Medium	0,77 (Excellent)	Used
3	Enough	Medium	0,44 (Good)	Need Revision
4	Enough	Easy	0,11 (Poor)	Used
5	High	Easy	0,55 (Good)	Used
6	Low	Medium	0,55 (Good)	Used
7	Enough	Easy	0,22 (Satisfactory)	Used
8	Low	Medium	0,55 (Good)	Need Revision
9	Very low	Medium	0,11 (Poor)	Need Revision
10	Enough	Medium	0,66 (Good)	Used
11	Very low	Hard	0 (Poor)	Need Revision
12	High	Medium	0,66 (Good)	Used
13	Low	Medium	0,55 (Good)	Used
14	Enough	Medium	0,11 (Poor)	Need Revision
15	Low	Easy	0,33 (Satisfactory)	Need Revision
16	Enough	Medium	0,55 (Good)	Used
17	Very low	Medium	0,11 (Poor)	Need Revision
18	Low	Medium	0,66 (Good)	Used
19	Enough	Easy	0,33 (Satisfactory)	Used
20	Low	Medium	0,33 (Satisfactory)	Used
21	Enough	Medium	0,66 (Good)	Used
22	Very low	Medium	0,11 (Poor)	Need Revision
23	Enough	Medium	0,66 (Good)	Used
24	Low	Easy	0,55 (Good)	Used
25	Enough	Easy	0,33 (Satisfactory)	Used

The test item judgment by several experts as confirmed in Appendix A after the objective test has been analyzed, judged and validated in terms of validity, reliability, discriminating power, difficulty level, and distractor. From this analysis, all of the question can be used as an objective test but there are several questions need to be revised. Afterward, the final test item will be used as an objective test for this research to measure the students' concept mastery. The new blueprint of test item is shown in Table 3.14

Table 3.14 Objective test blueprint (after revision)

No	Subtopic of Coordination and Response	C1	C2	C3	C4	Total
1	Describe the CNS and PNS in human nervous system	1,2,3,9	25	8		6
2	Describe the voluntary and involuntary action		5,7		4,6	4
3	Describe the sequence of Reflex Arc		13	10,14,2 4	11,12,2 1	7
4	Describe the types of neurons	15, 16	17,22,2 3	18		6
5	Describe the structure of neurons	19	20			2
Total		7	8	5	5	25
Percentage		28%	32%	20%	20%	100%

3.4 Research Procedure

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

1) Preparation stage

Before doing the research, the author need to analyze all of the variables in this study in the beginning. The following is an explanation of the research preparatory stage:

- a. Investigating research problem
- b. Identifying the research objective
- c. Deciding the research variables and research strategy
- d. Conducting the literature review of the variables: web-based inquiry, inquiry based learning, concept mastery, and the coordination and response topic
- e. Designing research instrument: Worksheet, rubric, and objective test, and designing the strategy: lesson plan
- f. Validating the instruments to the experts
- g. Revise the research instruments based on the experts' judgment and students' validation result

2) Implementation Stage

At this point, the author began conducting research in order to gather the data. The following is an explanation of the research implementation stage:

- a. Deciding the research subject
- b. Conducting pre-test to investigate the initial score
- c. Implementing treatment using web-based inquiry
- d. Conducting post-test after treatment.

3) Completion Stage

At this point, the data collection was analyzed. The following is an explanation of research completion stage.

- a. Analyzing the data gained using SPSS and Microsoft excel
- b. Discussing the result based on data gained
- c. Drawing conclusion based on data gained

The flowchart of this research are derive as shown in Figure 3.1.

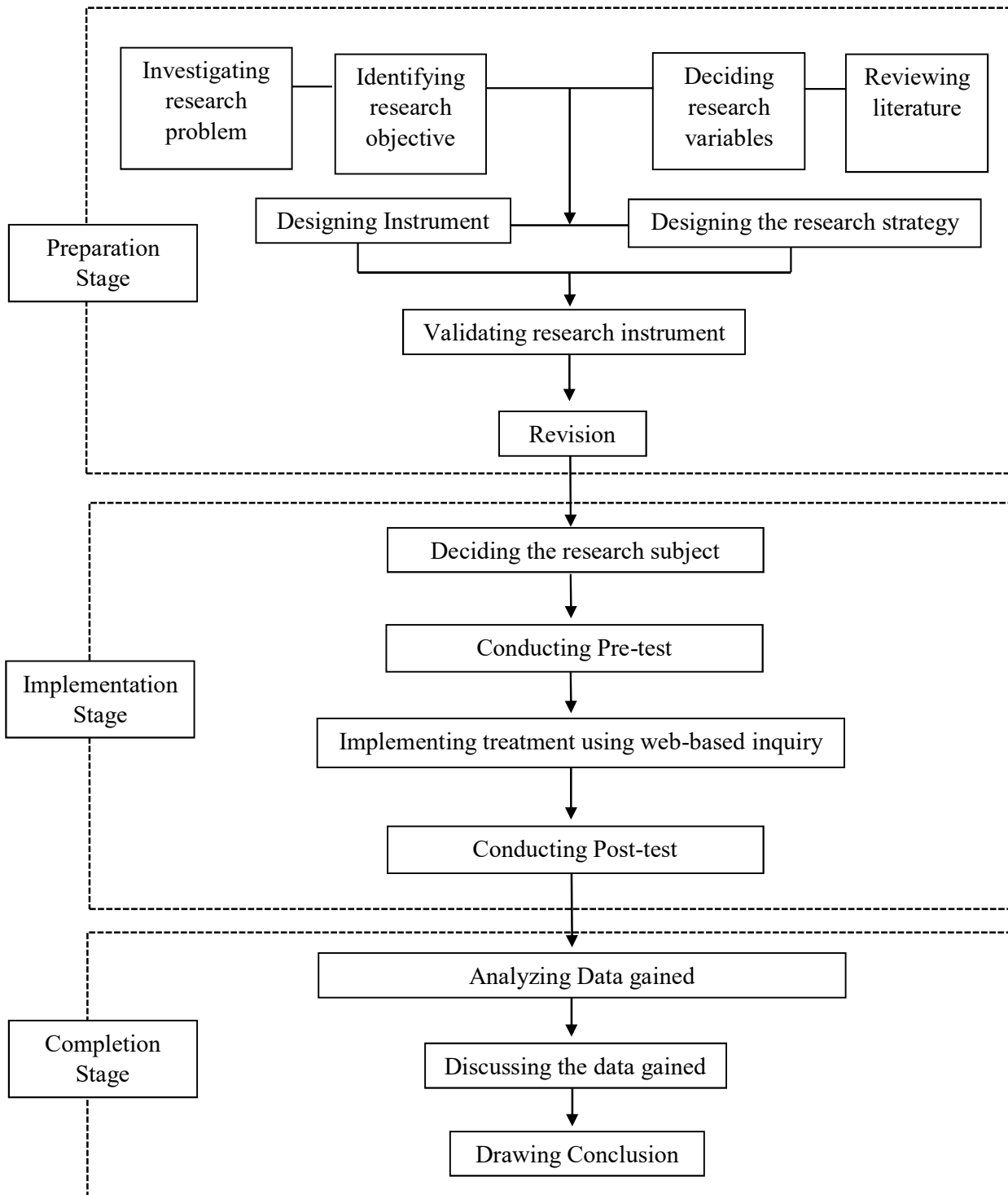


Figure 3. 1 Flowchart of the research

3.5 Data Analysis

3.5.1 Science Inquiry Skill

1) Scoring of the test

The data collected from the worksheet and the answer in the WBIL. The perfect and complete answer will gain 5 points, the imperfect and incomplete answer will gain 1 point. This point will be divided by maximum total score and multiplied by 100, so the score will turn into 100 for maximum score. The score is determined from students' science inquiry skills adapted from Ješková et al (2018) and Wenning (2007). To summary, the score will be calculated using the formula below:

$$Score = \frac{Total\ Score\ Gained}{Maximum\ total\ score} \times 100$$

2) Statistical Descriptive Analysis

To make the data well organized, the data will be analyzed by statistical descriptive analysis. According to (Minium et al., 1993) the purpose of descriptive statistics is to organize and to summarize observations so that they are easier to comprehend. The research data can be included number of the data, maximum score, minimum score, mean, etc. Depends on the needs of the researcher

3.5.2 Objective Test

The data gained for students' concept mastery is quantitative data. After the data was collected using the objective test, it was processed and analyzed using SPSS IBM Version 25, which can help to process statistic data accurately. The explanation of the data processing technique is described as follows:

1) Scoring of the test

The results from the objective test was used to assess the students' improvement in conceptual mastery. The total score was calculated by sum the number of correct answers. After that, it was divided by maximum score

and multiplied by 100. The highest score is 100, meanwhile the lowest score will be 0.

2) Statistical Descriptive Analysis

The purpose of descriptive statistics is to organize and to summarize observations so that they are easier to comprehend. The research data can be included number of the data, maximum score, minimum score, mean, etc. Depends on the needs of the researcher (Minium et al., 1993).

3) Normality test

The normality test was measured to determine the sample data. The normality test may also be used to evaluate if an unintentional variable in a data collection is likely to be normally distributed (Mohd Razali & Bee Wah, 2011). The data is normally distributed if the significant value more than 0.05 (sig. > 0.05). If the data is normally distributed, the data will be analyzed using a parametric test. Meanwhile, if the data was not normally distributed, it will be analyzed using a non-parametric test. Based on this research the data was normally distributed because the sig.value > 0.05

4) Homogeneity test

To determine the homogeneous of data, the homogeneus test was used and checked. The data is homogeneous if the significant value more than 0.05 (sig. > 0.05). Based on this research, the data was homogenous because the sig value > 0.05

5) Paired sample t-test

The paired sample t-test was measured to compares the means of two measurements taken from the same individual in the pre-test and post-test. The data can be said there is a significant difference if the sig value (2-tailed < 0.05). The data also normally distributed and homogeneous, therefore, this research used paired sample t-test for measuring the significant difference.

3.6 Assumption

The following are some of the assumptions that might be used to describe the research's foundation:

1) Inquiry-based teaching has been the most recommended approach in science education for decades because its strategies are student-centered, independent, conducting investigations to find the answer by proving it (Zhou & Xu, 2017).

2) Web-based inquiry scientific environment is a platform for students to collaborate on inquiry-based science projects using evidence and resources from the Internet (Manoj & Devanathan, 2010).

3) Web-based e-learning courses, web-centric courses, and web-enhanced courses can help students develop the three criteria for digital literacy: fundamental media skills, critical knowledge of advanced media, and communication abilities (Setyaningsih et al., 2019).

3.7 Hypothesis

The hypothesis that is tested in this research are stated as follows:

H₀: There is no difference on students' concept mastery after implementing web-based inquiry on the coordination and response topic

H₁: There is a difference on students' concept mastery after implementing web-based inquiry on the coordination and response topic

3.8 Operational Definition

The operational definition of this research is used to prevent the misconception and misunderstanding in this research, the operational definitions of this research were clarified as follow:

1) Web-Based Inquiry Learning

In this research, the website used is developed by Yasin (2020) named Web-Based Inquiry Learning (WBIL), this website can be accessed through this link <http://learn-app.ddns.net/>. The phases of inquiry students can be measured using the WBIL based on the questions provided in the website. Included research question formulation, hypothesis formulation, experiment plan, collecting data, and making conclusion. The data gained by scoring the students' answer on the website using rubric adapted from Ješková et al (2018) and Wenning (2007). The website used *bahasa Indonesia* as an

instructional, but according to the regulation from the school, the students were asked to answer the questions using English.

2) Students' Science Inquiry Skill

There are five phases of guided inquiry skill adapted from Ješková et al (2018) and Wenning (2007), which will be analyzed into science inquiry skill. The students' inquiry skill will be analyzed based on their answer in the WBIL and the worksheet provided by the researcher. In details, the worksheet measure how the students design the experiment and analyzing the data, while in the web it measures how the students formulate question, hypothesis, and making conclusions. The scoring will be given for students' answer based on the rubric.

3) Students' concept mastery

In this research, the students' concept mastery will be identified using 25 multiple choice number of the test items. This test items was worked as the research instrument to see the impact before and after implementing the WBIL during the learning processes. The test items consist of pretest and posttest, with cognitive domain based on Bloom's Taxonomy revised version. According to Anderson & Krathwohl (2001) the cognitive domain consist of C1 (Remembering), C2 (Understanding), C3 (Evaluating), and C4 (Applying), C5 (Evaluating) and C6 (Creating). In this research, the cognitive level used from C1 until C4 based on the core in the syllabus of IGCSE (Cambridge curriculum) and schools' regulation.