CHAPTER 3

RESEARCH METHODOLOGY

1.1 Research Method and Research Design

The research method that will be used in this research is Pre Experimental. Creswell (2012) stated that weak experimental involves a within-group or within-individual procedure in which a single group or single individuals are studied. The design that will be used in this research is one group pre-test and post-test designed by Mertler & Charles, 2008. In this design, there were four experimental classes that are not significantly different each other. The four classes will be taught using the same treatment. The pretest will be conducted to investigate the prior knowledge of the students. After that, they will be treated with PhET simulations. Then, it ended with a post-test to measure the improvement of students' understanding. There is no control group in this design. Table 3.1 is the design that is used in this research.

Table 0.1
Pre-test and Post-test Design

Pre-test	Treatment	Post-test
O_1	X	O_2

(*Source: Mertler & Charles, 2008*)

O_1 : Pre-test of students' achievement test

X   : Implementation of States of Matter and Density PhET simulation

O_2 : Post-test of students' achievement test

In the learning activities, the design of teaching-learning tools is very important. The design of teaching-learning is the plan make by teacher to provide teaching tools that is helpful for the teaching-learning process. Teaching tools that is used in the classroom should consider several factors, such as class conditions, students' level of cognitive, and environment. It is true that different schools will have different learning environment, which is why a design cannot implement to the same school although they learn the same topic.

In this study, there are four learning tools designed by the teacher to be able to meet research objectives. The four learning tools are Lesson Plan, Students Worksheet, States of Matter test, and Interest Questionnaire. The learning tools that are used were adopted from experts and previous research. The adopted learning tools then modified to improve the quality so it meets the students' need. The modification of the four learning tools will be described in Table 3.2.

Table 0.2
Analysis of Learning Tools

Learning Tools	Adapted from	The Absences	Modification
Lesson Plan	PhET Simulations	The framework of lesson plan provided in PhET simulations is not same with Curriculum 2013 framework. The lesson plan only provides the main activities, but does not provide the introduction and closing activities that will do in the classroom. The lesson plan does not provide the rubric or evaluation sheet to asses the students understanding.	The final lesson plan uses main activity that is providing in PhET simulation. The main activities will also suit to the objectives of the lesson. The introduction and closing activities are following the lesson plan framework of Curriculum 2013.
Worksheet	PhET Simulations	The worksheet in PhET simulations only provides simple questions about the activity that includes PhET simulations, such as observation of particles, checking the density of the certain object, etc. The simulations do not provide a worksheet for an experiment that is needed in this study.	The final worksheet is made of a teacher by adding the phase changes in laboratory activities. The questions of activities adapted from PhET simulations.
States of Matter Test	Government Integrated	The questions in the book only cover the	The final state of matter test is the

Learning Tools	Adapted from	The Absences	Modification
	Science Book for 7 Grade (IPA 7 Zaipudin, IPA 7 Wasis,	first cognitive domain that is remembering the definition of the concept. It does not provide the questions that relate to the use of PhET simulations.	combination of integrated science book and questions in PhET simulations. The questions use because it provides cognitive domain C1 (remembering), C2 (understanding) and C3 (analyzing).
	PhET Simulations	The questions from PhET simulations only cover the questions about particles of matter and density.	
Questionnaire	Glynn & Koballa	The questionnaires consist of 5 science aspects that are too general if used in this study. The aspect of *Self-efficacy and Assessment Anxiety*, *Career Motivation* and *Grade Motivation* are not used because it measured the scientific interest for the future. The questionnaire also does not provide specific questions about Physic subject (States of Matter topic)	The final questionnaire is the combination of Students Interest Questionnaire and Self Determination of PhET aspect. The final questionnaire consists of 3 aspects, which are Science Attitude, States of Matter Attitude and Self Determination of PhET.
	Prima, Putri & Rustaman	The statements about PhET simulation does not consist of the introduction of PhET simulations. Thus, the students will confuse to answer the statements.	

1.2 Population and Sample

The location of this research is One of Private Junior High School Bandung. The curriculum of this school is National Curriculum 2013. It uses Indonesian language as the main language.

The population in this research will be 7th-grade students. There are four classes of 7th-grade students in this school selected as participants. For the research samples, need all classes as an experimental group. Therefore, the sampling technique of this research is purposive sampling. (Fraenkel, Wallen, & Hyun, 2013) stated that purposive sampling research use their judgment based on prior information, to select a sample that they believe will provide the data they needed.

1.3   Operational Definition

In order to avoid any differences in understanding in this study, it is necessary to clarify the definition of each operation used:

1) PhET (Physical Education Technology) use in this study is "States of Matter" and "Density" simulations. The evaluation of PhET simulations is measured using interview.

2) Students' Interest in this study consists of three aspects, which are Science Attitude, States of Matter Attitude, and Self-determination of PhET Simulation. Students' interest is measured using questionnaire.

3) Students' Understanding based on Taxonomy Bloom from C1 until C3, which are remembering, understanding, applying and analyzing. Students' understanding is measured using students' achievement in the multiple choice test.

1.4   Assumption

The assumptions as the foundation of this study as follow.

1) PhET simulations as a computer based learning media provides simple and interactive physic problems simulations (Panis, 2017).

2) PhET simulations provide multiple images at submicroscopic level to visualization abstract concept to concrete concept (Correia, 2018).

3) PhET simulations overcome students' misconceptions about Chemistry Subject, especially in chemical equilibrium concepts (Ganasen, 2017).

1.5 Hypothesis

Hypothesis that is tested in this study are as follow:

H_0 : There is no improvement in students' understanding in learning States of Matter topic using PhET mobile application.

H_1 : There is an improvement in students' understanding in learning States of Matter topic using PhET mobile application.

The hypothesis of this research will be tested using T-Test.

H_0 : There is no improvement in students' interest in learning States of Matter topic using PhET mobile application.

H_1 : There is an improvement in students' interest in learning States of Matter topic using PhET mobile application.

The hypothesis of this research will be processed using Gain Score and Students' Interest Rubric (SIR).

H_0 : There is no correlation between students' understanding and interest in learning States of Matter topic using PhET mobile application.

H_1 : There is a correlation between students' understanding and interest in learning States of Matter topic using PhET mobile application.

The hypothesis of this research will be tested using Pearson Correlation.

1.6 Research Instrument

In this research, instrument is necessary to be used for gaining data. The research will observe through objective test and questionnaire. The objective test instrument will be pre-test and post-test question and questionnaire is give after teaching-learning process. The instruments were used in this research is states in Table 3.3.

Table 0.3
Research Instrument

No.	Instrument	Data Obtained
1.	Objective Test	Students' Understanding
2.	Interest Questionnaire	Students' Interest

Further description of the instruments is described as follows:

1.6.1 Objective Test

Objective test in this research will be questions about states of matter concept. The purpose is to measure students' understanding. The cognitive domain used in the objective test are remembering (C1), understanding (C2) and applying (C3). In order for the test items of the research instruments to be appropriate for this research, the test item should be checked for its validity as follows:

1.6.1.1 Validity Test

The instrument should be valid so the validity testing of an instrument is a must. (Crocker, 2008) stated that validation refers to the process through which empirical evidence is gathered to support the use of test scores for a stated purpose. While (Cohen, 1994) stated that validity in quantitative data might be improved through careful sampling, appropriate instrumentation and appropriate statistical treatments of the data. For the validity it can't be 100 percent valid.

$$rxy = \frac{n \sum XY - \sum X \sum Y}{\sqrt{(n \sum x^2 - (\sum X)^2)(n \sum Y^2 - (\sum Y)^2)}}$$

(Source: Tuckman, 1975)

Where:

r_{xy} = items correlation coefficient

x = items scores

y = total score of each student

n = amount of subject

$\sum X$ = sum of tthe otal score of all students for each question

$\sum X$ = sum of total score of all students for whole test

The formula above can be used to determine test item validity. Validity interpretation is represented in Table 3.4.

Table 0.4
Validity interpretation

The amount of r value	Interpretation
0.80 < r < 1.00	Very High
0.60 < r < 0.79	High

0.40 < r <0.59	Prosperous
0.20 < r < 0.39	Low
0.00 < r < 0.19	Very Low

(Source: Minium, 2011)

1.6.1.2 Reliability Test

Reliability in quantitative research is essentially a synonym for dependability, consistency and reliability over time, over instruments and over groups of respondents. It is concerned with precision and accuracy. Therefore, reliability will be calculated using the following formula:

$$\alpha = \frac{K}{K-1} \; 1 - \frac{\sum_{t=1} \rho \frac{2}{\gamma i}}{\sigma^2_x}$$

(Source: Cronbach, 1951)

The level of reliability of question will be represented in Table 3.5.

Table 0.5
Validity interpretation

Gained r value	Interpretation
0.80 - 1.00	Very High
0.60 - 0.79	High
0.40 -0.59	Prosperous
0.20 - 0.39	Low
0.00 - 0.19	Very Low

(Source: Jabobs and Chase, 1992)

1.6.1.3 Difficulty Level

The difficulty level is a number that show the level of difficulty or easy the test item. The items that are extremely easy on a pretest should cause the test developer to ask whether instruction in this particular content is necessary for these examinees. Vice versa, the items that are extremely difficult for after instruction may indicate that the instruction was ineffective or that the item specification includes content or processes not covered by the instructional

objective (Crocker et al., 2008). Below is the formula that will be used to find the difficulty level:

$$\mathrm{P}i = \frac{Ai}{Ni}$$

Where:

Pi = Difficulty level

Ai = Number of students who answers correctly

Ni = Total number of students

To measure the difficulty level each test item of question has used the range of each difficulty level will be represented in Table 3.6.

Table 0.6
Validity interpretation

Difficult Range	Classification
< 0.00 - 0.00	Very Difficult
0.00 - 0.30	Difficult
0.30 - 0.70	Medium
0.70 - 1.00	Easy

(Source: Arikunto, 2010)

1.6.1.4   Discrimination Power

Discrimination power is provide information about individual differences either on the construct purportedly measured by the test. The goal is to identify items for which high-scoring examines have a high probability of answering correctly and low-scoring examinees have a low probability of answering correctly. Once the upper and lower groups have been identified, the index of discrimination (D) is computed as:

$$D = P_u - P_l$$

(Source: Crocker, 2008)

Where p_u is the proportion in the upper group who answered the item correctly and P_l is the proportion in the lower group who answered the item correctly. Values of D may range from -1.00 to 1.00. Positive values indicate that

the item discriminates in favor of the upper group, while negative values indicate that the item is a reverse discriminator. The discriminating power index will be shown in Table 3.7.

Table 0.7
Validity interpretation

D =	Quality	Reccomendations
> 0.39	Excellent	Retain
0.30 – 0.39	Good	Possibilities for improvement
0.20 – 0.29	Mediocre	Need to check / review
0.00 – 0.19	Poor	Discard or review in depth
< -0.01	Worst	Definitely discard

(Source: Backhoff, Larrazolo, & Rosas, 2000)

1.6.1.5 Distractor

Distractor is the incorrect opinion which is provided in a multiple choice question and students are to choose the correct option. Usually there are four choices in each multiple choice question.

$$corrected\ score = R = \frac{W}{n-1}$$

(Source: Kaplan and Saccuzo, 2012)

Where:

R   = Number of right answer

W   = Number of wrong answer

N   = Number of choice in each item

1.6.2 Students' Interest Questionnaire

One of useful instrument for collecting survey information without presence of the research and often comparatively straight forward to analyze is questionnaire. The purpose of questionnaire is to see the improvement of students' interest in learning physic especially states of matter concept. Same with the objective test, students will fill the questionnaire before and after learning activity. The questionnaire in this research is adopted from (Glynn, Taasoobshirazi, & Brickman, 2009) and previous research. The Students' Interest Questionnaire was

distributed to students in the beginning of the class, before the states of matter topic was taught and in the end, after the states of matter topic being taught. Students' Interest Questionnaire consists of statements of students after they were taught States of Matter concept using PhET simulations.

The analysis of the questionnaire was obtained using the following formula:

$$P = \frac{f}{n} x\ 100\%$$

(Source: Sugiyono, 2011)

Where:

P = Percentage

F = Frequency of answer

N = Total of response

The result of above percentage is then categorized into the interest level based on Interest Level Rubric in Table 3.8.

Table 0.8
Interest Level Rubric

No	Percentage	Interest Level
1.	<21%	Very Low
2.	21% - 40%	Low
3.	41% - 60%	Medium
4.	61% - 80%	High
5.	81% - 100%	Very High

(Source: Sugiyono, 2011)

1.6.3 Recapitulation of Objective Test Instrument

The instrument of this research need to be tested in class before uses to asses students. The objective test will be tested in 8 grade students of the same school, who have learned states of matter concept when they were in grade 7. The objective test will be tested using ANATEST 4.0.9 in form of validation, reliability, distraction level and discriminating power. Table 3.9 is the recapitulation result of the objective test.

Table 0.9

Recapitulation of Objective Test Items

No	DP	Category	DL	Category	Validity	Category	Decision
1.	62.50	G	72.41	E	0.582	P	Used
2.	37.50	G	65.52	M	0.343	L	Used
3.	62.50	G	55.17	M	0.460	P	Used
4.	62.50	G	44.83	M	0.528	P	Used
5.	62.50	G	65.52	M	0.409	P	Used
6.	75.00	E	72.41	E	0.669	H	Used
7.	87.50	E	48.28	M	0.723	H	Used
8.	25.00	Mc	65.52	M	0.229	L	Revised
9.	75.00	E	44.83	M	0.654	H	Used
10	75.00	E	51.72	M	0.579	P	Used
11	75.00	E	68.97	M	0.660	H	Used
12	25.00	Mc	41.38	M	0.229	L	Revised
13	62.50	G	44.83	D	0.513	P	Used
14	62.50	G	68.97	M	0.542	P	Used
15	12.50	W	65.52	M	0.163	VL	Revised
16	75.00	E	17.65	D	0.638	H	Used
17	50.00	G	75.86	E	0.448	P	Used
18	75.00	E	48.28	M	0.623	H	Used
19	0.00	W	62.07	M	0.028	VL	Revised
20	12.50	W	68.97	M	0.188	VL	Revised

Note:

VD = Very Difficult	Mc = Medicore	VL = Very Low
D = Difficult	W = Worst	L = Low
M = Medium	P = Poor	Pr = Prosperous
E = Easy	G = Good	H = High
	E = Excellent	VH = Very High

1.6.4 Data Analysis

The result of this research is gathered by quantitative approach. The data which were gathered in the research were gained from students' pre-test and post-test that measures students' understanding and from both questionnaire and interview to measures students' interest toward PhET simulation implementation in the learning processes. The result will describe whether there is an improvement in students' understanding and interest or not, and the relation of students' understanding and interest itself. The further explanation will explain below.

1.6.4.1 Data Analysis for Students' Understanding Aspect

The data of students' understanding is processed using SPSS 2.0, which has function to determine the score of students' pre-test and post-test. The process of data calculation will explained below.

1) Scoring test items

The test item contains twenty questions of multiple choice questions. The test items were used both in pre-test and post-test for four classes. The correct answer is given 5 points and wrong answer is given 0 points.

2) Calculation of Gain Score and Normalized Gain

After all the data of objective test score is obtained, the data was proceeding by checking the normality and calculating the gain. The calculation of gain is for determine the differences between the score of pre-test and post test, the differences score will show whether there is improvement in students' understanding or not. After obtain the gain, and then normalized gain can be determined. Gain score can be calculated by the formula:

$$G = S_f - S_i$$

(Source: Hake, 1998)

Where:

G = Gain score

S_f = Post test score

S_i = Pre test score

Normalized gain of each student <g> was determined by this formula:

$$< g >= \frac{\%G}{\%Gmax} = \frac{\%S_f - \%S_i}{100 - \%S_i}$$

(Source: Hake, 1998)

<g> = Normalized gain

G = Actual gain

Gmax   = Maximum gain possible

S_f = Post-test score

S_i = Pre-test score

Average of normalized gain (<g>) which is formulated as:

$$< g >= \frac{\% < G >}{\% < G > max} = \frac{(\% < S_f > - \% < S_i >)}{(100 - \% < S_i >)}$$

<g>   = Normalized gain

<G>   = Actual gain

<G> max   = Maximum gain possible

$<S>_f$ = Average of post-test score

$<S>_i$ = Average of pre-test score

The value Normalized gain that has been gained is interpreted using interpretation Table 3.10 as follows.

Table 0.10
Interpretation of Normalized Gain

Value	Classification
<g> ≥ 0.7	High
0.7 > <g> ≥ 0.3	Medium
<g> ≤ 0.3	Low

(Source: Hake, 1998)

3) Normality Test

Normality test aims to know the sample which comes from population has normal distribution or not. In this research, normality statistic test was done by using SPSS 2.0 **Kolmogorov-Smirnov** with significance level (α) of 0.07. The statistic criteria as if significance value more than 0.05, hence data is

normally distributed if the significance value more than 0.05 and data not normally distributed if the significance value is less than 0.05.

4) Homogeneity Test

Homogeneity test is used to determine a sample from population that is originated from class that homogenous. The homogeneity test in this research is also uses statistic test from SPSS 2.0, with significance level (α) of 0.259. When the significance value $\geq$ 0.05, the data are considered as homogenous (Sudjana, 2015).

5) T-Test

In order to determine whether the students have achieved the standard score after being treated with PhET simulation, a sample T-Test was done post-test score. Data was the normalized and homogened first in order to do the T-Test in SPSS 2.0. H_0 is accepted if the significance level is $\leq$ 0.05 while it will reject if its significance level $\geq$ 0.05.

1.6.4.2 Data Analysis for Students' Interest

The questionnaire is used for students' response in learning activity about PhET simulations. The analysis of questionnaire was used Microsoft Excel 2010. The data was taken from 121 students of 7th grade in one of Junior High School in Bandung. The questionnaire consists of sixteen statements about science attitude and students' self perspective about PhET simulation. This questionnaire is adapted from (Glynn & Koballa, 2009) and (Prima, Putri, & Rustaman, 2018). Sixteen number in questionnaire not only state about the positive statement but also negative statement. The distribution of positive and negative statement in the questionnaire will be explained in the Table 3.11.

Table 0.11
The Distribution of Positive and Negative Stateent in Questionnaire

Statement	The number of statement	Total number
Positive	1, 2, 4, 6, 7, 8, 9, 11, 12, 14, 15, 16, 18	13
Negative	3, 5, 10, 17, 18, 19, 20	7
Statement	The number of statement	Total number

The statements also divided into four choices of strongly agree, agree, disagree and strongly disagree. Each choice has different score based on Likert-score. The scoring of the questionnaire will be explained in Tabel 3.12.

Table 0.12
Likert Score

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Positive	4	3	2	1
Negative	1	2	3	4

1.6.4.3 Data Analysis of Correlation for Students' Understanding and Interest

The objective of correlation analysis is to analyze the relation of between two variables. The correlation will be analyzing using Pearson Correlation test in SPSS 20. The criteria correlation between two variables is shown in Table 3.13.

Table 0.13
Criteria of Correlation

Correlation	Criteria
0	No correlation
0.00-0.24	Weak correlation
0.25-0.50	Middle correlation
0.51-0.75	Strong correlation
0.76-0.99	Very strong correlation
1	Perfect correlation

(Source: Sarwono, 2009)

1.6.5 Research Procedure

There are three stages that should be performed in a research, which are preparation stage, implementation stage, and completion stage. The preparation stage is started with analyzing problems by researchers. The problems found by reading journals and books related to science teaching in Indonesia. After got some issues about science teaching learning, the writer read the journals that related to the issue. And then writer also collect some issue related to 21st century

skill on the National Curriculum 2013. After resuming the research problem statement, researcher analyzes the idea of PhET simulation, how it will be implemented on junior high school and also its relation to topic of States of Matter on National Curriculum of 2013.

This research will be performed in a school class environment. And there are some documents that need to be prepared by the researcher before the research conducted. First, the researcher needs to design the instrument for measuring the students' understanding and students' interest towards PhET simulations. The instrument consists of multiple questions, questionnaires, and interview questions. The researcher also need to design lesson plan for 3 topics in 3 classrooms, which are solid, liquid, gas subtopic; phase change subtopic; and density subtopic. After all documents prepared, it will be checked by the expert. The expert will be the lecturer from university. The expert will give suggestion to improve the quality of the research instrument. The revised instrument then tested using SPSS to determine the reliability, validity, difficulty level, discrimination power, and destructor of each question. To make sure that the instrument valid and ready to be use, the writer will do validation process to measure the quality of instrument.

After the instrument and lesson plan are ready, researcher are ready to do the research in school. During the research, researcher will be a teacher for three meeting for three 7th grade students and teach about States of Matter topic. In the beginning and in the end of teaching process, the students will be given a set of pre-test and post test questionnaires to measure the effect of PhET simulations toward students' understanding and interest on science subject. At the end of the class, researcher will interview some students and teachers to know about their opinion on PhET simulations.

The final stage of this research is completion stage, in which the researcher analyzes the result of pre-test and post-test questionnaire from all the classes. To calculate the answer on the questionnaire, researcher will use SPSS. And at the end of the research, researcher will summarize and conclude the result of the study based on data and literatures.
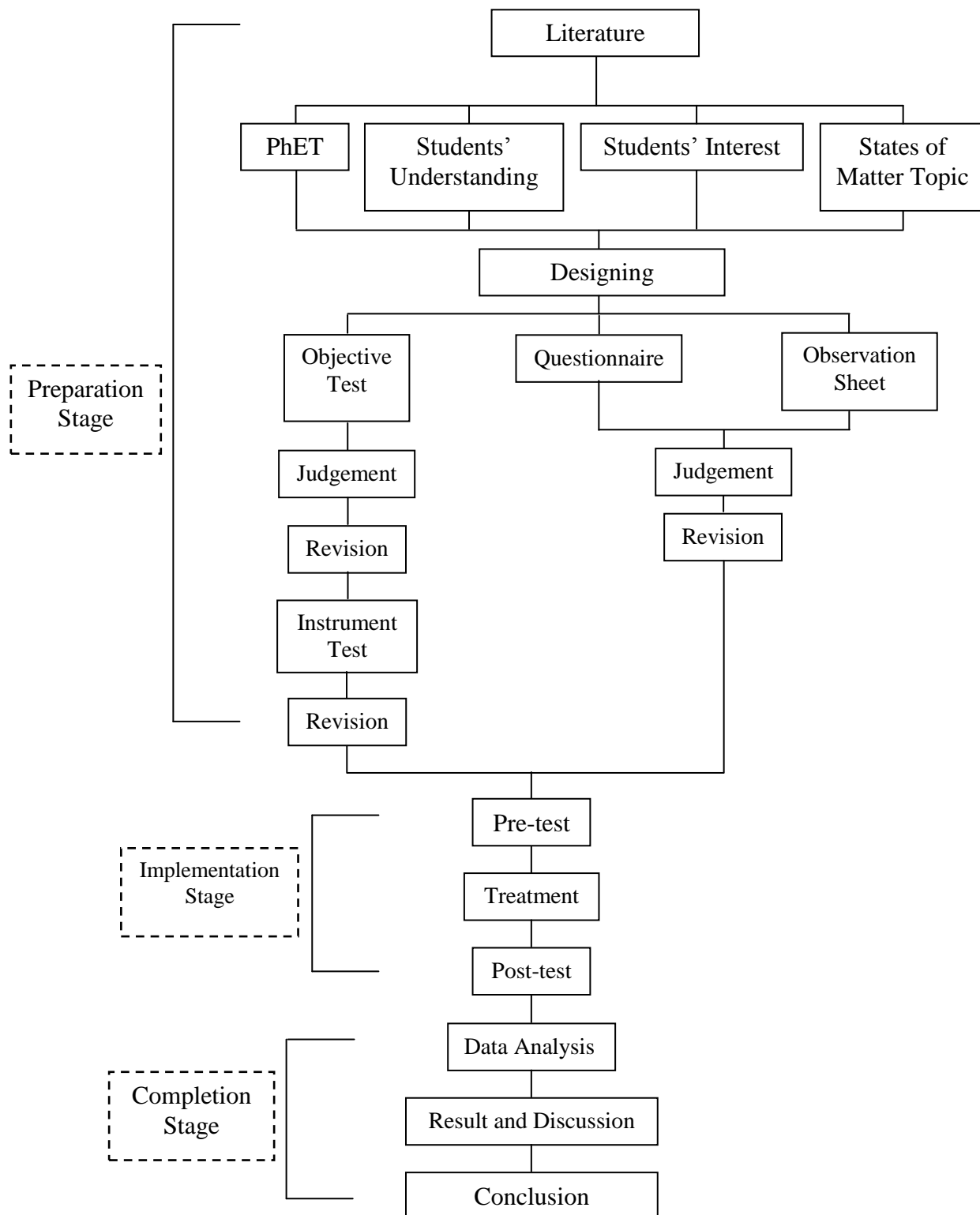
Figure 0.1 Diagram of Research Procedure