CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method

This research was conducted use quantitative research method. The researcher identifies a research problem in quantitative research based on trends in the field or the desire to explain why something happens (Creswell, 2012b). Quantitative Research Methods can be used in both intervention and non-intervention studies. Intervention research usually has a goal of explaining the impact of intervention on two opposing groups. While research without intervention may explain the relationship between two variables in one group of subjects based on the pattern observed, or describe the tendency of a population, research with intervention may explain the relationship between two variables in another group of subjects based on the pattern observed. The method also collects data using an instrument with questions and replies that may be measured or witnessed. After then, the data will be examined using statistical processes (Creswell, 2012a). This research include to the non-intervention research.

The research design used is survey research design. According to Creswell (2012), in survey research design, the researcher must administer a survey to a sample to describe the population's views, beliefs, behaviors, or traits. The survey design may be appropriate since it considers all of the procedures needed in conducting a survey on a phenomenon to be examined (Kothari, 2004).

Survey research entails using instruments such as interview questions, questionnaires, and tests to describe the characteristics of a group (Fraenkel, Wallen & Hyun, 2011). Students' performances in scientific attitude domains and scientific literacy aspects were profiled using two instruments in the form of a written test. The information was gathered using Google Form, an online survey platform.

3.2 Population and Sample

The population can be describing as members of the human race, animal, events, or entity that reside together in one location and deliberately become the final focus of the results of the analysis. This research used stratified random sampling. In stratified sampling, researchers divide (stratify) the population based on a given attribute (e.g., gender) and then take a sample from each subset (stratum) of the population using simple random sampling (e.g., females and males). This ensures that the sample contains specific traits that the researcher desires (Creswell, 2012a).

The target population of this research is 9th grade of junior high school students from private school in Bandung City and public school in Kuningan. As the aim of this research to describe the scientific attitude and scientific literacy of 9th grade junior high students on Learning biotechnology. The limitation of access for the entire 9th grade of junior high school students from private schools in Bandung City makes the researcher decide to take the sample. All of the schools are officially accredited A and use the Indonesian National Curriculum.

In the stratified random sampling for this study, the first stratum of the selected research sample is focused on high school students. The second stratum, grade 9, was chosen to be more specific. For the third stratum, not all of the samples in schools in this study were taken, they were taken randomly.

The total of 171 students were involved in this research with an age average 13-14 years old. The distribution participant shown in Table 3.1

Table 3.1

Participant Distribution

Population	School	Gender	Number of Students	Percentage
9th grader	Private	Male	57	33.33%
		Female	45	26.32%
	Public	Male	30	17.54%
		Female	39	22.81%

3.3 Operational Definition

The operational definitions of this research were explained in order to avoid misunderstandings and misconceptions in this research. The operational definitions of this research are as follows:

1) Scientific Attitude

   In this research, Scientific Attitude defined as an attitude that consists of five aspects; curiosity, objectivity, critical thinking, open-mindedness, and perseverance to be measured.

2) Scientific Literacy

   A test with 25 multiple-choice questions and a questionnaire are used to determine scientific literacy. The Learning biotechnology is used in the test. The questions are mostly delivered through articles, photos, and graphs. The test is conducted in Bahasa in order to reach a large number of possible respondents. It is distributed to students via the internet. Using IBM SPSS Statistics 25 and Microsoft Excel, a descriptive analysis is carried out to generate findings.

3.4 Research Instrument

Scientific Attitude domain and Scientific Literacy aspects are measured using two types of research instruments. All of the results are then added together to determine the students' scientific attitude and literacy. Table 3.2 shows the instruments that were used to carry out this research.

Table 3.2

The List of Research Instrument

Data	Instrument
Students' scientific attitude	Questionnaire
Students' scientific literacy	Scientific literacy test, and questionnaire

3.4.1 Students' Scientific Attitude

Questionnaire was used as the research instrument to assess the student's scientific attitude. The test's accessible link are, http://gg.gg/PrivateScientificAttitudeQuestionnaire, http://gg.gg/PublicScientificAttitudeQuestionnaire. The results were then analyzed using SPSS software (version 25) to determine scientific attitude in public and private schools, as well as scientific literacy in public and private schools.

3.4.1.1 Questionnaire

The Scientific attitude of the students were assessed through the questionnaire that is adapted by Harlen in Fatonah & Prasetyo (2014) and Pitafi (2012). The instrument that is used in this research is the statement in questionnaire of scientific attitude. The indicators of the statements posed in the questionnaire has been adapted by the previous researcher. Table 3.3 shows the structure of the statements. Questionnaires can be self-administered or administered by a professional, they can be given individually or in groups, and they usually contain a set of items that reflect the research goals (Ponto, 2015).

Table 3.3

The Initial of Scientific Attitude Questionnaire

No	Dimensions	Indicators	Statement Number
1.	Curiosity	Enthusiastically looking for answers	1,2,3,4,5,6
		Attention to the object being observed	7,8,9 10,11,12,13
		Enthusiastic about the scientific process	
2.	Objectivity	Make decisions according to facts	14,15,16,17
		No prejudice	18,19
		Do not mix facts with opinions	20,21
3.	Critical thinking	Doubt a situation	22,23,24
		Repeating the activities carried out	25,26
		Do not ignore data even if it's small	27,28
4.	Open Mindedness	Respect other people's opinions/findings	29,30,31,32 33,34,35
		Doesn't always feel right	
5.	Perseverance	Repeating the experiment even if it results in failure	36,37,38

	Completing one activity even though the classmate finished early	39,40,41

3.4.2 Students' Scientific Literacy

The competency test and the questionnaire is applied in this research to assess the students' scientific literacy. The test's accessible link are http://gg.gg/PrivateScientificLiteracyTest , http://gg.gg/PublicScientificLiteracyTest . The results were then analyzed using SPSS software (version 25) to determine scientific attitude in public and private schools, as well as scientific literacy in public and private schools. The following are the instruments' descriptions:

3.4.2.1 Competency Test

Students' scientific literacy is assessed through a competency test. On the topic of biotechnology, a competency test is given. Furthermore, the competencies include scientifically explaining phenomena, evaluating and designing scientific inquiry, and scientifically interpreting data and evidence while taking into account content knowledge, procedural knowledge, and epistemic knowledge.

Table 3.4

The Initial Blueprint of Scientific Literacy Competency Test

No	Subtopic/Knowledge Competencies	Explain phenomena scientifically			Evaluate and design scientific enquiry			Interpret data and evidence scientifically		
		C	P	E	C	P	E	C	P	E
1.	Biotechnology and its Development	27								
2.	Application of Biotechnology in Life	4, 5, 7, 9, 10, 17, 18, 20, 21, 22, 28, 29, 30, 31	11, 32, 33, 34	3, 19	14, 26	8, 15	1, 2	12, 13	6, 23	16, 24, 25

To make sure if the test was appropriate to be administered, the test through the reviewing by experts' stage. Three experts joined in the instrument judgment process, and then validated by testing them on students

who had already studied about the learning biotechnology, which included 85 students from various schools in the 9th with 33 students and 10th grades with 52 students. Due to distance learning, the initial test item validation is done online. The question 1 until 22 were distributed to 9th grader student, where the question number 23-34 were distributed to 10th grader student.

Students' validation scores were then evaluated using SPSS 25 to determine their validity, reliability, difficulty level, discriminating power, and distractor. The correlation between item score and total score represents the validity of test items.

3.4.2.2 Questionnaire

In the attitude domain, a questionnaire is used to assess students' scientific literacy. Interest in science, valuing scientific approaches to inquiry, and environmental awareness are all factors taken into account by PISA. Using a Likert-scale, the questionnaire is based on the PISA 2015 assessment and analysis framework.

Table 3.5

Questionnaire on Scientific Literacy Blueprint (Attitude Domain)

No	Aspects	Indicators	Likert Scale			
			1	2	3	4
1.	Interest in Science	Interest in science learning				
2.		Science activities that are focused on the future				
3.		Motivation to learn science				
4.		Science's self-efficacy				
5.		Continue to studies in science outside of the school				
6.		Career orientation				
7.		Science career preparation in school				
8.		Specific careers' occupational prestige				
9.		Out-of-School Science Experiences				
10.		Science's overall value				
11.	Valuing Scientific Approaches to Enquiry	A commitment to the scientific method of enquiry when it's appropriate				
12.		Science's self-efficacy				
13.		A commitment to evidence as the basis for material world explanations.				
14.		Criticism is valued as a technique of determining the validity of any				

		ideas.
15.		Science's self-efficacy
16.	Environmental Awareness	Environmental awareness is important
17.		Environmental awareness is important
18.		Environmental challenges are perceived differently by different people
19.		Environmental challenges are perceived differently by different people
20.		Optimism about the environment

The Likert scale was used to measure the scientific attitude questionnaire used in this study. The Likert scale is used to measure "attitude," which is a scientifically established term (Joshi, Kale, Chandel, & Pal, 2015). The scale was stated in number from 1 to 4 which starts from strongly disagree to strongly agree.

Table 3.6
Scientific Attitude Questionnaire on A Likert Scale

Scale	Criterion	Point
1	Strongly disagree	1
2	Disagree	2
3	Agree	3
4	Strongly Agree	4

In scientific literacy, each scale is a condition for earning the value of the scientific attitude domain, according to Table 3.6. On a scale of one to four, the student strongly disagrees with the statement and receives one point from the determined option. The questionnaire is reviewed by experts with relevant backgrounds in education, notably in science education, to ensure that it is suitable for implementation. Expert judgment results in the form of statements, as well as the requirement for additional information. The number of statements used is still the same with the same indicators, only a few revisions have been made.

3.5 Data Analysis Technique

1) Validity

A given result's validity refers to its accuracy, usefulness, appropriateness, and relevance (Fraenkel, Wallen & Hyun, 2011). This test was conducted to see if the instrument was valid and if the question was capable of measuring scientific literacy competency. SPSS is the program that was utilized in this study to determine the validity value. Table 3.5 shows the validity value interpretation. The formula for determining validity is shown below:

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

Known:

r_{xy}= items correlation coefficient

x = items scores

y = each student's total score

n = the number of subjects

∑x = sum of all students' total scores for each question's item.

∑y = total score of all students on the entire test

(Fraenkel, Wallen & Hyun, 2011)

The validity interpretation is shown in table 3.7 below.

Table 3.7
The Value of Validity and Its Interpretation

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, King & Bear, 1993)

2) Reliability

The stability, reliability, and precision of a test result are all examples of reliability. The constancy of the answer is frequently mentioned. As a result, the following formula may be used to compute the reliability:

$$a = \frac{K}{K-1} 1 - \frac{\sum_{t=1}^{K} \sigma_{Yi}^2}{\sigma_x^2}$$

Known:

K = items numbers

σ_x^2= the difference (square of standard deviation)

σ_{yi}^2 = item variation detected

(Bonett & Wright, 2015)

Table 3.8
Value of Reliability in Interpretation

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

In this study, the difficulty level refers to the degree of difficulty in answering questions for students, not from the perspective of the teacher. The difficulty level is calculated by multiplying the number of students who properly answer questions by the total number of students who take the test (Chauhan & Bhoomika, 2013). This is the formula for determining the level of difficulty:

$$p = \frac{N}{A}$$

Known:

P = Difficulty level

A = Number of students who properly solved the item

N = Number of students who attempted the item in total

Table 3.9
Difficulty Level Interpretation Value

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

(Cohen, Manion & Morrison, 2008)

4) Discriminating Power

Discriminating power is used to categories things based on the likelihood of high-scoring examiners reacting correctly vs the likelihood of low-scoring examiners reacting correctly (Backhoff, Larrazolo & Rosas, 2015). Table 3.8 lists the categories of discriminating power.

Table 3.10
Interpreting Power in A Discriminating Power

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 a component of the option that provides an incorrect alternative option in order to distract students with the incorrect option. The amount of distractors in each question can be determined by counting the number of students who choose the incorrect answer.

3.6 Instrument Analysis Result

The competency test was developed in stages, beginning with the adaption of the school curriculum then continuing with expert judgment and validation. Furthermore, the objective test's validity, reliability, difficulty level (DL), discriminating power (DP), and distractor power were all employed to examine it. Following the analysis, the item reliability score was determined to be 0.68 and 0.70 indicating that it is in high category. Table 3.9 summarizes the results of the objective test analysis.

Table 3.11
The Recapitulation of Competency Test Analysis

Number	Validity	DL (difficulty level)	DP (discriminating power)	Acceptance
1	Enough	Medium	0.50 (Good)	Used
2	Enough	Easy	0.47 (Good)	Used
3	Low	Easy	0.34 (Satisfactory)	Used
4	High	Medium	0.68 (Good)	Used
5	Very Low	Medium	0.14 (Poor)	Need revision
6	Enough	Easy	0.59 (Good)	Used
7	Very Low	Easy	0.12 (Poor)	Need revision
8	Low	Medium	0.37 (Satisfactory)	Used
9	Low	Medium	0.34 (Satisfactory)	Used
10	Enough	Easy	0.42 (Good)	Used
11	Very low	Easy	0.06 (Poor)	Need revision
12	Enough	Easy	0.44 (Good)	Used
13	Enough	Medium	0.47 (Good)	Used
14	High	Easy	0.61 (Good)	Used
15	High	Medium	0.66 (Good)	Used
16	Low	Difficult	0.28 (Satisfactory)	Used
17	Very low	Medium	-0.53 (Question is deleted)	Rejected
18	Very Low	Difficult	0.05 (Poor)	Need revision
19	Low	Medium	0.22 (Satisfactory)	Need revision
20	Low	Medium	0.30 (Satisfactory)	Need revision
21	Enough	Easy	0.37 (Satisfactory)	Need revision
22	Enough	Medium	0.51 (Good)	Used
23	Low	Medium	0.36 (Satisfactory)	Need revision
24	Very Low	Easy	-0.12 (Question is deleted)	Rejected
25	Low	Medium	0.25 (Satisfactory)	Used
26	Very Low	Easy	0.37 (Satisfactory)	Used
27	Low	Medium	0.23 (Satisfactory)	Used
28	Very Low	Medium	0.16 (Poor)	Need revision
29	Very Low	Easy	-0.22 (Question is deleted)	Rejected

Number	Validity	DL (difficulty level)	DP (discriminating power)	Acceptance
30	Very Low	Easy	-0.15 (Question is deleted)	Rejected
31	Low	Medium	-0.05 (Question is deleted)	Rejected
32	Low	Medium	0.22 (Satisfactory)	Used
33	Low	Medium	0.31 (Satisfactory)	Used
34	Very Low	Medium	0.00 (Poor)	Need revision

All of the questions can be utilized as competency tests after the competency exam has been analyzed, judged, and validated, but several questions require change. The final exam item utilized as a competency test after that. The revised ones are considered to be applied based on expert recommendations, competency domains, and subtopic distributions. The final test items were reduced to 25 multiple choice questions with recapitulation as follows. Appendix contains the information.

Table 3.12
Scientific Literacy Competency Test Blueprint (After Revision)

No	Subtopic/Knowledge Competencies	Explain phenomena scientifically			Evaluate and design scientific enquiry			Interpret data and evidence scientifically		
		C	P	E	C	P	E	C	P	E
1.	Biotechnology and its Development	27								
2.	Application of Biotechnology in Life	4, 5, 7, 9, 10, 17, 18, 20, 22, 28	11, 32	3	14, 26	8, 15	1, 2	12, 13	6, 23	16, 25

3.7 Research Procedure

The research procedure is divided into three key stages in order to make this research effectively organized in terms of systematic. Preparation, implementation, and completion are the three primary steps, which described

as follows:

1) Preparation stage

Before starting the research, the author must first assess all of the variables in this study. The research preparation step is explained in the following way:

a. Investigating the research problem
b. Determining the research objective
c. Choosing the research variables
d. Conducting a literature review of scientific attitude, scientific literacy, and learning biotechnologys
e. Creating research instruments: scientific attitude questioner, competency test, and questionnaire for attitude domain
f. Validating the instruments with experts
g. Revise the research instruments based on the judgement of experts and the validation results of students

2) Implementation Stage

At this time, the author began gathering data through conducting research. The step of research implementation is explained as follows:

a. Choosing a research topic
b. Distribute the instrument (questionnaires and competency tests to private and public schools) after learning the topic of biotechnology

3) Completion Stage

The data collection was analyzed at this point. The research completion step is explained in the following points:

a. Process and analyze the data
b. Discuss the results based on the information obtained
c. Draw conclusions based on the information obtained

The flowchart for this study is illustrated in Figure 3.1.

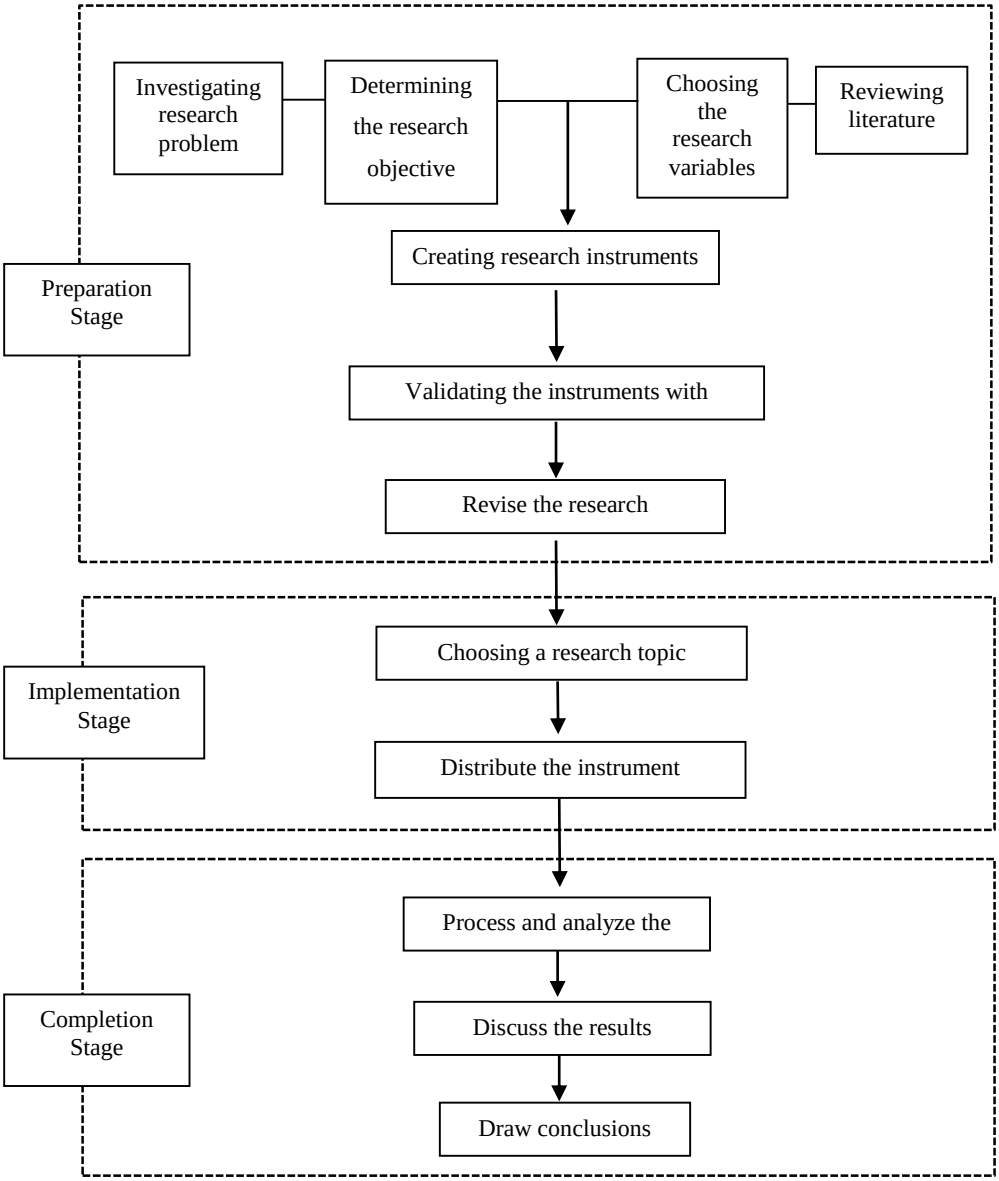

Figure 3. 1
Research procedure flowchart