

CHAPTER III

RESEARCH METHODOLOGY

3.1. Research Design

The study was used quasi-experimental because the random assignment is not used (Fraenkel et al., 2012). The research design used the matching-only posttest design. This arrangement involves two groups. The experiment class using practicum drawing based modeling and the control class using practicum diagram of food web.

Table 3.1 The matching-only posttest design (Fraenkel et al., 2012).

Experiment Class	X_1	O
Control Class	X_2	O

X_1 = drawing – based modeling X_2 = diagram of food web

O = post test

The matching-only posttest design is chosen because the researcher considers that two classes which were chosen had similar the average score, and the purpose of this study for the first time wanted to know drawing based modeling can stimulate students' understanding and argumentation. This study analyzed the effect of drawing based modeling and diagram of food web on students' understanding and argumentation skills on the concept of ecosystem. To clarify the research design, the variables used as follows.

1. Independent variable: drawing based modeling and diagram of food web on the concept of ecosystem.
2. Dependent variable: students' understanding and argumentation on the concept of ecosystem.
3. Moderator variable: the level of development of students' reasoning abilities and teacher's teaching strategies.
4. Intervenning variable: sex, age, ethnic of the students, teacher's education history, and teacher's gender.
5. Control variable: tenth-grade students and students' domicile (Subang).

3.2. Population and Sample

The research was conducted at one public school in Subang, West Java, in tenth-grade senior high school of natural science majors that applied curriculum 2013 during instructional process. Data is obtained in the period April until Mei 2017. A population is defined as generalization consists of subjects that cover whole quality and specific properties; meanwhile, the sample is a part of whole quality and specific properties of a population (Sugiyono, 2008).

The populations in this research are students' understanding and students' argumentation skills. Sampling method used purposive sampling. Purposive sampling was used because the researcher has special qualifications of some sort or is deemed representative on the basis of prior evidence (Fraenkel et al., 2012). Two classes were selected on the basis of the researcher's consideration that the two classes which were chosen had a similar average score. The sample from two different classes is consisting of 64 students. They are placed into two groups; 32 students in the experiment class and 32 students in the control class.

3.3. Operational Definition

An operational definition is required in order to give the clarity of the research that has to be suitable the expected aims that described as follows:

1. Drawing based modeling in this study used SimSketch as an online computer program that enables students to create the model based on scientific phenomena and run the model into a simulation. All students' activities when doing modeling assignment were recorded by using the application program 4video screen capture for computer or laptop and DU recorder for tablet or smartphone.
2. The students' understanding of the concepts of the ecosystem is measured by using the objective test in form of 30 multiple choice questions as a posttest. The objective test was developed based on the revised of Bloom's Taxonomy cognitive domain in the cognitive level of remembering (C1), understanding (C2), applying (C3), analyzing (C4), and evaluating (C5).
3. The students' individual and group argumentations are based on written arguments expressed by students' answers on the worksheet when they doing

individual task and group task which involve group discussion. The students' level and coherency arguments were measured by using rubrics.

4. The students' argumentation in this study is measured by using argumentation test which is focused on the concept interaction, especially predator-prey system in the food web. The students' level and coherence of arguments were measured by using rubrics.

3.4. Instruments

There are three types instruments used in this research to measure students' understanding and argumentation skills, they are objective test, students' worksheet, and written argumentation test. The steps to develop each instrument administered in this study explain as follows.

1. Judgement

The instruments were first reviewed for its construct and content validity by author's supervisor. The judgement sessions were held during several sessions. After each judgment sessions the instruments were revised. After the instruments were approved by the first supervisor, they were then administered in the pilot testing.

2. Try out

After judgment session the instruments were administered in a pilot testing session to test its' criterion validity. The try out was done to a sample of the kinds of individual that will be required to respond in the final data collection. Since the participant of this research was high school students. A total of 39 high school students, the instrument were being tested to a sample of students who already learned the ecosystem concept.

3. Factor Analysis

After pilot testing, the quantitative instruments were analyzed using a test item analysis. The objective test was analyzed using the ANATES V.4, the analysis itself encompassed these aspects; validity, reliability, difficulty level and discriminating power.

Three types' instruments used in this research to measure students' understanding and argumentation skills were used objective test, students'

worksheet, and written argumentation test. The explanation of instruments as follows.

1. Objective test

The instruments were being tested to a sample of students who already learned the ecosystem topic. A total 39 senior high school students were as participant in this study. After pilot testing, the instruments were analyzed using the ANATES V.4 to measure the validity, reliability, difficulty level, and discriminating power.

Table 3.2 The blue print of objective test item before revision

Sub Topics	Level of cognitive domain					Total	Percentage
	C1	C2	C3	C4	C5		
Component of the ecosystem	1	2	-	-	-	2	5%
Interactions	3,4,5,6,18	7,8,9,11,12,13,15,16	17,19,22,23,24	10,14,20,25,26,27	21,28,29,30	28	70%
Energy flows	31,36	32	33	34,35	-	6	15%
Biogeochemical cycle	37	38	-	-	39,40	4	10%
Total	9	11	6	8	6	40	100%
Percentage	22,5%	27,5%	15%	20%	15%	100%	

The entire test item were judged by the experts and tested to the students that have learned about the concept of Ecosystem, then after that the students' answer was analyzed using a ANATES software. The result of ANATES was being the consideration to eliminate the test items. Some of the test items were selected, revised or deleted. The new blue print of the objective test was arranged and used as the fix research instrument. From 40 test items, there are 30 test items used. The new blue print of objective test items after being analyzed and revised was shown in the Table 3.4.

Before the objective test being used, the objective test was tested to the students that have learned about ecosystem concept, which are the students of 11th grade in the same school of the sample students. Before analyzed and judged. Objective test consist of 40 questions. The validity, reliability, discriminating power and difficulty level of instrument was analyzed. The test was given to 39

11th grade students. The recapitulation of objective test analysis result is shown in the table 3.3.

Test item recapitulation

Reliability test: 0, 83

Table 3.3 The recapitulation of objective test analysis result

Question number	Discriminating power (%)	Difficulty level	Validity	Decision	New Number question
1	45,45	Medium	0,341	Used	1
2	45,45	Easy	0,357	Used	2
3	45,45	Easy	0,369	Used	3
4	18,18	Medium	0,138	Rejected	-
5	45,45	Medium	0,372	Used	4
6	81,82	Medium	0,643	Used	5
7	9,09	Very easy	0,092	Rejected	-
8	54,55	Easy	0,529	Used	6
9	72,73	Hard	0,570	Used	7
10	-27,27	Hard	-0,202	Rejected	-
11	18,18	Medium	0,197	Rejected	-
12	45,45	Hard	0,426	Used	8
13	0,00	Medium	0,109	Rejected	-
14	27,27	Very easy	0,293	Rejected	-
15	36,36	Hard	0,494	Used	9
16	36,36	Medium	0,272	Revised	10
17	18,18	Medium	0,134	Rejected	-
18	18,18	Medium	0,155	Rejected	-
19	18,18	Easy	0,142	Rejected	-
20	45,45	Hard	0,448	Used	11
21	45,45	Medium	0,424	Used	12
22	18,18	Very hard	0,353	Used	13
23	27,27	Easy	0,241	Revised	14
24	72,73	Medium	0,572	Used	15
25	45,45	Medium	0,475	Used	16
26	45,45	Medium	0,387	Used	17
27	36,36	Medium	0,409	Used	18
28	63,64	Medium	0,541	Used	19
29	54,55	Medium	0,452	Used	20
30	72,73	Easy	0,592	Used	21
31	63,64	Medium	0,462	Used	22
32	72,73	Medium	0,507	Used	23
33	18,18	Hard	0,273	Revised	24
34	54,55	Medium	0,436	Used	25
35	36,36	Medium	0,276	Revised	26
36	27,27	Medium	0,189	Rejected	-
37	27,27	Medium	0,191	Used	27
38	36,36	Hard	0,349	Used	28
39	27,27	Medium	0,280	Revised	29

40	36,36	Hard	0,426	Used	30
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The test item has been tested in terms of validity, reliability, discriminating power and difficulty level also judged by several experts then revised so that it is adequate to be used as the research instrument to obtain the data of students' mastery. The following table is the blue print of objective test as the research instrument to determine students' understanding which is based on cognitive domain.

Table 3.4 The blue print of objective test after analyzed

Sub Topics	Level of cognitive domain/number of questions					Total	Percentage
	C1	C2	C3	C4	C5		
Component of the ecosystem	1	2	-	-	-	2	6,67%
Interactions	3,4,5	6,7,8	9,10, 13,14 15	11,16, 17,18	12,19, 20,21	19	63,33%
Energy flows	22	23	24	25,26	-	5	16,67%
Biogeochemical cycle	27	28	-	-	29,30	4	13,33%
Total	6	6	6	6	6	30	100%
Percentage	20%	20%	20%	20%	20%	100%	

2. Students' worksheet

To obtain the data of participants' self-regulated learning during the learning activity, participants were required to complete two types of worksheet: individual and group worksheet. There are five essay questions and two of them are related to students' argumentation. Question no. 3 is related to students' individual argumentation and question no. 5 is related to group argumentation. The students' worksheet can be seen in Appendix 2.

3. Written Argumentation Test

The essay test is used for determining the quality of students' written argumentation skill in answering the questions provided by the teacher. The questions consist of six questions regarding the concept of interaction, especially on the predator-prey system. It will be assessed based on the Toulmin's Argumentation pattern which is data, claim, warrant, backing, qualifier, and rebuttal. The argumentation test had already consulted and validated by the

supervisor in a related field in order to modify or revise argumentation test that was not appropriate with the content, or argumentation component based on Toulmin. The blueprint of written argumentation test is shown in Table 3.5 and the example of written argumentation is shown in Table 3.6.

Table 3.5 The blue print of written argumentation test

No	Subtopic	Questions indicator	Level of cognitive domain
Case study 1	Interactions	1. Analyzing the causal factors of caterpillar explosion phenomena	C4
		2. Predicting the explosion of caterpillars in the future	C2
		3. Assessing the use of pesticides to outgrow the phenomenon of caterpillar explosion	C5
Case study 2		4. Analyzing the causal factors of Tomcat explosion phenomena	C4
		5. Predicting the explosion of Tomcat in the future	C2
		6. Assessing the use of insecticides to outgrow the explosion of Tomcat	C5

Table 3.6 The example of written argumentation test

No	Question
1	<p>Tahun 2011 lalu, terjadi ledakan populasi ulat bulu di sejumlah daerah seperti di Kabupaten Probolinggo, Mojokerto, Jombang dan Provinsi Bali. Dalam catatan guru besar Ilmu Hama Tanaman IPB, Prof Aunu Rauf, setidaknya ada 4 peristiwa ledakan populasi ulat bulu. Di Pasar Minggu (Jaksel) pada tahun 1980, ulat jambu alias <i>Trabala vishnou</i> pernah mengalami ledakan. Kasus lainnya ditemukan di Bogor pada tahun 1985 saat populasi <i>Maenas maculifascia</i> menyerang kenanga. Ulat flamboyan alias <i>Pericyma cruegeri</i> pernah mengalami ledakan populasi di Bogor pada 1994. <i>Hyperaeschrella insulicola</i> alias ulat rambutan bahkan meledak populasinya di Subang hampir setiap 3 tahun.</p>  <p>Sumber : Detiknews, Rabu 13 April 2011.</p> <p>Pertanyaan :</p> <ol style="list-style-type: none"> Berdasarkan kasus di atas, Apa penyebab terjadinya fenomena ledakan ulat bulu? Jelaskan alasan kalian! Berikan bukti yang mendukung jawaban kalian!

3.5. Data Processing and Analysis

3.5.1. Students' Understanding

Students' understanding test in the form of multiple choice questions that are consist of 30 questions. Based on arrangement of cognitive level from C1 (remembering) until C5(Evaluating) will be assessed based on scoring. The students' answer was analyzed by using ANATES after objective test. Data analysis was done by calculating the score of cognitive in posttest only. For each correct answer will be given score 1 whereas wrong answer will be given score 0. Scores then will be converted into 0-100 scale value.

$$\text{Students' score} = \frac{\text{total right answer}}{\text{maximum score}} \times 100$$

In this research, the next step in analysis is testing the instrument. The data was gained from 64 students of 10th grade in a senior high school. After the data have already been collected, ANATES was used to analysis the validity, reliability, difficulty level, and discriminating power. Data statistical analysis is needed to support the data of improvement students' understanding and to prove the hypothesis test. The steps were obtained as follow.

a. Normality test

Normality test is executed in order to analyze whether samples comes from population that has normal distribution or not. SPSS version 16.0 is used as supporting software to determine normality test for each posttest based on Kolmogorov – Smirnov. Data is considered as normal distribution if the criterion is higher than assumption of significance in two tailed.

b. Homogeneity test

The data was obtained is from normal distributed, the next step is homogeneity test. In this research Levene's test was chosen. Levene's test (Levene, 1960) is used to tests if samples have equal variance. The equal variance across sample is called homogeneity variance. Homogeneity test is needed because to determine a sample from population that is originated from two classes that homogenous. The homogeneity test used significance level (α) 0,05. When significance value is $\geq 0,05$, data is considered as homogenous (Sudjana, 2005).

c. Hypothesis test : Parametric test

Parametric test is used in certain condition of result data research, the normal data distribution and homogenous data. Parametric test method are classify in to one sample T-test, independent sample T-test, summary independent sample T-test and paired sample T-test. Meanwhile this research was adapted the independent sample T-test because the data is two unrelated groups on the same continuous, dependent variable.

3.5.2. Students' argumentation rubric

The data analysis technique for students' argumentation skills was done by audio–video recording. The transcription process was done only during the discussion session in learning activities. Audio-video transcription only uses to support the data. Students' level of arguments and coherence of arguments were analyzed based on students' answer of worksheet and written argumentation test using modified rubric in table 3.7 and 3.8.

Table 3.7 Level of students' argument (Widodo et al., 2016)

Level	Description	Example
1	Present a claim only.	I am going to use pesticide (<i>claim</i>).
2	Present a claim and data and/or warrant.	I am going to use pesticide (<i>claim</i>) because pesticide contains chemicals that will kill the insects (<i>data</i>), so that the number of the pests will decrease (<i>warrant</i>).
3	Present <i>claim, data, warrant, and backing/ qualifier/ rebuttal</i> .	I am going to use pesticide (<i>claim</i>), but I will choose only natural pesticide (<i>qualifier</i>) because pesticide contains chemicals that kills pests (<i>data</i>) The number of the pests will decrease (<i>warrant</i>).
4	Presents <i>claim, data, warrant, backing, and qualifier/ rebuttal</i> .	I am going to use pesticide (<i>claim</i>), but I will choose only natural pesticide (<i>qualifier</i>) It is because pesticide contains chemicals that kills pests (<i>data</i>) The number of the pests will decrease (<i>warrant</i>) because pesticides kills pests (<i>backing</i>).

Level	Description	Example
5	Presents all components of argumentations: <i>claim, data, warrant, backing, qualifier, and rebuttal.</i>	I am going to use pesticide (<i>claim</i>) although I know that pesticide is not good for the environment (<i>rebuttal</i>) It is better to use natural pesticide (<i>qualifier</i>) because pesticide contains chemicals that kills pests (<i>data</i>) The number of the pests will decrease (<i>warrant</i>) because pesticides kills pests (<i>backing</i>).

Table 3.8 Level of coherency and relationship between components in the examination scripts (Widodo et al., 2016)

Category	Description of the rubric
Higher coherency	<i>Claim is logic and is supported by a correct and relevant grounds (data, warrant, backing)</i> Example: To fights rice pests we can use controlled insecticide and natural predators of the insect insecticides works by affecting the physiology of the insects while predators prey the insects.
Reasonable coherency	<i>Claim is logically make sense and is supported by sound ground.</i> Example: I am going to use insecticide because it will kill pests.
Limited coherency	<i>Claim logically makes sense but no supporting grounds or the ground is incorrect or irrelevant.</i> <i>Claim doesn't logically make sense and provides no supporting grounds.</i> Example: Building a wooden fence around the rice field to protect rice field from pests.

The number of student arguments for each level of argument in each class is calculated in percent by using the formula proposed by Purwanto (2010) as follows.

$$PV = \frac{R}{MS} \times 100\%$$

Where:

PV = Percent value sought or expected

R = The raw score obtained (in this study: the number of arguments that

exist at the level determined)

MS = Ideal expected maximum score (in this study: the total number of students' argument in determined class

3.6. Research Procedures

This research is carried out into three stages; preparation, implementation, and final stage. The stages description will be explained as follows:

1. Preparation stage

- a. Preliminary study on the students' problem and characteristics.
- b. Conducting literature study from various resources such as book, journals, and articles.
- c. Analyze the science content of senior high school literature review is conducted to support the concept.
- d. Formulate research problem and question.
- e. Design the implementation including designing the lesson plan, teaching sequences.
- f. Designing the instruments as tool to collect data which consist of objective test, student's worksheet, and written argumentation test.
- g. Judging the instrument such as objective test, student's worksheet, and written argumentation test.
- h. Revising the instruments based on experts' suggestion.
- i. Conducting test for multiple choices question and analyze the result test by ANATES.

2. Implementation stage

- a. Students in the experimental class were introduced about how to use SimSketch, especially this training is more emphasized on how to use modeling tools contained in SimSketch. This activity is conducted during one session or 45 minutes outside the time of the research. Initial test students use their mobile phones to access SimSketch because SimSketch can be accessed online but cannot be stored directly, therefore, we use other software to record modeling activities using SimSketch i.e. DU

recorder application for on handphone/tablet and 4video screen capture for students that use laptop/netbook. Students can access SimSketch on their handphone but when will operate not all students' handphone support the program because of different specification so we decided to use the computer which is in school computer lab. Luckily computers in the school labs and wifi facilities support. Generally, students are able to operate SimSketch but they are a little bit confused with the language of instruction in SimSketch because it uses the Dutch language, but they could follow and implement well. The example of students' activity using SimSketch can be seen as follow:

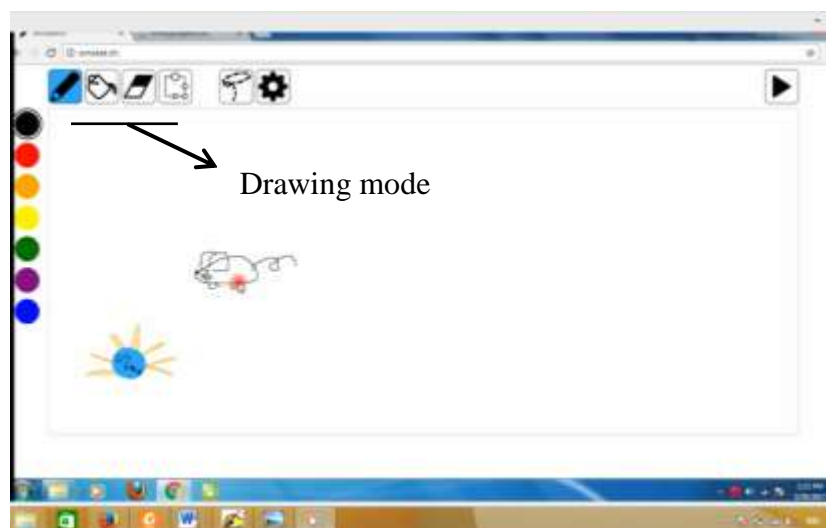


Figure 3.1 Drawing modes such as pencil is used to drawing object or models

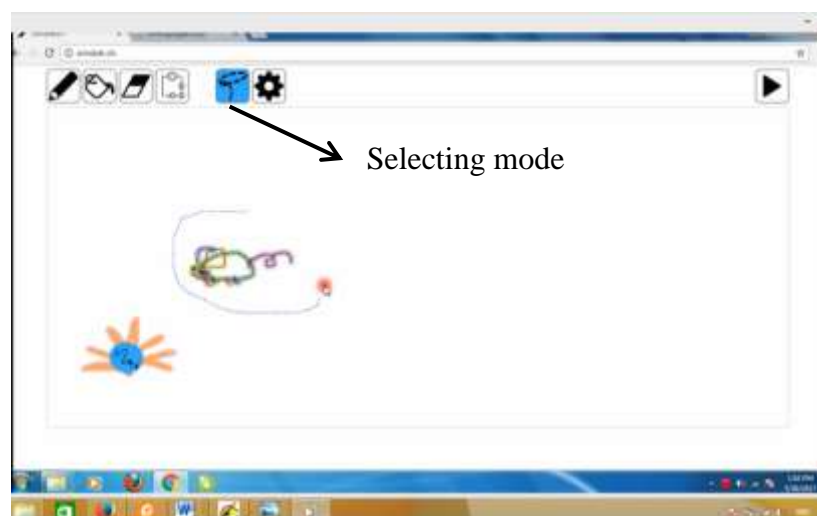


Figure 3.2 Selecting modes is used to consider as one object by the program can be selected by drawing a circle around them

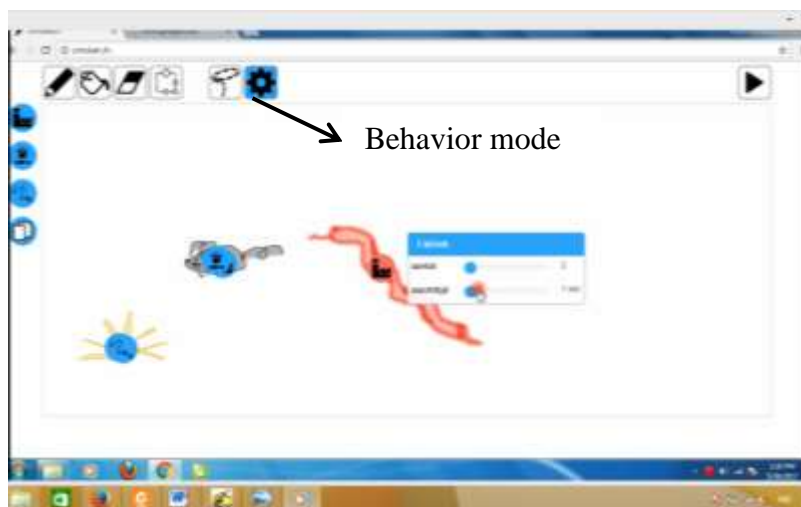


Figure 3.3 Behavior modes on SimSketch

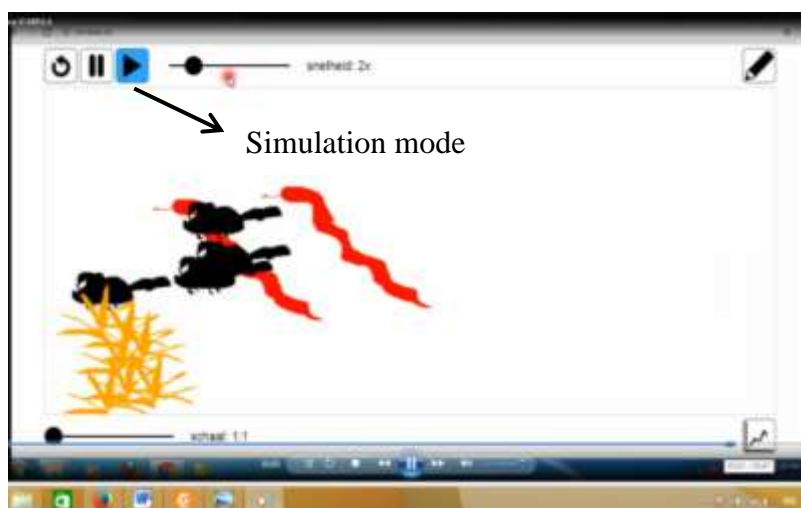


Figure 3.4 Models when simulation

- b. Practical activity was conducted during the 3-hour lesson or one meeting, both experimental class and control class is equipped with students' worksheet. The activities of the practicum focus on the sub-topic of interaction, especially the predator-prey system that composes the food web in rice field ecosystem. The practice is divided into individual and group task. In the group task, students held discussions with each member of the group. All practicum activities are recorded. The transcripts of the students' conversations recorded during the group work are only used as

supporting research data. While students' arguments analyzed were individual argument and group argument in writing based on student answer in students' worksheet. The next activity was followed by a class discussion of the subtopics of energy flow. Documentation of this activity can be seen in Appendix 13. To distinguish teaching process done in experiment and control class can be seen in the table 3.9.

Table 3.9 Learning scenario in experiment class and control class

Experiment class	Control class	Time
Fist meeting (3x45 minutes)		
Opening activity		
<ul style="list-style-type: none"> • <i>Teacher greets students</i> • <i>Brainstorm students' knowledge on biotic and a biotic component in ecosystem</i> • <i>Teacher explains goals and purpose of ecosystem learning Students are formed into several groups</i> 	<ul style="list-style-type: none"> • <i>Teacher greets students</i> • <i>Brainstorm students' knowledge on biotic and a biotic component in ecosystem</i> • <i>Teacher explains goals and purpose of ecosystem learning Students are formed into several groups</i> 	15'
Main activity		
<ul style="list-style-type: none"> • <i>Students observe several kinds picture of ecosystem interaction</i> • <i>Brainstorms on ecosystem interaction</i> • <i>Students ask related questions to ecosystem interactions</i> • <i>Teacher give worksheet on individual and group works</i> • <i>Students open 4video screen capture on computer to record their activity on their individual and group work</i> • <i>Individually, student draw models/drawing use Simsketch online application to be simulated into 30 minutes duration to answer worksheet.</i> • <i>In group, student have their</i> 	<ul style="list-style-type: none"> • <i>Students observe several kinds picture of ecosystem interaction</i> • <i>Brainstorms on ecosystem interaction</i> • <i>Teacher gives individual and group worksheet on creating food web</i> • <i>Teacher records students' activity</i> • <i>Individually, students arrange animal and plants picture on diagram as explained on worksheet to answer the following questions</i> • <i>In group works, students have discussion to revise and complete interaction diagram to be more complex and to answer the worksheet.</i> 	100'

Experiment class	Control class	Time
<p><i>discussion among the rest members to complete their answer on worksheet</i></p> <ul style="list-style-type: none"> • <i>Students have their discussion on correlation between food web and energy flow</i> 	<ul style="list-style-type: none"> • <i>Students have their discussion on correlation between food web and energy flow</i> 	
Closing activity		
<ul style="list-style-type: none"> • <i>Teacher and students make summary about interaction in ecosystem.</i> • <i>Students submit individual and group worksheet and recorded activity</i> • <i>Teacher says leave taking</i> 	<ul style="list-style-type: none"> • <i>Teacher and students make a conclusion on interaction in ecosystem</i> • <i>Students submit their worksheet and food web diagram</i> • <i>Teacher says leave taking</i> 	20'
Second meeting (3x45 minutes)		
Opening activity		
<ul style="list-style-type: none"> • <i>Teacher says greeting</i> • <i>Teacher reviews the prior material on correlation among energy flow, food chain and food web</i> 	<ul style="list-style-type: none"> • <i>Teacher says greeting</i> • <i>Teacher reviews the correlation among energy flow, food chain and food web</i> 	10'
Main activity		
<ul style="list-style-type: none"> • <i>Students observe kinds of biogeochemical pictures on slides</i> • <i>In each group, students are asked to have discussion on kinds of biogeochemical cycle</i> • <i>The spoke persons of each group present their discussion result</i> 	<ul style="list-style-type: none"> • <i>Students observe kinds of biogeochemical cycle on slides</i> • <i>Teacher asks students to be involved in groups to have their own discussion on biogeochemical</i> • <i>The spoke person of each group presents the results of their discussion</i> 	60'
Closing activity		
<ul style="list-style-type: none"> • <i>Teacher and students review the important material on biogeochemical cycle</i> • <i>Teacher gives post test</i> • <i>Teacher says leave taking</i> 	<ul style="list-style-type: none"> • <i>Teacher and students draw conclusion on biogeochemical</i> • <i>Teacher gives post test</i> • <i>Teacher says leave taking</i> 	65'

3. Final stage

Final stages consist of data processing, data analysis, inferring, and final report making. Deeper analysis how significance of students' understanding towards

cognitive learning outcomes will be discussed based on statistical method and valid literatures. Recommendation for further research is also arranged to produce better research outcome in the future.

- a. Collecting data as result discussion in video audio transcript
- b. All of data are calculated
- c. The result of data calculation are analyzed
- d. Constructing the discussion to elaborate the result of analysis related to theoretical foundation
- e. Consulting the research result with the lecture
- f. Drawing the conclusion based on result analysis
- g. Recommendation that conduct after finishing the implementation that what should avoid in this research to next research with same research