

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Method

Research needs an appropriate method and design to gain the expected result that would be beneficial for the field and future researches. In order to achieve the purpose of this research, descriptive research is used. Descriptive research is designated to accurately describe existent occurrences. The primary objective of descriptive research is to describe existing phenomena in a systematic manner (Atmowardoyo, 2018). Thus, it only talks about something naturally and measures what is already in place. Without manipulating the independent variable to influence the responses of the subjects, this research was carried out to identify current phenomena, and there was no treatment given to the subjects when obtaining the data (Radhakrishnan, 2013). This research is done in an online classroom which focuses on finding out the students' creativity and communication skill with the implementation of the STEAM learning approach. The data gathered in this research is used to describe the implementation of the STEAM learning approach, students' creativity, and students' communication skill in learning sound and waves topic.

3.2 Participants

Due to the COVID-19 pandemic, the class has turned into an online learning class as the students conduct the class at home. By that, the research is conducted in online learning with the students as the participants. The participants of this research were the 8th-grade students placed in an all-girls classroom of one of the junior high schools in Bandung that applies the 2013 National Curriculum. The total amount of students who participated in the implementation of the STEAM learning approach in this research is 24 female students. However, only 11 female students managed to complete all of the STEAM learning approach phases until a project result was produced. The characteristics of the selected students come from a school that is capable of using STEAM as the learning approach in science learning, and the

students haven't studied the topic of sound and waves. The students have experienced the implementation of the STEAM learning approach before. The sampling method used is convenience sampling as it is choosing participants because they are readily and easily available (Taherdoost, 2018). The target population participants are included for the objective of this research who meet specific functional requirements such as their availability at a given time or willingness to participate (Etikan, 2016).

3.3 Research Instrument

A research instrument is required to be used to collect the data. In this research, there are three instruments used to obtain the data, which are the implementation of the STEAM learning approach, students' creativity, and students' communication skill. The research instruments used are described below.

3.3.1 The Implementation of STEAM Learning Approach

The implementation of the STEAM learning approach is analyzed during a classroom observation. An observation sheet is a non-test instrument used to investigate the learning experiences in the implementation of the STEAM learning approach. In the observation sheet, there is a list of the learning phases and learning experiences in implementing the STEAM learning approach. It is divided into scientific and engineering practices. The scientific practice in the implementation of the STEAM learning approach is implemented with the Discovery Learning model. Therefore, the learning phases that are observed are stimulation, problem statement, data collection, data processing, verification, and generalization (Suminar & Meilani, 2016). The engineering practice is applied with the Project-Based Learning (PjBL) model, which comprises the reflection, research, discovery, application, and communication phases (Suminar & Meilani, 2016). The observation sheet used in this research can be shown in Table 3.1.

Table 3.1
STEAM Learning Approach Observation Sheet

Learning Phase	Learning Experiences	Implementation		Note
		Yes	No	
Scientific Practice (Discovery Learning model)				
Stimulation	Answering stimulating questions			
Problem Statement	Answering the follow-up questions to be more detailed about the topic Noting the temporary answer (hypothesis) to be tested later			
Data Collection	Playing an online game related to the topic to learn the concepts Playing an online simulation to have a virtual experiment related to the topic The students fill a			
Data Processing	worksheet to process the information from the game and simulation Comparing the result with the hypothesis constructed at the beginning			
Verification	Concluding the information gathered from the lesson			
Generalization				
Engineering Practice (Project-Based Learning model)				
Reflection	Reviewing the concepts that have been learned Getting an explanation about the project activity that will be done, which is making a simple instrument from recycled materials Getting an explanation about the project worksheet and the way to fill it			

Learning Phase	Learning Experiences	Implementation		Note
		Yes	No	
Research	Finding information about sound and waves and its relation to the musical instrument			
	Brainstorming project ideas with the following challenge: how to make a musical instrument from recycled materials?			
Discovery	Deciding the project based on the information obtained			
	Planning and designing the project by following the worksheet format			
Application	Making musical instruments that can be played well			
	Testing the musical instrument			
Communication	Evaluating the musical instrument that has been made			
	Presenting the project result			

The implementation of the STEAM learning approach is analyzed by using an observation sheet. It analyzes how the learning experiences in the STEAM learning approaches are executed. There is a list of the learning phases and learning experiences in implementing the STEAM learning approach. The implementation of each learning experience is examined by checking the “Yes” or “No” boxes in the observation sheet. After that, the amount of “Yes” and “No” is summed up to be converted into a percentage. To convert the score into a percentage, the formula used is:

$$\%LI = \frac{\sum IA}{\sum TA} \times 100\%$$

Description:

LI : The implementation of the learning experiences

IA : The amount of implemented aspect

TA : Total amount of the aspect

(Riduwan, 2010, as cited in Salikha, 2020)

After the percentage of the implementation of the STEAM learning approach is obtained, it is interpreted into several categories, as shown in Table 3.2.

Table 3.2
Interpretation of Learning Experiences Implementation

Percentage (%)	Interpretation
LI = 0	None of the learning experience is implemented
$0 < LI < 25$	A small number of learning experiences are implemented
$25 \leq LI < 50$	Almost half of the learning experiences are implemented
LI = 50	Half of the learning experiences are implemented
$50 \leq LI < 75$	Most of the learning experiences are implemented
$75 \leq LI < 100$	Almost all of the learning experiences are implemented
100	All of the learning experiences are implemented

(Riduwan, 2010, as cited in Salikha, 2020)

In this research, the implementation of STEAM learning approach is divided into scientific and engineering practice. Therefore, the data presented is the percentage of the implementation of the learning experiences in both scientific and engineering practices entirely.

3.3.2 Students' Creativity

The Creative Product Analysis Matrix (CPAM) rubric is used to examine the students' creativity in learning sound and waves by implementing the STEAM learning approach. The CPAM rubric has been judged by the experts, and it is said to be relevant to the objective of this research. This rubric is adapted from (Besemer & O'Quin, 1986), and there is no modification on the creativity criteria that is examined

by the students' project results. There are three conceptual dimensions that are proposed when examining the creativity of a product: Novelty (the newness of the product), Resolution (functionality, utility, and workableness of the product), and Elaboration and Synthesis (the stylistic qualities of the product) (Besemer & O'Quin, 1986). The indicator of CPAM rubric can be seen in Table 3.3.

Table 3.3
Creative Product Analysis Matrix (CPAM) Rubric Indicator

Creative Product Dimension	Criteria	Score		
		1	2	3
Novelty	Geminal: promoting new ideas to aid the product that has been made	The new idea to make musical instrument does not encourage others to develop new ideas	The idea to make musical instrument encourages others to develop new ideas but not by delivering the way to make something new form that	The idea to make musical instrument encourages others to develop new ideas by delivering the way to make something new form that
	Original: the idea is uncommon, and the idea is still fresh, different from the ideas that have been made	The idea to make the product entirely comes from the previous finding	The idea to make the product comes from the previous finding with some adaptations	The idea to make the product comes purely from students, not found in other sources
	Transformational: the idea presented is combining different perspectives	Only one perspective generates the idea	Two perspectives generate the idea	More than two perspectives generate the idea
Resolution	Adequate: the idea serves as a solution to	The student serves a solution that does not	The idea is served to answer the	The idea is served to answer the

Creative Product Dimension	Criteria	Score		
		1	2	3
	the given problem adequately	answer the problem	problem related to sound sufficiently	problem related to sound significantly
	Appropriate: the idea is appropriate with the given problem	The idea is slightly appropriate to answer the given problem	The idea is sufficiently appropriate to answer the given problem	The idea is explicitly appropriate to answer the given problem
	Logical: the idea is presented by following the agreed rules	The students present the idea by following less than 30% of the agreement and procedural rules that have been discussed	The students present the idea by following less than 70% of the agreement and procedural rules that have been discussed	The students present the idea perfectly by following 100% of the agreement and procedural rules that have been discussed
	Useful: the idea to make the product is applicable and beneficial for the practical application	The product that is made based on the student's idea can be applicable but only once	The product that is made based on the student's idea can be applicable and beneficial continually with specific requirement	The product that is made based on the student's idea can be used continuously without the specific requirement
	Valuable: users value the product as it complies with a financial and physical requirement	The product is created by using only one of these criteria of materials; simple, accessible, and low-cost materials	The product is created by using two of these criteria of materials; simple, accessible, and low-costs	The product is created by using all these criteria of materials; simple, accessible, and low-costs

Creative Product Dimension	Criteria	Score		
		1	2	3
Elaboration & Synthesis	Attractive: the product captures the viewer's attention as it comprises several accessories that beautify the product	The product is decorated using one accessory that beautifies the product	The product is decorated using two accessories that beautify the product	The product is decorated using more than two accessories that beautify the product
	Complex: the product combines some materials to improve the use of the product	The product is made by using one material	The product is made by combining two different materials	The product is made by combining more than two different materials
	Elegant: the idea is delivered communicatively and comprehensibly	The idea is communicated not interactively by using one concept related to sound	The idea is communicated interactively by combining two different concepts related to sound	The idea is communicated interactively by combining more than two concepts related to sound
	Organic: the product is created by utilizing the recycled materials	The product is executed by utilizing its materials but still lacking	The product is executed by utilizing its materials adequately	The product is executed by utilizing its materials maximally and neatly
	Well-crafted: the product is made by integrating with a clear and interesting design to work well	The product can work with the need of a slight refinement, and the product is made with a monotonous design	The product can work well and is presented with a moderate design	The product can work well and is presented with an interesting design
	Expressive: the idea is	The idea is delivered in	The idea is delivered in a	The idea is delivered in a

Creative Product Dimension	Criteria	Score		
		1	2	3
	communicated in a proper manner	between only communicative way/comprehensible and still lacking	communicative way and is comprehensible but still lacking	communicative way and is comprehensible

(Adapted from Besemer & O'Quin, 1986)

The design of the CPAM rubric that has been used to investigate the students' creativity is shown in Table 3.4. Score 3 is indicated as "High", 2 is indicated as "Medium", and 1 is indicated as "Low".

Table 3.4
Creative Product Analysis Matrix (CPAM) Rubric Design

No.	Creative Product Dimension	Criteria	Score		
			1	2	3
1	Novelty	Germinal Original Transformational			
2	Resolution	Adequate Appropriate Logical Useful Valuable			
3	Elaboration & Synthesis	Attractive Complex Elegant Organic Well-crafted Expressive			

(Adapted from Besemer & O'Quin, 1986)

The results of students' creativity are analyzed, both students' skills in general and each dimension of creativity. The score on the CPAM rubric is presented by the conversion of the raw score in a percentage form for each group. The percentage result is segmented into certain criteria that determine the creativity categories. To

change the score into a percentage, a formula (Purwanto, 2008, as cited in Herana, Patahuddin, & Jumadi, 2020) is used:

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

Description:

NP : Percentage

R : Raw Score

SM : Maximum Score

The scoring percentage interprets the creativity as it is classified into some criteria that can be shown in Table 3.5.

Table 3.5
Interpretation of Score Percentage Criteria

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

(Purwanto, 2008, as cited in Herana et al., 2020)

3.3.3 Students' Communication Skill

To examine students' communication skills, a rubric is used. The rubric was adapted from Dunbar, Brooks, and Miller (2006), and there is no change in communication skill indicators. The rubric has been judged, and it is said to be relevant to the research objectives. This rubric is specifically used to measure students' oral communication skills in learning about sound and waves by implementing STEAM learning approach. The rubric to measure students' communication skill is as shown in Table 3.6.

Table 3.6
Communication Skills Rubric Indicator

Indicators	Assessment Criteria				
	Advanced 4	Proficient 3	Basic 2	Minimal 1	Deficient 0
Chooses and narrows a topic	The topic presented is well specified and focused, delivered appropriately with the audience	The topic presented is well specified and delivered appropriately with the audience	The topic presented is specified but slightly appropriate with the audience	The topic presented is too complex and general, delivered inappropriately with the audience	There is no topic determination
Communicates the topic thesis	The topic thesis is delivered clearly with a complete preview of the points and catching the audience's attention excellently	The topic thesis is delivered well with some previews of main points; catching the audience's attention	The topic thesis is delivered but not specified; it presents a bit preview of points to the audience	Unclear delivery of topic thesis; not explicitly stated and lack of audience's attention	The topic thesis is not delivered well with no preview of points to the audience
Provides appropriate and supporting material	Delivering the topic with many supporting materials (e.g., data, facts, etc.) that come reliable sources that are cited properly	Delivering the topic with several supporting materials (e.g., data, facts, etc.) with some reliable sources that are cited properly	Delivering the topic with adequate materials with a few sources that are cited properly	Delivering the topic with a small number of materials without any citation	Delivering the topic only based on argument/opinion, with no supporting materials and no citation of sources
Uses an appropriate organizational pattern	The topic is organized excellently, with main	The topic is organized well with	The topic is delivered in a good	The topic organization and the main points	The topic is delivered randomly with a poor

Indicators	Assessment Criteria				
	Advanced 4	Proficient 3	Basic 2	Minimal 1	Deficient 0
	points in a good structure and constructive transitions	some clear main points but still in a good structure and using some constructive transitions	flow with unclear main points, using slight transitions	are not clear with nonexistent transitions	organizational pattern and nonexistent transitions and main points
Uses vocal variety	Expressing the vocal smoothly with the use of vocal variation in rate, pitch, and intensity also showing enthusiasm; no fillers (e.g., uh, um	Using a vocal variation in rate, pitch, and intensity appropriately with a few fillers but not pausing; showing enthusiasm	Expressing some vocal variation in rate, pitch, and intensity with some fillers and pauses; showing enthusiasm	Unstable voice variation; using vocal variation in a not suitable section of the topic, using fillers and pauses; not enthusiastic	Expressing the vocal poorly with the lack of vocal variation; sounded just flat and not enthusiastic
Uses appropriate pronunciation, grammar, and articulation	Speaking with appropriate language, pronunciation, and articulation, also utterly free from grammar error and inappropriate language	Using appropriate language with no grammar error and inappropriate language; articulation, and pronunciation needs a slight	Using language appropriately with a few grammar errors and needing a slight refinement of articulation and pronunciation	Delivering with some grammar errors and several inappropriate languages, needing a refinement of articulation and pronunciation	Using inappropriate language with many grammar errors, needing a refinement of articulation and pronunciation

Indicators	Assessment Criteria				
	Advanced 4	Proficient 3	Basic 2	Minimal 1	Deficient 0
refinement on					

(Adapted from Dunbar et al., 2006)

The communication skill rubric design used to examine the students' communication skills is shown in Table 3.7. Score 4 is implied as "Advanced", 3 is implied as "Proficient", 2 is implied as "Basic", 1 is implied as "Minimal", and 0 is implied as "Deficient".

Table 3.7
Communication Skill Rubric Design

No.	Indicators	Score				
		0	1	2	3	4
1	Chooses and narrows a topic					
2	Communicates the topic thesis					
3	Provides appropriate and supporting material					
4	Uses an appropriate organizational pattern					
5	Uses vocal variety					
6	Uses appropriate pronunciation, grammar, and articulation					

(Adapted from Dunbar et al., 2006)

Students' communication skills are analyzed entirely, for each indicator, and for each student. The score is determined by using a rubric of communication skills adapted from Dunbar, Brooks, and Miller (2006). The rubric has six indicators that measure students' oral communication skills in each aspect of it. The most suitable criteria are marked with 4. Meanwhile, the least related criteria are marked with 0. The communication skill scores are interpreted in some categories, as shown in Table 3.8.

Table 3.8
Interpretation of Communication Skill Score

Proficiency Score	Interpretation
4.00 – 3.25	Advanced
3.24 – 2.75	Proficient

2.74 – 2.25	Basic
2.24 – 1.00	Minimal
0.99 – 0	Deficient

(Schreiber, Paul, & Shibley, 2012)

3.4 Operational Definition

An operational definition of this research is stated to avoid misconceptions. The terminologies are expressed as followed:

- 1) The implementation of STEAM learning is divided into scientific and engineering practice. In scientific practice, STEAM learning approach is integrated with the Discovery Learning model. The learning phases are stimulation, problem statement, data collection, verification, and generalization. In engineering practice, it is integrated with the Project-Based Learning (PjBL) Model. The five phases of learning are the reflection phase, research phase, discovery phase, application phase, and communication phase. Each phase encouraged the students to be actively involved in completing a project to solve problems. The students did a project related to sound and waves topic: making a simple musical instrument from recycled materials as the project result. The product has to solve the problems given. Also, the product has to fulfill STEAM aspects.
- 2) Students' creativity in this research focuses on the students' skills to provide innovation to develop valuable solutions in the future as they can also solve problems. The students' project result is examined to measure their creativity. To examine students' creativity, the Creative Product Analysis Matrix (CPAM) is used to assess students' creativity from their project result as the product in learning about sound and waves.
- 3) Students' communication skill in this research refers to the skill that covers some elements such as speaking, reading, listening, and writing skills. In this research, the communication skill is specified into the oral form of communication. The students presented their project results in the form of

video presentations. Hence, a rubric for communication skills adapted from (Dunbar et al., 2006) is used to measure students' communication skills.

3.5 Research Procedure

The research procedures of this study are divided into three stages following the order of systematic research: the preparation stage, implementation stage, and completion stage. The plot of the research in each stage can be seen below.

1) Preparation Stage

The preparation stage consists of gathering relevant research from previous studies related to the STEAM learning approach, students' creativity, communication skills, and sound and waves topics. The steps taken in this stage are as follows.

- a) Problem identification.
- b) Specific analysis on the research independent and dependent variables.
- c) Determining the components that strengthen the research, such as the school curriculum, specific science contents, teaching model, and teaching method.
- d) Research problem formulation and elaborating it into research questions.
- e) Constructing the instruments to gather data of students' attainment that consist of the rubrics which then judged and validated by the experts.
- f) Research instruments revision based on the experts' judgments.
- g) Constructing a lesson plan and teaching materials to assist the implementation of the STEAM learning approach.

2) Implementation Stage

The implementation of the STEAM learning approach was conducted to obtain the data of students' creativity and communication skills. There were

the learning activities that complete a project related to sound and waves topic. The steps of the implementation stage are as stated below.

- a) Conducting the learning activities in sound and waves topic.
- b) Observing the learning activities of the implementation of the STEAM learning approach in sound and waves topic.
- c) Assessing students' creativity using Creativity Product Analysis Matrix (CPAM) rubric based on students' project product in STEAM learning approach.
- d) Assessing students' oral communication skills using the rubric adapted from Dunbar, Brooks, and Miller (2006) based on students' communication skills in presenting their project product in the STEAM learning approach.
- e) Collecting the data.

3) Completion Stage

During this final stage of the research, the data were analyzed and reported in a systematic research paper. The steps are as follows.

- a) Processing the data based on the research instrument.
- b) Arranging further discussions based on the data processed.
- c) Constructing conclusion and recommendation based on the data result and discussion.
- d) Completing the research paper.

Overall, the flowchart of the research procedures can be shown in Figure 3.1.

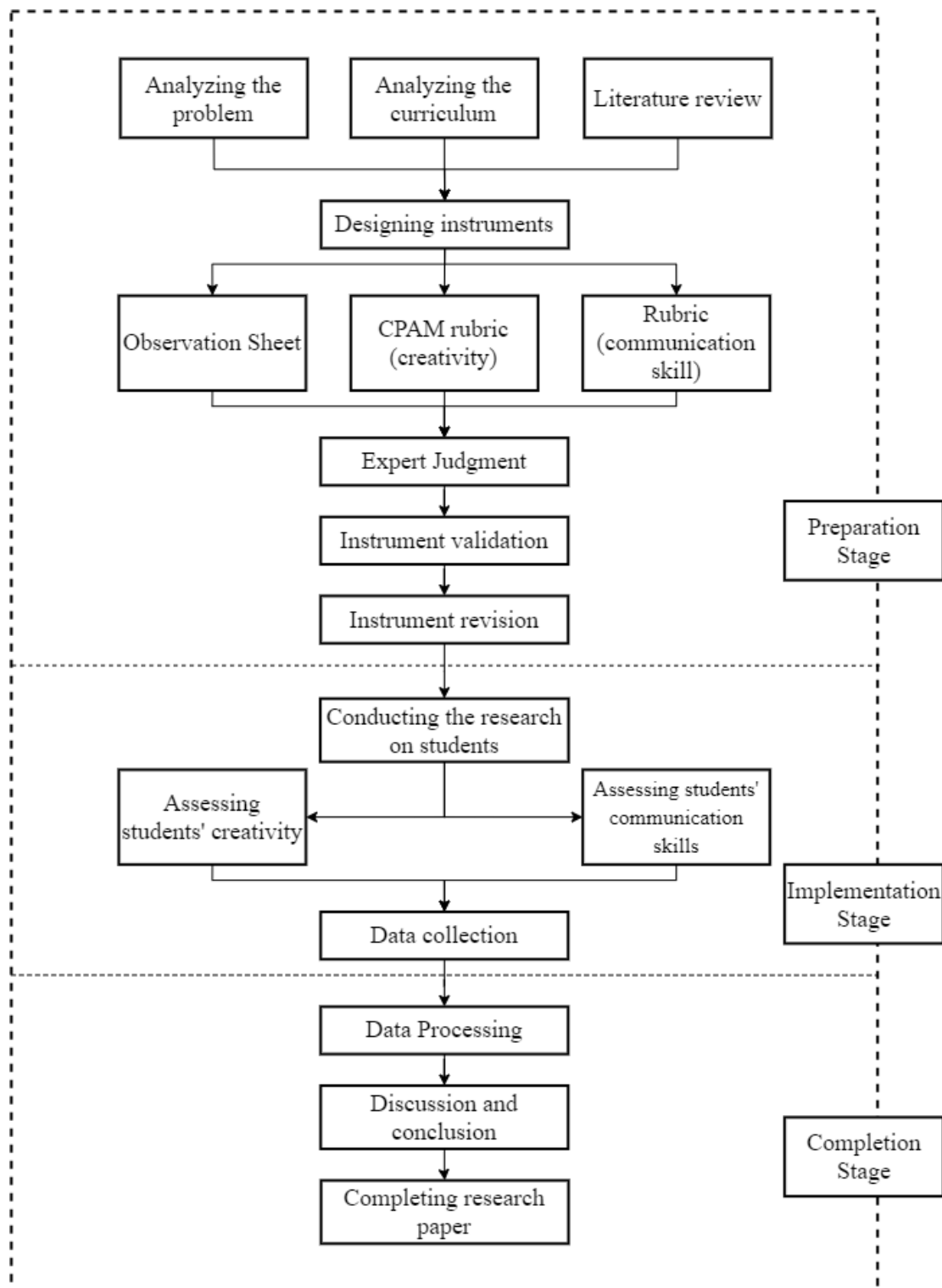


Figure 3.1 Flowchart of Research Procedures