CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method

The research is aimed to analyze the profile students' critical thinking skill by using STEM e-module on environmental pollution topic. To analyze students' impression about STEM based e-module on environmental pollution topic not including its impact or effectiveness toward students' achievements. Based on the purpose of the research, the descriptive method is used to seek and to provide an accurate description of observed phenomena, this method requires a more detail analysis of various aspects of phenomena and their relationship (Fraenkel, Wallen, & Hyun, 2013).

3.2 Research Design

The design of this research is non-experimental with natural descriptive design as purposed to provide a description of educational phenomena. Current situation of research variable are elaborated descriptively and classified based on its type, characteristics or condition, then draw into conclusion (Gall, D.M, Gall P.J, Borg R, 2002). This method, the research focus to describe the profile of students critical thinking in STEM based learning by using e-module.

3.3 Population and Sample

The location of this research is Public Junior High School in Ciamis. The characteristic of the school used Indonesia language in the teaching-learning process, and implement curriculum 2013.

The population in this in this research is 7th grade students in school who have not get environmental pollution topic but familiar using a computer and the curriculum used is curriculum 2013. The samples in this research are one class which consist of 21 students.

The sampling technique was used in this research is purposive sampling. Purposive sampling that the researcher use their judgment to select sample

they believe based on previous information of the population that led the researcher to believe that sample selected would be representative of the population and will provide the data they need (Fraenkel et al., 2013). The samples in this research has been choose by the researcher as the representatives of the populations because the school doesn't apply the higher achiever class and lower achiever class.

3.4 Operational Definition

In order to avoid misconception about this research. Thus some operational definition are explain in this research, the terminologies described as follows:

1. STEM based e-module is e-module develop using Macromedia Flash, the e-module topic is environmental pollution, focus on STEM education encompasses the processes of critical thinking, analysis, and collaboration in which students integrate the processes and concepts in real world contexts of science, technology, engineering, and mathematics, fostering the development of STEM skills and competencies (Anderson, M.C, Munoz, Alicia, Neylon, Lyn, Perkin, Dough, Robinson, 2014). STEM based e-module in this research used as teaching aid, the e-module involve students to do STEM activity. The e-module contain of three chapters, in this research only use environment chapters, each chapter has STEM project and for environmental pollution the project is make water filtration. The STEM based e-module used in this research is already validate by the expert, and already develop by ("Artikel Penelitian," n.d.).
2. Critical thinking is process in which person tries to answer rationally those question that cannot be easily answered and for which all relevant information is not available, critical thought is complex process and if done well it will help us to examine intricate ideas systematically to better understand both issue and consequences. The critical thinking in this research is based on Inch critical thinking that has eight element that can lead students' to critical thinking, and the eight element is question at issue, purpose, information, concept, assumptions, point of view, interpretation and inference, implication and consequences. The critical thinking in this research measure by objectives test, the type of the test is essay open ended questions. the standardized critical thinking

test adopted from (Paul, Richard and Elder, 2007) are testing three or four of such concept as analysis, inference, synthesis, and interpretation and those standardized is tested through questions that highlight every element of critical thinking.

3.7 Research Instrument

In this research, instrument is necessary for obtain data. There are several types of instrument used in this research. Those instrument are described below:

3.7.1 Critical Thinking Objectives Test

The test item instrument used to test students' critical thinking. In this research, the critical thinking test is based on Inch's critical thinking 2006 which covers eight indicators such as questions at issue, purpose, information, concept, assumptions, point of view, interpretation and inference, implication and consequences. The type of questions is open ended essay, the questions was constructed based on eight indicator of Inch's critical thinking.

The standardized critical thinking test adopted from (Paul, Richard and Elder, 2007) are testing three or four of such concept as analysis, inference, synthesis, and interpretation and those standardized is tested through questions that highlight every element of critical thinking. The test item were judge by the experts and tested to the students who have learn about environmental pollution, and the students' answer was analyze by using ANATES (the result attached on appendix C1. recapitulation of empirical validation). The result of ANATES was use to select test item.

The rubric is used to measure students test item answer. Rubric make the assessment process more accurate and fair, and teacher is more likely to be consistent in his or her judgment (Wolf & Stevens, 2007).

3.7.2 Observation Sheet

Observation sheet was used to check whether the learning process using STEM based e-module in class was implemented right. It used to gain the qualitative data in this research. The observation sheet of this research is available at appendix B6.

3.7.3 Questionnaire of Students Impression and Teacher Response

The questionnaire was used to know the students' impression and teacher respond after using STEM based e-module. The questionnaire is consist of five aspects, there are the program, critical thinking, content, experience, and STEM based project activity. The questionnaire use Linkert scale to measure attitude, opinion, and perception (Siregar, 2013), the statement use in this research is positive statement consist of strongly agree, agree, disagree, strongly disagree. The questionnaire can be seen on table 3.1 and 3.2

Table 3. 1
Questionnaire of Students Impression to E-module.

No	Statement	SA	A	D	SD	Comment
	A. Program					
1	The e-module button is easy to click					
2	The color of e-module's button are contrast with background.					
3	The video is clear and high resolution.					
4	The picture is clear and high resolution.					
5	The color of text and background is contrast and it's easy to read.					
6	The text in the screen is proportional					
7	The font type, size and color of the text is clear so it is easy to read.					
8	The direction is easy to understand.					
	B. Critical Thinking					

No	Statement	SA	A	D	SD	Comment
1	The picture and video help me to identify an issue or problem.					
2	The objectives of the project are clear.					
3	The information develop ideas to solve the problem.					
4	The information give broad point of view.					
5	The content lead to the right decision to solve problem.					
	C. Content					
1	The animation is represents the content.					
2	The video is easy to comprehend.					
3	The content of e-module has been delivered clearly.					
4	The video and animation help me to understand the content.					
	D. Experience					
1	I don't have any problem in using e-module.					
2	There is no confusing sentences.					
3	The language is easy to comprehend					

No	Statement	SA	A	D	SD	Comment
4	I intend to use e-module to help me learn.					
5	I would choose reading electronic versions if I had options to choose between electronic copies, and printed paper for certain e-modules.					
6	I intend to increase my usage rates of electronic books in the future					
7	The e-module give me positive experience					
	E. STEM Project Activity					
1	The project solve real world problem.					
2	The project uses science concept					
3	The project integrates science, technology, engineering, and mathematics.					
4	I can choose an appropriate material to make the project					
5	I can modify the project.					
6	I can arrange clear instruction to make the project.					

No	Statement	SA	A	D	SD	Comment
7	The questions of instruction are clear.					
8	I can manage the time to make the project.					

The teacher questionnaire also has five aspect, there are aspects program, critical thinking, content, experience, and STEM based project activity. The form of teacher impressions is questionnaire used to know teacher impressions after using STEM based e-module. The questionnaire using Likert scale with positives statements, the teacher should choose strongly agree, agree, disagree and strongly disagree. The score for strongly agree is 4, agree is 3, disagree is 2, and disagree is 1. The questionnaire also provided with comment sections, to give their comment about the e-module that their use, this comment sections also used as reference for the development of e-module.

Table 3. 2
Questionnaire of Students Impression to E-module

No	Statement	SA	A	D	SD	Comment
Program						
1	The e-module is easy to click					
2	The color of e-module's button are contrast with background.					
3	The video is clear and high resolution.					
4	The picture is clear and high resolution.					
5	The color of text and background is contrast and it's easy to read.					
6	The text in the screen is proportional					
7	The font type, size and color of the text is clear so it is easy to read.					
8	The direction is easy to understand.					

No	Statement	SA	A	D	SD	Comment
Critical Thinking						
1	The picture and video lead students to identify an issue or problem.					
2	The objective of the project is clear.					
3	The information lead students to develop ideas to solve the problem.					
4	The information give broad point of view.					
5	The content lead students to the right decision to solve problem.					
Content						
1	The animation is represent the content.					
2	The video is easy to comprehend.					
3	The content of e-module has been delivered clearly.					
4	The video and animation help me to teach the content.					
5	There is no term or sentences that lead students to misconceptions.					
Experience						
1	I don't have any problem in using e-module.					
2	There is no confusing sentences.					
3	The language is easy to comprehend					
4	I intend to use e-module for teaching learning process.					
5	I would choose reading electronic versions if I had options to choose between electronic copies, and printed paper for certain e-modules.					
6	I intend to increase my usage rates of electronic books in the future					
7	I intend to use e-module to for teaching process.					

No	Statement	SA	A	D	SD	Comment
8	The e-module give me positive experience					
STEM Activity						
1	The project lead students solve real world problem.					
2	The project use science concept					
3	The project integrate science, technology, engineering, and mathematics.					

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3.8 Instrument Development and Analysis

The objective test was tested before the implementation. The instrument developed started by analyzing the eight elements of critical thinking and sub-element which suitable for the concept of environmental pollution. The objective test was validated and tested by students who already learn about environmental pollution which is 8th grade students. The objectives test consisted of discriminating power, level of difficulty, validity, and reliability.

3.8.1 Discriminating power.

Discriminating power use test item as measurement to differentiate students that mastery the competency and students who not mastery the competency (Arifin, 2013). The interpretation of discriminating power shown in table 3.3.

Table 3.3
Interpretation of Discriminating Power

D	Criteria
0,00 – 0,19	Poor
0,20 – 0,29	Fair
0,30 – 0,39	Good
40 and up	Very Good

(Source: Arifin, 2013)

3.8.2 Level of Difficulty

Measurement level of difficulty is measurement of difficulty degree the test item. The difficulty level it has to be proportional, not too easy and not too difficult (Arifin, 2013). The interpretation of difficulty level shown in table 3.4.

Table 3.4
Interpretation of Difficulty Level

P	Criteria
0,00 – 0,30	Difficult
0,31 – 0, 70	Medium

0,71 – 1,00	Easy

(Source:Arifin, 2013)

3.8.3 Validity

Validity defined as the appropriateness, correctness, meaningfulness, of the evidence that support any inferences from the scores (Fraenkel, Wallen, 2012). Before the instrument use to collecting data, instrument should be tested to fulfill the requirement of valid instrument (Susetyo, 2015). The interpretation of validity researcher use Arifin's *Evaluasi Pembelajaran* book as reference as shown in the table 3.5.

Table 3.5
Interpretation of Validity Score

r value	Validity Criteria
0,81 – 1,00	Very High
0,61 – 0,80	High
0,41 – 0,60	Medium
0,21 – 0,40	Low
0,00 – 0,20	Very Low

(Source: Arifin, 2013)

3.8.4 Reliability

Reliability refers to instrument that the result of the test is consistent or not changing or relatively the same if it is tested repeatedly (Susetyo, 2015). The reliability the researcher using Anates V4 software, and to show that the test is trusted. The interpretation of reliability instrument it shown in table 3.6.

Table 3.6
Interpretation of Reliability Instrument

Correlation Coefficient	Reliability Criteria
0,81 – 1,00	Very High
0,61 – 0,80	High
0,41 – 0,60	Medium
0,21 – 0,40	Low

0,00 – 0,20	Very Low

(Source:Arifin, 2013)

3.9 Instrument Analysis result

The instrument was made into 24 essay questions, every element of critical thinking have three questions but at the end, it will choose one question from every element of critical thinking so it has eight questions for pretest and posttest. The test item tried to 8th grade students from a Public school in Ciamis. The result of the test it is shown in table 3.7. For the reliability test, the result is 0.86 it means very good.

Table 3.7
Analysis Test Item by ANATES V4

Critical Thinking Element	Questions No	Discriminating Power		Level of Difficulty		Validity		Note
		Value	Category	Value	Category	Value	Category	
Questions at Issue	1.a	0,27	Fair	0,52	Medium	0,50	Medium	Accepted
	1.b	0,05	Poor	0,36	Medium	0,29	Low	Rejected
	1.c	0,33	Fair	0,44	Medium	0,59	Medium	Accepted
Purpose	2.a	0,38	Fair	0,36	Medium	0,67	High	Accepted
	2.b	0,33	Fair	0,22	Difficult	0,62	High	Accepted
	2.c	0,44	Good	0,27	Difficult	0,73	High	Accepted
Information	3.a	0,22	Fair	0,27	Difficult	0,46	Medium	Accepted
	3.b	0,16	Poor	0,30	Difficult	0,32	Low	Rejected

Critical Thinking Element	Questions No	Discriminating Power		Level of Difficulty		Validity		Note
		Value	Category	Value	Category	Value	Category	
	3.c	0,11	Poor	0,16	Difficult	0,29	Low	Rejected
Concept	4.a	0,11	Poor	0,11	Difficult	0,27	Low	Rejected
	4.b	0,05	Poor	0,02	Difficult	0,26	Low	Rejected
	4.c	0,11	Poor	0,16	Difficult	0,41	Medium	Accepted
Assumption	5.a	0,16	Poor	0,25	Difficult	0,21	Low	Rejected
	5.b	0,38	Fair	0,41	Medium	0,56	Medium	Accepted
	5.c	0,05	Poor	0,25	Difficult	0,12	Very Low	Rejected
	6.a	0,16	Poor	0,13	Difficult	0,35	Low	Revised
Point of View	6.b	-0,05	Poor	0,13	Difficult	-0,18	Very Low	Rejected
	6.c	0,11	Poor	0,16	Difficult	0,28	Low	Revised
Interpretation and Inference	7.a	0,05	Poor	0,25	Difficult	0,25	Low	Rejected
	7.b	0,11	Poor	0,05	Difficult	-0,01	Very Low	Rejected
	7.c	0,11	Poor	0,22	Difficult	0,36	Low	Revised
Implication and Conceq uences	8.a	0,22	Fair	0,16	Difficult	0,44	Medium	Accepted
	8.b	0,05	Poor	0,25	Difficult	0,09	Very Low	Rejected
	8.c	0,16	Poor	0,36	Medium	0,47	Medium	Accepted

3.10 Data Processing Technique

3.10.1 Score of Test Item

To analyze the data critical thinking skills and observation sheet, it processed by counting the percentage to analyze the result descriptively. The formula that used in this research shown below.

$$\text{Percentage of critical thinking skills} = \frac{\text{Gain of score}}{\text{Total score}} \times 100\% \quad (3.1)$$

The interpretation criteria of critical thinking use (Yuliati et al., 2018) as reference as shown in the table 3.8.

Table 3.8
The Criteria of Critical Thinking

Test Score	Criteria
2.26 – 3.00	Very Critical
1.51 – 2.25	Critical
0.76 – 1.50	Enough Critical
0 – 0.75	Not Critical

3.10.2 Calculating Questionnaire of Impression

The questionnaire consists of positive statement with the Linkert scale strongly agree, agree, disagree, and strongly disagree. For the scoring is 4 for strongly agree, 3 for agree , 2 for disagree , 1 is for strongly disagree (Siregar, 2013). To measure the value of students impression by multiplying total response score by the value of response and divide it by the total number of respondent (Mahfira, Sanjaya, & Rusyati, 2018). The interpretation of students' impression value in table 3.9.

$$Students\ imprssion\ value = \frac{total\ score\ valaue}{total\ number\ of\ respondent}$$

Table 3.9
Interpretation of students Impression Value

Value	Interpretation
<3.00	Negative Impression
>3.00	Positive Impression

(Source: Mahfira et al., 2018)

3.11 Research Procedure

To make the research systematically arrange, the procedure of the research is divided into three stages which is preparation, implementation, and completion. In preparation stages the researcher identified the problem, formulate the research objectives, analyzed the eight element of critical thinking, curriculum 2013, STEM based e-module, determined the topic. After that make the literature review of critical thinking, STEM based e-module, and literature review about environmental pollution topic. And then finding the appropriate school for conducted the research. The last stage, on preparing stage is making instrument and validate it to the expert, and tested to the students, after that revise the instrument before used it as the instrument to measure the critical thinking skills.

The Implementation stage, there are three procedure. The first is implanted the e-module, the second is give objective test, and the last is collected data from teacher and students questionnaire. The last stages is analyzed that has been collected, make the discussions based on the result analysis, the last is make the conclusions and completing the research.

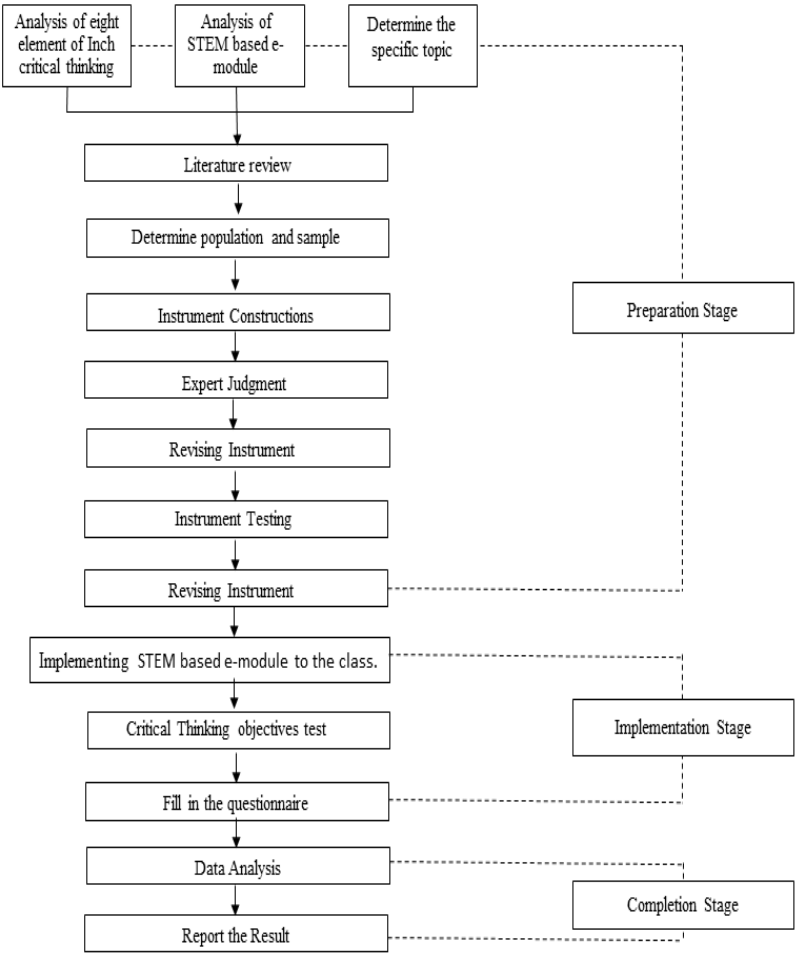

Figure 3. 1 Research Procedure