CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Methodology

In this chapter the research method and design were used to analyze the improvement of students' critical thinking ability after the 5E-learning cycle model was implemented. This chapter includes research method and design, population and sample, operational definitions, assumption, hypothesis, research instrument, data analysis, research procedure and research flowchart.

3.1.1 Research Method

Based on the purpose of the research, this research method used in this research was a pre-experimental method that was established by (Fraenkel & Wallen, 2012), this method was conducted to analyze the relationship and effects on the variables. In this method, there is only one group as the experimental group without any control group to compare with the experimental group. This method was based on the researcher consideration from the school situation where the researcher was taken the data, which are affected on the number of students' sample for this research. So the researcher make a decision to used only one data group was taken, from the pretest to posttest without a control group. Therefore, in this study researchers analyze student critical thinking ability before and after learning the excretory system in human topic by using 5E-learning cycle model, with only one class as a learning model treatment.

3.1.2 Research Design

The researcher design used the one-group pretest–posttest research design. In this one group pretest posttest design, a one or single group is observed not only after a treatment but also before (Fraenkel et al., 2011). All of one group pretest and posttest were conducted to analyze the impact of the 5E- learning cycle model implemented for student critical thinking ability. The table here explained the implementation of the 5E- learning model in class experiments, to improve their critical thinking ability in human excretory system topics. This research design is given in Table 3.1.

Table 3. 1

Pre-experimental One Group Pretest-Posttest Design

Pre-Test	Experimental Treatment	Post-Test
O_1	X	O_2

(Fraenkel & Wallen, 2012)

O_1: Pretest before implemented 5E- learning model

X: Treatment by learning in the experimental class

O_2: Posttest after implemented 5E- learning model

Based on the Table 3.1, the design in a one-group pretest-posttest design used to measure student' critical thinking ability. However, the initial data (pre-test) was carried out for students'critical thinking ability, and then the treatment was carried out on students using the 5E- learning cycle model. After all the learning activities are completed, the final data (post-test) is carried out. The goals of this design is to analyze the effect of implementation 5E- learning cycle models to the material excretory system in human topic.

3.2 Population and Sample

The population of this research is the 8th grade students' in Junior high school in Bandung, Indonesia. The school used bilingual language as the communication and delivery language in the teaching and learning process (Appendix A.1). There are 21 students who have participated in this research with 14 males and 7 females from ages 14 years old-15 years old. The students' from one group class join this research completely from the beginning until the end of the topic.

The technique for students was chosen through the convenience sampling technique, and it is a type of sampling where the first available primary data source was used for the research without additional requirements. A convenience sampling sample is a group of people who are readily available to participate in this study Fraenkel et al (2011). Because of the pandemic situation this research conducted in both the learning, online system and offline system. Based on Table 3.2 there was the distribution of sample percentage from 8th grade students' in junior high school.

Table 3.2

Distribution of Research Participant

Population	Sample		Percentage (%)	Total (%)
8th grade students'	Male	14	66.67%	100
	Female	7	33.34%	

According to Table 3.2 the sample number of male is 14 students' with the percentage 66.67% participant, meanwhile the sample number for females is 7 with the percentage 33.34% participant.

3.3 Assumption

The assumption of this research as the foundation in this research explained as follows:

1) The application of 5E- Learning Cycle is able to improve students' critical thinking ability and ability. This learning models can stimulate students in critical thinking, namely the 5E- Learning Cycle consisting of the Engagement stage, Exploration stage, Explanation stage, Elaboration stage, and Evaluation stage (Miarti et al., 2021)
2) Students' critical thinking ability can improve significantly, after implementing Learning Cycle 5E-. This model shows potential for enhancing these ability in science education and can be considered as an alternative approach (Wati et al., 2021).

3.4 Hypothesis

The hypothesis for this research are explained as follow:

H_0: There is no difference between students' critical thinking ability before and after the implementation of using 5E- learning model on the excretory system in human topic

H_1: There is a difference between students' critical thinking ability before and after the implementation of using 5E- learning model on the excretory system in human topic

3.5 Research Instrument

In this research, it is required to use the instrument to gather the data of students' critical thinking ability. There are several types of instruments that were used in this research, which are objective tests essay, rubrics for the essay and also students

respond after implementing the 5E- learning model in this research. Those instrument are described below:

3.5.1 Students' Critical Thinking Objective Test

In this instrument the objective test is used to analyze students' critical thinking ability. The objective test given before the treatment (Pre-test) to know about the initial students' critical thinking ability before the implemented the 5E- learning cycle model, and after the treatment students' given the objective test again (Post-test) to analyze the improvement of students' critical thinking ability after implementation of 5E- learning cycle model. However, for type of questions is essays, and for both pre-test and post-test there are 9 questions that must be answered by the students' answer.

Furthermore in this research the objective test questions is measured by applying students' critical thinking ability rubric (White et al., 2011), which consist of three aspects for analyzed the students' critical thinking ability which are Ability to integrate conflicting studies into a unified conclusion, Ability to design an situations or suggest to answer some problem in certain knowledge, Ability to conceptualize other interpretations of the same data. The distribution of the question for students' critical thinking ability shown in Table 3.3. The form of the instrument can be seen in (Appendix A.2), and the state of the rubric for scoring students' critical thinking ability score was shown more detailed on (Appendix A.3)

Table 3. 3

Blue Print of Students' Critical Thinking Test Distribution

No.	Aspect of Critical Thinking Skill	Number of Questions			Total	Percent
		Excretory Organ	Problem	Prevention for excretory Diseases		
1.	Ability to deal with conflicting data and reach a conclusion (A1)	1	3	5	3	33.4%
2.	Ability to design an situation or experiments to resolve ambiguities in certain knowledge (A2)	2	6	7. 9	4	44.5%

No.	Aspect of Critical Thinking Skill	Number of Questions			Total	Percent
		Excretory Organ	Problem	Prevention for excretory Diseases		
3.	Ability to conceptualize other interpretations of the same data (A3)		4	8	2	22.3%

The following are examples of questions in the critical thinking ability instrument are presented in Table 3.4.

Table 3.4

Example of the Instrument Question of Students' Critical Thinking Ability

Indicator (Ability)	Example of Questions
Ability to deal with conflicting data and reach a conclusion (A1)	Based on that, please explain the advantages of a longer loop of Henle in kidney and its effect on urine production, give your explanation!
Ability to design an situation or experiments to resolve ambiguities in certain knowledge	There are many factor that makes our lungs damaged, and base on the data one of the factor is cigarette, did you agree? Please be as specific as possible and give as many reason as you can think of.
Ability to conceptualize other interpretations of the same data (A3)	What other cause could a person argue for the situations? Choose only one: Person 1,2,3…. If you should choose one, who is the person you will be safe first, or it is not possible to say who will be the first to choose? Please explain!

The students' critical thinking ability test consisted of 9 essay questions, for each questions researcher represent based on the three ability of students' critical thinking ability, so that questions that already answered by students' could be easily to described students' critical thinking ability. The answer of the description test are assessed used a rubric test that refers to Assessment of critical thinking ability from (White et al., 2011). Instrument about this ability to analyzed students' critical thinking ability that have been made are already consulted with the experts The results of validation of the students' critical thinking ability questions are presented in Table 3.5.

3.5.1.1 Instrument Development Analysis and Result

Critical thinking ability in this research measured by objective test, for development an objective test is requires. The objective test must be tested before it tested to the students, the content validity of this objective test is judged by experts or panelist. For checking the validity researcher used the Content Validity Ratio (CVR) based on the (Lawshe, 1975).

$$CVR = \frac{n_e - \frac{n}{2}}{\frac{n}{2}}$$

(Lawshe, 1975)

According to the formula above, the CVR is the content validity ratio with the n_e is the total number of validator or panelist and n is the total of panelist that indicating whether the test item is relevant or not. For the test item relevance is based on the suitable of the critical thinking aspect with the learning objective. The result of the content validity is shown on the Table 3.5 below.

Table 3.5

Result of Expert Judgement

Test Item No	CVR	Decision	Suggestion
1.	1	Valid	- The information of the question can be in article or narrative contain about contrasting ideas of the topic
2.	1	Valid	- The information of the question can be in article or narrative contain about contrasting ideas of the topic
3.	1	Valid	
4.	1	Valid	
5.	1	Valid	- Add some official source of the articles
6.	1	Valid	- Changes the indicator ability of question
7.	1	Valid	
8.	1	Valid	
9.	1	Valid	

Based on the table, all the test item are valid and in line with the content validity ratio. However, there are also another minor revision regarding to the questions of ability, and some suggestions to make a better questions in the content of test items, these adjustments from recommendations provided by experts through their informed judgment. For the detail of the validation from expert judgement shown on the (Appendix A.4) section.

3.5.2 Students' Critical Thinking Rubric

A rubric was also used to measure students' critical thinking ability. In this research, the rubric used for give the score for the objective test Based on the (White et al., 2011) The Assessment of Critical Thinking Ability (ACTA) survey assesses students on three main critical thinking abilities essential to the evaluation of multiple lines of evidence, which are ability to integrate conflicting studies into a unified conclusion, ability to design an situation or suggest to answer some problem in certain knowledge, ability to conceptualize other interpretations of the same data. In this rubric also students score divided into 4 level of critical thinking ability. The rubric of students' critical thinking ability shown in Table 3.6.

Table 3. 6

Critical Thinking Aspect Rubric

Score	Critical Thinking Aspects		
	Ability to deal with conflicting data and reach a conclusion (A1)	Ability to design an situation or experiments to resolve ambiguities in certain knowledge (A2)	Ability to conceptualize other interpretations of the same data (A3
4	Students give all the explanation, and data. And also give the conclusion	Design a situations, explain how to solve the problem and also mention the reason	State the data with explanation from all interpretation, to argue for a different cause than the one they choose
3	Students give the all the explanation and data, but didn't give the conclusion or reasoning	Design an situations, and explain the reason to solve the problem	State the data with explanation, but with another interpretation is possible that what they choose

Score	Critical Thinking Aspects		
2	Students give the answer or conclusion, but didn't answer the reasoning	Design an situations, but didn't answer to solve the problem/the reason	State the data with the explanation, but does not see that another interpretation is possible
1	Do not mention any data or concept in Arguments.	Do not design an situation or suggestion about the opinion relate to questions	Do not mention any data or explanation from all studies

(White et al., 2011)

The rubric above aims to analyze students' critical thinking level ability, but after we gain the score of the objective test, it must be interpreted to categorize the students' critical thinking ability. In this research the criteria for the interpretation are based on (Paul & Elder, 2019), and the detailed shown on Table 3.7.

Table 3.7
Interpretation of Students Critical Thinking Ability

Score	**Interpretation**
3.51 – 4.0	Master Thinker
3.11 – 3.50	Advanced Thinker
2.41 – 3.10	Practicing Thinker
1.71 – 2.40	Beginning Thinker
1.01 – 1.70	Challenged Thinker
0 – 1.0	Unreflective Thinker

(Paul & Elder, 2019)

According to the Table 3.7 above, there are students' critical thinking ability interpretation from 0 to 4.0 score, the interpretation score consists of unreflective thinkers until master thinkers that shows on the table above based on the (Paul & Elder, 2019).

3.5.3 Students' Questionnaire Respond

In this study, researchers used questionnaire research to determine students' responses or experience of the 5E- learning cycle model. The number of questions that are asked to students' consist of 6 questions. For the questionnaire research used Likert scales. According to (Dörnyei & Dewaele, 2022), the main types of closed questions used in questionnaire research in applied linguistics, and his list is also pertinent to research involving language and intercultural communication. He

identifies three main types of graduated responses items Likert scales, semantic differential scales and numerical ratings scales and also lists true-false items, multiple choice items, and rank order items. Likert scale applied as one of the most frequently used for psychometric tools in education and social science research (Joshi et al., 2015).

These consist of a stimulus statement which students respond by implementing a 5E- learning model indicating how much (or little) they agree with it. In this research this questionnaire is used to analyze students' responses after the 5E-learning model implemented in their class. Likert and Likert type scale, aims to understand the opinion or perceptions or subject related with a single 'latent' variable (Joshi et al., 2015). The indicators include the 5E- learning model and about their critical thinking ability. This table 3.8 shows the criteria for students' questionnaire responses.

Table 3. 8

Student questionnaire respond

Criterion	Score
Strongly disagree (SD)	1
Disagree (D)	2
Neither agree nor disagree (NAD)	3
Agree (A)	4
Strongly agree (SA)	5

(Joshi et al., 2015)

The used of Likert type scale to analyze the students' respond towards the implementation of 5E- learning cycle model, to measure is that students' agree or not about the implementation this model in their classroom, their respond also helpful to giving some suggestion to researcher and teacher to using this model in their science teaching learning.

3.6 Data Analysis

The data analysis for this research which is students' critical thinking ability were obtained quantitatively. After the data collected, the results of the question were analyzed through several stages using SPSS 24 software version, which are to see the improvement data from pretest and posttest students' answers, and also it can help to process the statistical data. The processing of the analyzing data for each steps are explained below:

3.6.1. Scoring Test (Essay)

The result of data was collected from the objective test score that researchers gave to the students' during this experiment, and it consisted of 9 questions for one topic, for each question it was to score up to 4 points. The point in each answer is divided by the total of the score number, and multiplied by 100. The scoring point is based on the ACTA rubric of students' critical thinking skill that adapted from (White et al., 2011). The average score of students' result both pretest and also posttest are calculated for finding the improvement of each students'

3.6.2 Normalized Gain Score

Normalized gain is the change in the class average score divided by the maximum possible gain. This measure can become the same value for classes with quite different examples (Coletta & Steinert, 2020). So this normalized gain is used in order to show the improvement or difference of students' critical thinking ability in pretest and posttest. The Average of Normalized Gain (N-gain) introduces firstly by Hake's in 1998, and the formula stated below:

$$\text{Normalized Gain} = \frac{\text{Score (Posttest)} - \text{Score (Pretest)}}{\text{Score (Ideal)} - \text{Score (Pretest)}}$$

The value of the data categorized based on the N-gain table stated below:

Table 3.9

N-gain Score Category

N-Gain Score	Category
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

(Hake, 1998)

3.6.3. Normality Test

Normality test is used to determine whether the data come from normal distributions or not. In this normality test there are two kinds of normality tests, the most widely used method test which are Shapiro-Wilk and Kolmogorov-Smirnov, and both of them depend on the sample size. If the sample size is small or less than (<50 samples), the researcher can use Shapiro-Wilk. But if the sample size is larger sample size or greater than 50 (>50 samples), Kolmogorov-Smirnov is used (Mishra

et al., 2019). The significant value (α) indicates if the data distribution normal or the data distribution not normal, as shown below:

a. If the significant value is greater than (sig > 0.05), we can categorize the data as normally distribution and continue the parametric test or Shapiro-Wilk, meanwhile
b. If the significant value is less than (sig < 0.05), we can categorized the data as not normally distribution and continue to non-parametric test or Kolmogorov-Smirnov

3.6.4. Homogeneity Test

The homogeneity test was used in this research to analyze and check whether the data are homogeneous or not. If the significant value is greater than 0.05 (sig. > 0.05), the data are categorized as homogeneous. However if the significant value of the data is less than 0.05 (sig. < 0.05) the data categorized as not homogeneous. In this research the homogeneity test used to determine the variance of the data. According to (Levene, 1960) this levene's test used to test if the samples have equal variance.

3.6.5. Mean Difference Test (Paired Sample t-test)

This research test can be used to analyze the difference between pretest and posttest. The mean difference test is conducted after the normality of the data has already been determined. If the data is normally distributed we can apply it to a parametric test, which uses a Paired Sample t-test. But if the data is not normally distributed, we can use non-parametric tests such as the Wilcoxon signed-rank test. The data can be concluded as a significant difference if the significant value (sig.2-tailed) is 0.05. Based on the data form analysis of the objective test in this research the data normally distributed so this research used Paired sample t-test to identify the difference result between pretest and posttest. These steps are also used to determine whether our hypothesis is rejected or accepted. H_1 accepted and H_0 rejected if the sign (2-tailed) value less than 0.05 (sig < 0.05), however if H_1 is rejected, and H_0 accepted when the sign (2-tailed) more than 0.05 (sig > 0.05) is shown.

3.6.6. Statistical Descriptive Analysis

Descriptive statistical analysis is important for this researcher because it is used to summarize and show about the result observations to make them easier to understand about this research. Based on the (Mishra et al., 2019) There are three major types of statistical descriptive analysis, which are frequency (number of students participating), mean, median, mode, variance, standard deviation, etc. (Appendix A.5)

3.7 Research Procedure

For doing and making this research arranged systematically, there are three main steps to do. Such as the preparation stage, implementation stage, and completion stage. For each stage explained below.

1) Preparation Stage

   The first step is preparation stage, it is also the initial steps for the researcher for conduct their research. First of all the researcher conduct the literature review, and analyze what is the problem in our science learning that mostly happened in this time. Then the researcher formulate and Find the problem that is going to be analyze for the research, after that formulate the research problem and classifying the problem into the research questions and formulating the research objectives. Then determine another components of the research, teaching model, teaching method and also the science contents for the research. The researcher already get the topic for the research, the next step conduct literature review about students' critical thinking ability, 5E Learning Cycle Model. And Excretion in Humans topic. Arranged the research proposal, Construct the research instrument to take the data from the students', that consist of the rubrics by modifying existing instrument rubric and essay questions, then validated and judged by the experts, Revision the research instrument based on the experts judgements. The last step in preparation is construct the components for taking a data, which are lesson plan, learning media, and teaching materials for the implementation the 5E learning model

2) Implementation Stage

The Implementation stage is the second step for making the research paper, in this stage the 5E learning cycle model was conducted to take the data of students' critical thinking ability, and also the instrument is ready to obtain the data. The steps of the implementation stage, consist into several phase it was explained below:

a) Researcher giving the Pre-Test questions to the students before teaching the materials about excretion in humans. The pretest was conducted to measure the students' critical thinking abilities before learning excretory system in human material in KD. 3.10 and 4.10 and carried out during class hours. The pretest analyze after students' filling out the students' critical thinking ability test questions.

b) Learning is carried out in four meeting, and it is include for the pretest and posttest. Then, the learning is applied by using 5E-learning cycle model on excretory system in human material. The learning activities can be seen in Table 3.10. For the detailed of learning activity of 5E learning cycle model can been seen in (Appendix A.6) for the detailed material for teaching used this model used worksheet on (Appendix A.7) and power point on (Appendix A.8)

Table 3.10

Learning Activity

Step	Learning Experiences	Time
Introduction	1. Teacher start the class by greet the students and check students attendance 2. Students and Teacher start the class to say *Bismillah* and start to pray before starting the lesson 3. Students given some motivation before start the class 4. Teacher delivers the learning objective and benefit of the lesson that is going to be discussed. 6. Students recall the last material that already discuss	10 Minutes

Step	Learning Experiences	Time
Main Activity	**5E- Learning Cycle** **Engagement** 7. Students are motivated by teacher with presenting problems in contextual, teacher showing the example several problem in human excretion organ : (Kidney Stone, Acne and etc) 8. Teacher engage students "Why can these diseases happen in our excretory organs?" "Why we must drink water everyday" 9. Students answer the question that teacher asked 10. Teacher guide students to learn about "The problem in excretory organ in humans" 11. Teacher divide students into several group **Exploration** 12. Students in each group doing discussion together to solve the answer the question, about excretion in humans problems in worksheet 1 13.The teacher supervises the group discussion and gives guidance when the students needed 14. Students get the conclusion for the worksheet 1 **Explanation** 15. Students of representative a group present the result after doing the discussion, on the worksheet 1, and for another group can give the questions, suggestion or feedback **Elaboration** 16. Students doing a discussions again in their respective groups to solve the questions contained in worksheet 2 17. Teacher observes the student discussion activities, assesses student activity in discussions and provides guidance when needed.	100 Minutes

Step	Learning Experiences	Time
	18. Representative of students showing their results of group discussion, and for another students give some suggestion or comment	
	Evaluation	
	19. Teacher gives an evaluation questions (Quiz) to students	
Closure	20. Students fill an evaluation questions individually in time which have been specified	10 Minutes
	21. After the time is over, Students collect their own answers	
	22. Students give the conclusion/important points for today's meeting Students and Teacher saying hamdalah together to end the meeting in today's session	

c) In this implementation stage the researcher also observing the students learning activities during the 5E-learning cycle model applying in the class (Appendix A.9). The end of the research by providing the Post-Test question to the students after all the learning materials about excretion in humans already finished. After that researcher collecting the data result from the Pre-Test and Post-Test.

3) Completion Stage

The completion stage is the third step or the final stage for the research. In this stage we analyze the data and make it systematically in a research paper. The step for the completion stage are, calculating and analyzed the data based on the result of the test in research instrument. After that discussed the result based on your finding and based on the data statistical tests to answer the hypothesis. The last stage constructing the conclusion and recommendation based on the data result and discussion before and completing the report of final research paper

3.8 Research Flowchart

The flowchart below shows the research procedures for completing this research paper.

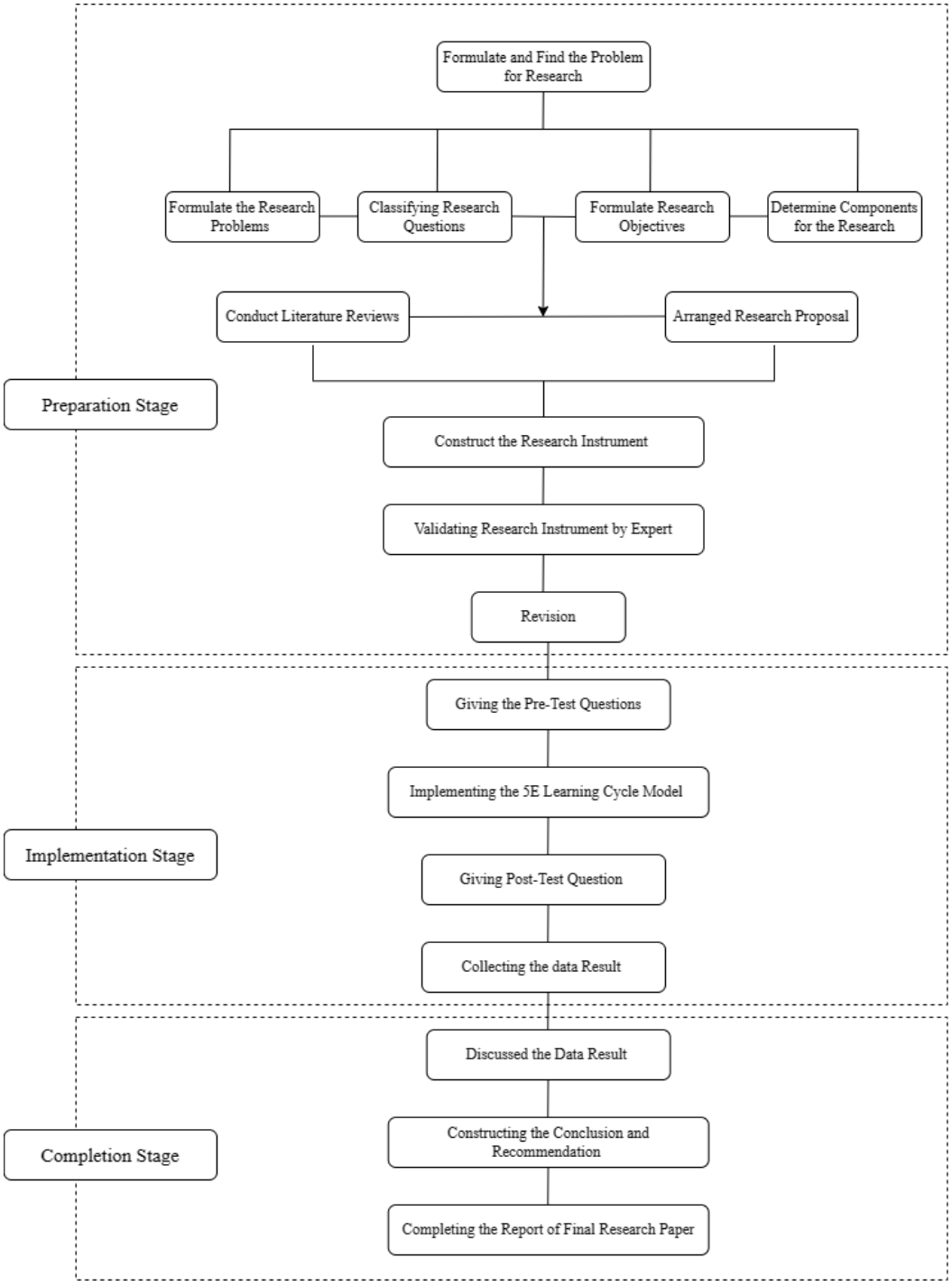

Figure 3.1 Research Procedure Flowchart