# CHAPTER III
# RESEARCH METHODOLOGY

## 3.1 Research Method

In this research, the research method that was used is pre-eperimental method. Pre-experimental are research method was observed after a treatment has been applied to test whether the treatment has the potential to cause change (Poellhuber, 2020). This research was used one group pre-test and post-test design. This method is suitable with the objectives of this research which is to improve the impact of Draw IO as digital mind map on students' concept mastery and students' creativity in learning human influence on ecosystem.

## 3.2 Research Design

This research was used One Group Pre-test and Post-test Design. Pre test and post test design is a type of research design that is most often utilized by the researchers to determine the effect of a treatment or intervention on a given sample (Creswell, 2014). This research design is characterized by two features. All the participants assigned to experimental group. The participants are given the treatments. The treatments is applying Draw IO as a digital mind map on their learning activities. Within pretest and posttest research designs, the treatment effects will be determined by calculating the difference between the first assessment and the second assesments. The diffferences between pre-test to the post-test design are the outcome of interest, which are presumed to be the result of the intervention (Creswell, 2014). This research design used to see the use of Draw IO as digital mind map to improve Students' concept mastery and students' creativity in learning human influence on ecosystem topic. The research design shown in table 3.1 below

**Table 3.1**
Pre and Post Test Design

| $O_1$ | X | $O_2$ |
|---|---|---|
| Pre Test | Treatment (Mind map) | Post Test |

## 3.3 Population and Sampling

This research was conducted in one of the International private school in Bandung Barat which used Cambridge Curricullum. There were 29 students on grade $9^{th}$ which consist of Human Influences on Ecosystem topic in their learning process. There were 16 female students and 13 male students who participated on this research.

The sampling technique in this research was used cluster sampling. Cluster sampling is is a probability sampling technique where researchers divide the population into multiple groups (clusters) for research. (Creswell, 2014). This research was used multiple stage cluster sampling. Multiple stage cluster sampling is sampling method that divides the population into groups (or clusters) for conducting research. Significant clusters of the selected people are split into sub-groups at various stages to make it simpler for primary data collection. The total of classes in secondary 3 level on this school are 3 classes. This research was used multiple stage cluster sampling it means that only one classes was participated for this research.

## 3.4 Operational Definition

In order to get the expected goals and avoid misunderstandings in interpreting the existing term in this research. Fred Kerlinger (1966) in *Foundation of Behavioral Research* book stated that operational definition spells out what the researcher must do by defining and giving meaning of the variable in order to measure the variable itself. In this research, operational definition of terms is cleared as follows:

### 3.4.1 Mind Map

Mind map is one of learning media of the students. In the mind map there are a lot information in simple way. Mind map can help students easy to understand about the topic. On the other hand, mind map is interesting learning media because it consists of color, picture, emoticons, and font type. In this research, students will create a mind map in human influence on ecosystems topic and the implementation of the mind map will be observed by the observer.

### 3.4.2 Students' Concept Mastery

Students' Concept Mastery that used in this research based on the cognitive domain by Bloom's Taxonomy is remembering (C1), understanding (C2), applying (C3), and analyzing (C4). This competence was measured by objective test, which consisted of the multiple-choice questions and essay questions (pre-test, before treatment, applied treatment on students and post-test, after treatment).

### 3.4.3 Students' Creativity

Students' creativity in this research is creativity of students after creating the mind map The indicator of creativity used in this research referred to the indicator developed by Guilfrod Rubric, namely fluency thinking skill, flexibility thinking skill, originality thinking skill, and elaboration thinking skill.

### 3.4.4 Human Influence on Ecosystems

In this research, human influence on ecosystems will be main topic for the students. The students will integrate the topic into physics, chemistry, and biology.

## 3.5 Assumption

According to the literature review, it could be assumed that

a. Mind Map would become a useful learning product for students' concept mastery the concept to get better score results in final test.
b. Mind Map would become a helpful learning product to trigger students to make creative product.

## 3.6 Hypothesis

To analyze hypothesis more significant by using pretest and posttest, the hypothesis for this research is:

a. $H_0$: There are no significant differences in students' concept mastery and students' creativity in learning human influence on ecosystems by using Draw IO as digital mind map.
b. $H_1$: There are significant differences in students' concept mastery and students' creativity in learning human influence on ecosystems by using Draw IO as digital mind map.

### 3.7 Cognitive Aspect Test

Cognitive aspect test is in form of multiple choices questions in order to describe the cognitive ability of students in understanding the concept and based on the Bloom Taxonomy revised. The level of cognitive process dimension that is measured is from C1 to C4.

In order to modify or revise the test item that was not appropriate with the content, distractor or question statement, the instrument will be consulting to the judge by some lectures and experts from related field. Table 3.2 shown the blue print planning for the test item.

**Table 3.2**
Blue print of Cognitive test item

| Topic | Cognitive Process Dimension and Number Of Test Item | | | | | |
|---|---|---|---|---|---|---|
| | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** |
| Food Supply | 1 | 2,3 | | | | |
| Extract Natural Resources | 4 | 5,6 | | | | |
| Deforestation | 8,22 | 7,21,23,24 | 10 | 9 | | |
| Marine Pollution | | 11,12,13 | | 13 | | |
| Removal Habitat | 15 | | 14,25,26 | | | |
| Pollution | 27 | 17,29,30 | 16,20 | 18,19,28 | | |

In order to make the research instrument is appropriate for the research itself; the instrument analysis of cognitive aspect test requires validity, reliability, difficulty level, and discriminating power. Based on basic competence, the questions on this instruments should be C3, C4, C5, and C6. In fact, on this instrument there are a lot of questions on C1 and C2. This instruments should be improved to the high level. Hopefully for the next researcher, they can consider the questions based on basic competence.

### 3.8 Research Instrument Analysis Based on Validation

The cognitive test was analyzed based on students validation and the judgments from the expert. The students validation was conducted in public school on 9$^{th}$ grade students. The participants of students validation were 30 students. All the students had studied human influences on ecosystems topic in 7$^{th}$

grade . The instruments consist of 30 questions in multiple choice. The concept in the questions are food supply, habitat destruction, and pollution. Cognitive domain based on the assesments of the revised Bloom's Taxonomy. Data analysis for students validation using ANATES V4 for multiple choice questions.

**1) Validity**

Validity is the most important characteristic of any test. Validity refers to the correctness, meaningfulness and usefulness of the specific conclusion that is collected (Fraenkel, 2011). Validation is the process to support the inference by collecting and analyzing evidence (Fraenkel, 2011). The software of ANATES was used in the process of validity of the instrument. The formula is described below:

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (XY)^2]}}$$

Where,

r = Correlation coefficient between x and y variable

N = Number of students

X = Total score in test item

Y = Total score of student'

(Fraenkel, 2011)

The formula above can be used to determine the validity of the sample item. The result from ANATES for the validity on this research instrument shown on the table 3.3:

**Table 3.3**
Validity Score

| Questions | Validation | Questions | Validation |
|---|---|---|---|
| 1 | 0,220 | 16 | 0,367 |
| 2 | 0,066 | 17 | 0,597 |
| 3 | 0,308 | 18 | 0,541 |
| 4 | 0,387 | 19 | 0,433 |
| 5 | 0,468 | 20 | 0,124 |
| 6 | 0,544 | 21 | 0,470 |
| 7 | 0,553 | 22 | 0,486 |

| | | | |
|---|---|---|---|
| 8 | 0,617 | 23 | 0,259 |
| 9 | 0,449 | 24 | 0,314 |
| 10 | 0,387 | 25 | 0,204 |
| 11 | 0,180 | 26 | 0,467 |
| 12 | 0,125 | 27 | 0,314 |
| 13 | 0,107 | 28 | 0,387 |
| 14 | 0,234 | 29 | 0,567 |
| 15 | 0,220 | 30 | 0,234 |

The data showed the validity of all the test item. The Table 3.4 showed about the criteria of each item.

**Table 3.4**
Validity Interpretation

| Correlation Coefficient | Validity Criteria |
|---|---|
| $0,80 < r \leq 1.00$ | Very High |
| $0,60 < r \leq 0,80$ | High |
| $0,40 < r \leq 0,60$ | Enough |
| $0,20 < r \leq 0,40$ | Low |
| $0,00 < r \leq 0,20$ | Very Low |

(King, Statistical Reasoning in Psychology and Education, 1993)

From the data it was showed that which questions should be revise and which questions should be used. The table distribution result of each questions is presented on the table 3.5

**Table 3.5**
Validity Result

| Question Number | Validity Score | Validity Criteria | Information |
|---|---|---|---|
| 1 | 0,220 | Low | Valid but need some revision |
| 2 | 0,066 | Very Low | Not Valid |
| 3 | 0,308 | Low | Valid but need some revision |
| 4 | 0,387 | Low | Valid but need some revision |
| 5 | 0,468 | Enough | Valid |
| 6 | 0,544 | Enough | Valid |
| 7 | 0,553 | Enough | Valid |
| 8 | 0,617 | High | Valid |
| 9 | 0,449 | Enough | Valid |
| 10 | 0,387 | Low | Valid but need some revision |
| 11 | 0,180 | Very Low | Not Valid |
| 12 | 0,125 | Very Low | Not Valid |
| 13 | 0,107 | Very Low | Not Valid |
| 14 | 0,234 | Low | Valid but need some revision |
| 15 | 0,220 | Low | Valid but need some revision |

| | | | |
|---|---|---|---|
| 16 | 0,367 | Low | Valid but need some revision |
| 17 | 0,597 | Enough | Valid |
| 18 | 0,453 | Enough | Valid |
| 19 | 0,433 | Enough | Valid |
| 20 | 0,124 | Very Low | Not Valid |
| 21 | 0,470 | Enough | Valid |
| 22 | 0,486 | Enough | Valid |
| 23 | 0,259 | Low | Valid but need some revision |
| 24 | 0,319 | Low | Valid but need some revision |
| 25 | 0,204 | Low | Valid but need some revision |
| 26 | 0,467 | Enough | Valid |
| 27 | 0,314 | Low | Valid but need some revision |
| 28 | 0,387 | Low | Valid but need some revision |
| 29 | 0,567 | Enough | Valid |
| 30 | 0,234 | Low | Valid but need some revision |

From the table it was showed that 25 questions can be used from this research instruments but some the questions need to improvement with the revising the questions. In the other hand, there are 5 question that should be change to another questions because it is has very low validity.

**2) Reliabiltity**

Reliability is described as the consistency of the scores or answer from one administration of an instrument to another and from one set of items to another (Fraenkel, 2011). It will be called as reliable when a test reliability and fit on several aspects in conducting the test item. Therefore, the formula to calculate the reliability is described as follows:

$$KR_{20} = r = \frac{N}{N-1}\left(\frac{S^2 \sum pq}{S^2}\right)$$

Where,

$KR_{20}$ = The reliability estimate (r)

$N$ = The number of items on the test

$S^2$ = The variance of the total test score

$P$ = The propotion of the people getting each item correct (this is found separately for each item)

$Q$ = The propotion of people getting each item incorrect
For each item, q equals 1 – $p$

$\sum pq$ = The sum of the products of $p$ time for each time

(King, Statistical Reasoning in Psychology and Education, 1993)

The formula above can be used to determine the validity of the sample item. The result of the reliability test for the research instrument on this research using ANATES V4 is presented on the table 3.6

**Table 3.6**
Reliability Data

| Subject | Score | Subject | Score |
|---|---|---|---|
| S1 | 20 | S16 | 19 |
| S2 | 13 | S17 | 17 |
| S3 | 5 | S18 | 16 |
| S4 | 13 | S19 | 18 |
| S5 | 15 | S20 | 17 |
| S6 | 14 | S21 | 15 |
| S7 | 10 | S22 | 14 |
| S8 | 8 | S23 | 11 |
| S9 | 10 | S24 | 13 |
| S10 | 12 | S25 | 17 |
| S11 | 16 | S26 | 15 |
| S12 | 14 | S27 | 8 |
| S13 | 16 | S28 | 9 |
| S14 | 20 | S29 | 12 |
| S15 | 14 | S30 | 12 |

The data based on students answer on google form. There are 30 participants of students consist of 13 male and 17 female. The data was showed about the total score of the correct answer of each students. The result of reliability test from the data shown on the table 3.7:

**Table 3.7**
Reliability Result

| Subject | Score |
|---|---|
| Avarage | 13.77 |

| | |
|---|---|
| Standar Deviation | 3.65 |
| XY Correlation | 0.63 |
| Reliabiity Test | 0.77 |

From the data the value of the reliability test is 0.77. Based on book from Minimum in 2013, The realibity interpretation to know the level of reliability test is presented on the table 3.8

**Table 3.8**
Reliability Interpretation

| Correlation coefficient | Realiability Intrepetation |
|---|---|
| $0.80 < r \leq 1.00$ | Very High |
| $0.60 < r \leq 0.80$ | High |
| $0.40 < r \leq 0.60$ | Enough |
| $0.20 < r \leq 0.40$ | Low |
| $0.00 < r \leq 0.20$ | Very Low |

(Source: Minium et al., 1993)

The reliability test with the value 0.77 have high the reliability, it means that we can use all the questions on the research instruments (Cognitive Test) for taking the data on pre test and post test.

**3) Difficulty level**

Difficulty is the mean score of test item corespond to the propotion of who answer the item correctly. Arikunto S stated that the question which is not too easy or not too diffcult to be answered could be defined as good question. Students will not be stimulated to try harder to answer when the question is too easy, otherwise the student will give up or lose heart when the question is too difficult (Arikunto, 2013).

The formula that can be used to measure the difficulty level is shown as follows :

$$P = \frac{Number\ \ of\ student\ \ who\ answered\ \ the\ item\ correctly\ \ (A)}{Total\ \ number\ \ of\ students\ \ who\ attempted\ \ the\ item\ \ (N)} \text{ X } 100$$

The difficulty level can be calculated by using ANATES software. The value can be interpreted in Table 3.9.

**Table 3.9**

Difficulty Interpretation

| Value | Criteria |
|---|---|
| 0-0,29 | Difficult |
| 0.30-0.69 | Middle |
| 0.70-1.00 | Easy |

(Arikunto, 2013)

The result of difficulty level for this research instruments using ANATES shown on the table 3.10:

**Table 3.10**
Difficulty Level

| Question Number | Difficulty Score | Information | Question Number | Difficulty Score | Information |
|---|---|---|---|---|---|
| 1 | 83.33 % | Easy | 16 | 66.67 % | Medium |
| 2 | 63.33 % | Medium | 17 | 33.33 % | Medium |
| 3 | 66.67 % | Medium | 18 | 63.33 % | Medium |
| 4 | 66.67 % | Medium | 19 | 46.67 % | Medium |
| 5 | 30.00 % | Hard | 20 | 23.33 % | Hard |
| 6 | 66.67 % | Medium | 21 | 46.67 % | Medium |
| 7 | 60.00 % | Medium | 22 | 56.67 % | Medium |
| 8 | 80.00 % | Easy | 23 | 63.33 % | Medium |
| 9 | 56.67 % | Medium | 24 | 83.33 % | Easy |
| 10 | 66.67 % | Medium | 25 | 30.00 % | Hard |
| 11 | 70.00 % | Medium | 26 | 56.67 % | Medium |
| 12 | 46.67 % | Medium | 27 | 66.67 % | Medium |
| 13 | 20.00 % | Hard | 28 | 70.00 % | Medium |
| 14 | 73.33 % | Easy | 29 | 63.33 % | Medium |
| 15 | 13.33 % | Very Hard | 30 | 23.33 % | Hard |

From the data showed, there are 4 questions in easy level, 20 questions in medium level, 5 questions in hard level, and 1 questions in very hard level. From the ANATES result, it showed that there are a lot of lower and upper students have wrong answer on the question with hard level. In the other hand, a lot of students have wrong answer on the questions with medium level. For the questions with easy level, a lot of students have right answer.

### 3.9 Research Instrument Analysis Based on Expert Judgments

Beside the students validation, the research instruments were also analyzed based on expert judgments. The expert judgments consist of 2 lecturers in IPSE

and 1 teachers from privat school which used Cambridge Curricullum.The judgments for this research instrument shown on the table 3.11:

**Table 3.11**
List of the Judgements

| No | Name | Occupation |
|---|---|---|
| 1. | J1 | IPSE Lecturer (Master in Biology) |
| 2. | J2 | IPSE Lecturer (Master in Chemistry) |
| 3. | J3 | Science Teachers (Cambridge Curriculum) |

From the expert judgments the creativity rubric can be used for assesing the creativity of the students mind map. In the other hand, the cognitive test need some improvement. There were some the question that should be revise. Here are the general comments from the expert judgments:

a. Revise some grammatical and typing errors
b. Revise some parts related to cognitive level
c. Better to add more questions that are categorized C4
d. Adjust the cognitive level with the item test questions
e. The questions are good enough to assess student concept mastery but most of the questions need an improvement on question style in English
f. Always refer to IGSCE Biology 2022 syllabus for the references of the questions

### 3.10 Creativity Rubric

Rubric for assesing creativity was adapted from Susianna (2016) and Rahayu (2018) combining creativity indicator and essential aspect fo mind map Development of creative mind map rubric was created. Creative minmap rubric will be shown in the table 3.12 below.

**Table 3.12**
Creativity Rubric

| Aspect | Criteria | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| **Fluency** | **Central idea** (Write the main idea, place | Central idea not place in the | Central idea not place in | Central idea Place at the |

| Aspect | Criteria | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| | main idea in the center) | center and not appropiate with the topic | the center but some idea appropiate with the topic | center and appropiate with the topic |
| | **Key words** (key word appropriate with concept, easy to read and free from spelling error) | Keywords not appropriate with concept and there is spelling error | Keywords appropriate with concept but there is some spelling error | Keywords appropriate with concept and free from spelling error |
| | **Colors** (the quantity of color which had been used whole the mind map include branch, link line, and illustration) | There is no different color used including branch, link, line, and illustrations) | Some color used including branch, link, line, and illustrations) but does not distinguish the keyword | Some color used including branch, link, line, and illustrations) and can distinguish the keyword |
| | **Branching** (The more key word / illustration / branches were used, the higher fluency level obtained) | There is more key words/illustrations/ branches were used, the higher fluency level obtained) | There is some only single branching for keyword | There are many branching for each keyword |
| **Flexibilty** | **Basic Ordering Ideas** (able to determine sub-topic that related to the main topic) | Sub topic cannot be determined and does not have relation with the main topic | Some sub topic can be determined and have relation with the main topic | All sub topic can be determined and does have relation with the main topic |
| | **Quantity of Branch** (level of differentiation among concepts, to the extent where the more specific concepts are connected to more general concepts) | The specific concept is not connected with general concept | Some specific concept is connected with general concept | The specific concept is connected with general concept |
| **Originality** | **Words** (using single key words per branch, | Consists of many key words | Consists of many key | Consists of single key |

| Aspect | Criteria | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| | using original answer or response but still related with topic) | on every branch | words on some branch | words per branch |
| | **Illustrations** (image, symbol represent keywords) | There is no illustrations that represent keywords | There is an illustrations but does not represent keywords | There is an illustrations that represent keywords |
| | **Emphasize** (adding highlight or boundaries in the group of information or important | There is no boundaries or highlight on important information | There is some boundaries or highlight on important information | Boundaries or highlight added on all of the important information |
| **Ellaboration** | **Higher level of the hierarchy** (The highest branch level or level in the hierarchy/farthest branch from the central mind map) | All branches placed on the same level | Branches have different hierarchy but does not represent the level | Branches have different hierarchy and represent the level |
| | **Relationship** (relation between information in same hierarchies) | There is no relation of information in same hierarchies | There is some relation of information in same hierarchies | There is a relation of information in same hierarchies |

Mind map scoring for each indicator has different total point. For the Fluency aspect has four criteria it means the maximum score is 12 points, while Elaboration has maximum points 6 since it has only two criteria exists. The formula used to calculate the score average of each indicator will be shown below:

$$Score\ Average = \frac{Total\ score\ in\ the\ whole\ questions}{number\ of\ questions}$$

The total score is gained by converting score into percentage. The technique of concerting the score into the percentage is used as follow:

$$NP = \frac{R}{SM} X\ 100\%$$

Where:

NP = Percentage

R = Raw Score

SM = Maximum Score

The interpretation of score percentage of students' creativity is categorized into certain criteria as shown in the Table 3.13.

**Table 3.13**
Score Criteria

| Percentage (%) | Criteria |
|---|---|
| 86-100 | Very Good |
| 76-85 | Good |
| 60-75 | Enough |
| 55-59 | Low |
| <54 | Very Lack |

## 3.11 Data Anaysis Technique

The quantitative technique was used to gather the data in this research. This technique was used to analyze tha Students' Concept Mastery and students' creativity. Information is shown below in detail as follow:

### 3.11.1 Students' Concept Mastery

There are multiple choice test to obtaine the students' concept mastery. SPSS Software was used to analyze the data of students' concept mastery and also to check the normality, homogenity, hypothesis test (Independent Sample t Test). There are 2 type of data was gained, firstly based on students level of cognitive domain C1 (Remembering), C2 (Understanding), C3 (Aplying), and C4 (Analysing). Secondly based on the sub topic of human influence on ecosystems topics which are the habitat destruction, removal of habitat, marine pollution, deforestation, and pollution. All the data shown and presented as the form of percentage of the correct answer, this data aims to define the examine of students' concept master.

### 3.11.2 Students' creativity

In this reserach, students' creativity was examined using creativity rubric that consist of 4 aspect such as flexibility thinking skills, fluency thinking skills, originality thinking skills, and ellaboration thinking skills. The data will be checked on google form. The result will be show on diagram.

## 3.12 Research Procedure

To make the research well organized systematicly, there are three part of procedure stages. There are preparation stage, implementation stages and completion stage. Detailed information will be shown as follow

### 3.12.1 Preparation stage

By having this stage it aims for the author to analyze the entire varibale in this research before conductiong the research itself. Detailed information is explained as follow :

1. Identifying the reearchs' problem
2. Literature study about students understanding, students' creativity , human influence on ecosystems topic was conducted by the author in order to enrich the knowledge. All the literatures come from the realible sources such as books, e-books,journals and the article as well.
3. The instruments for students' concept mastery and students' creativity were designed.
4. Validating the insturments to the expert judgements.
5. Validating the instruments to the students who have learned about related topic which in this reserach is human influence on ecosystems topic.
6. Revising the instruments based on validation activities done previously, both from the expert judgements or the students validation.

### 3.12.2 Implementation stage

In this stage, the researcher start to conduct the reearch in order to gain data needed for the research itself. The detailed information is shown as follow:

1. Deciding the subject of the research
2. Spreading the instruments of the research to the students

3. Gaining the data from both reseacrh instruments

### 3.12.3 Completition stage

This is the last stage of this research which means that the data collected and examined. The detailed information about this stage stated as follow:

1. The data is analyzed
2. The analyzed data is discussed
3. Making the conclusion based o the data discussion and analysis
4. Reporting the result

### 3.12.4 Research Flowchart