CHAPTER III
RESEARCH METHODOLOGY

A. Research Method and Design

1. Research Method

This research used the mixed method. According to Creswell (2012), mixed method is a procedure of collecting, analyzing and "mixing" both quantitative and qualitative methods in a single study or series of studies to understand research problems. Creswell (2012) also stated that basic assumption of mixed method is that the combination of quantitative and qualitative methods provides a better understanding of the research problem and question rather than use only a method.

2. Research Design

The design that is used in this research is convergent mixed method design. A basic rationale for this design is that one data collection form supplies strengths to offset the weaknesses of the other form, and that a more complete understanding of a research problem results from collecting both quantitative and qualitative data (Creswell, 2012)

In this design, quantitative analysis focuses on students' cognitive mastery that is measured by objective test in form of multiple choices, while qualitative analysis focuses on students' creativity that is measured by CPAM rubric developed by Besemer and Treffinger, and students' impression towards STEAM implementation. All result is analyzed separately based on ts own indicator and then compared to produce a better interpretation regarding the impact of STEAM-based learning on students' creativity and cognitive mastery in learning sound.

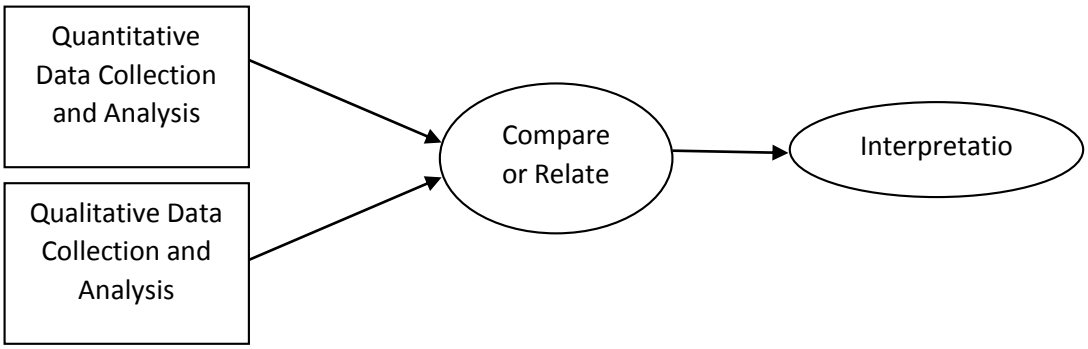

Figure 3.1 Convergent Parallel Design

(Source: Creswell, 2012)

B. Population and Sample

The population of this research is all of 8th grader of *Sekolah Nasional Plus* "X" which implements Cambridge Curriculum and KTSP in Bandung, while the sample was one class of 8th grader of that school. The sampling method used is Convenience Sampling because the class being researched is convenience for researcher and available to be studied (Creswell, 2012). Number of sample being studied are 12 students with 58% female and 42% male. Their ages are about 14 years old.

C. Research Instrument

Research Instruments are necessary to gather the data needed in this research. Instruments were used to gain data in this research are:

1. Objective Test

   Objective test based on Bloom's Revised Edition was used to measure students' concept mastery before and after implementing STEAM-Based Learning. Pre-test was conducted to gather students' prior knowledge, while post-test was conducted to find out whether or not students' cognitive mastery increased significantly. Objective test used consist of 10 questions. The cognitive skill level that was tested in this objective test are C1 (remembering), C2 (understanding), C3 (applying) and C4 (analyzing).

Table 3.1 Blue Print of Sound Topic Objective Test

No.	Learning Objective	C1	C2	C3	C4	Total
1.	The properties of sound in terms of movement of air particles.	1,2		4	5	4
2.	Recognise the link between loudness and amplitude, pitch and frequency, using an oscilloscope.	10	6,7,8	3	9	6
Total test item		3	3	2	2	10
Percentage (%)		30%	30%	20%	20%	100%

The instrument of objective test was analyzed with the following requirements.

a. Validity

Validity is an important key to effective research. It is a requirement for quantitative and qualitative/naturalistic research (Cohen, Manion & Morrison, 2007). Validity that will be used in this research is a content validity. It is concerned with coverage and representativeness of instrument rather than with patterns of response or scores. Simply said, it is about judgement, not only measurement (Kerlinger, 1986). According to Wolf (in Cohen, Manion & Morrison, 2007), content validity is needed to ensure features of a test. The features are:

1) Test coverage is the extent to which the test covers the relevant field.
2) Test relevance is the extent to which the test items are taught through, or are relevant to, a particular program.
3) Program coverage is the extent to which the program covers the overall field in question.

The instrument of this research has been validated by consulting to expert and used formula for Pearson's Coefficient of Correlation (Fraenkel & Wallen, 2009). It is defined as follows:

$$r = \frac{\sum XY - (\sum X)(\sum Y)}{\sqrt{\left(n\sum X^2 - ((\sum X)^2)\right)\left(n\sum Y^2 - (\sum Y)^2\right)}} \quad (3.1)$$

Where,

r : Pearson r
$\sum X$: Sum of scores in X distribution
$\sum Y$: Sum of scores in Y distribution
$(\sum X)^2$: Sum of the squared scores in X distribution
$(\sum Y)^2$: Sum of the squared scores in Y distribution
$\sum XY$: Sum of products or paired X and Y scores
n : Number of participants

(Fraenkel & Wallen, 2009)

Interpretation of validity is:

Table 3.2 Interpretation of Validity

Value of r	Interpretation
0.00-0.20	Very Low
0.20-0.40	Low
0.40-0.60	Enough
0.60-0.80	High
0.80-1.00	Very High

(Arikunto, 2010)

b. Reliability

Reliability is defined differently in quantitative and qualitative research. Reliability in quantitative research could also be defined as dependability, consistency and replicability over time, over instruments and over groups of respondents. It is concerned with precision and accuracy (Cohen, Manion & Morrison, 2007). There are three principal types of reliability. They are stability, equivalence and internal

consistency. Reliability coefficient is calculated by using Spearman-Brown prophecy (Fraekel & Wallen, 2009) formula which is simplified into:

$$R = \frac{2 \text{ x reliability for } \frac{1}{2}\text{test}}{1 + \text{ reliability for } \frac{1}{2}\text{test}} \quad (3.2)$$

Where,

R : Reliability of scores on total test

(Fraenkel & Wallen, 2009)

Reliability could also be calculated by using Kuder-Richardson Approaches, particularly KR20 and KR21. However, KR21 can be used only if it can be assumed that the items are of equal difficulty. Frequently used version of the KR21 formula is as follows:

$$KR21\ R\ coefficient = \frac{K}{K-1}\left[1 - \frac{M(K-M)}{K(SD)^2}\right] \quad (3.3)$$

Where,

K : Number of items on the test

M : Mean of the set of test scores

SD : Standard deviation of the set of test scores.

Table 3.3 Interpretation Reliability Coefficient

Reliability Coefficient	Interpretation
0.00-0.20	Very Low
0.20-0.40	Low
0.40-0.60	Enough
0.60-0.80	High
0.80-1.00	Very High

(Arikunto, 2010)

c. Difficulty Level

The difficulty of an item is understood as the number of persons who answer it correctly. Higher the number, the lower its difficulty level (Backhoff, Larrazolo and Rosas, 2000). The formula used to analyze item difficulty based on Cohen, Manion & Morrison (2007) is:

$$\frac{A}{N} \qquad (3.4)$$

Where,

A= Number of students who answered the item correctly

N= Total number of students who attempted the item.

Table 3.4 Category of Discrimination Power

Value of Difficulty Index	Interpretation
0.00-0.30	Difficult
0.30-0.70	Moderate
0.70-1.00	Easy

(Arikunto, 2010)

d. Discriminating Power

Item discriminability refers to the potential of the item in question to be answered correctly by those students who has particular quality and to be answered incorrectly by those students who has less particular quality in given field. It could be used to see differences between group of students, and discriminate between students' abilities in a given field (Cohen, Manion & Morrison, 2007). If it shows significant different between group of students, so it is qualified as item with high discriminability. On the contrary, if it is not, so the item is qualified as item with low discriminability. Item with high discriminability is desirable, while the one with low discriminability should be discarded.

The formula used to analyze discriminating power based on Cohen, Manion & Morrison (2007) as follows:

$$\frac{A - B}{\frac{1}{2}(N)}$$

(3.5)

Where,

A = The number of correct answers from the high scoring group

B= The number of correct answers from the high scoring group

N= The total number of students in the two groups

Ebel and Frisbie (in Backhoff, Larrazolo & Rosas, 2000) gives the following rule of thumb for determining the quality of items in terms of the discrimination index. They explain the value of item difficulty and their corresponding interpretation. It is presented in the form of table as follow:

Table 3.5 Discrimination power according to their D value

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

(Ebel and Frisbie (in Backhoff et al., 2000))

e. Distractor

Distractors are stuffs of multiple choice items, where incorrect alternatives are offered, and students have to select the correct alternative (Cohen, Manion & Morrison, 2007). Effectiveness of distractor can be seen by frequency count of how many it is selected by students. It could be said working effectively if it is selected many times. However, if it is seldom or never selected, then it is not working effectively and should be replaced.

2. Creative Product Analysis Matrix (CPAM)

Creative Product Analysis Matrix (CPAM) developed by Besemer and Treffinger was adapted to analyze students' creativity. This analysis matrix

was used to assess students' product in the end of the class. Adapted rubric of CPAM constructed by the author has been judged by two experts.

Table 3.6 Blue Print of CPAM Rubric

No	Dimension	Criteria
1.	Novelty	1. Originality 2. Germinal 3. Surprising
2.	Resolution	1. Value 2. Logic 3. Usefulness
3.	Style	1. Elegant 2. Complexity

3. Questionnaire

Questionnaire was used to analyze students' impression towards implementation of STEAM-based learning in learning sound. There are three aspects surveyed in this research. This instrument has been judged by two experts.

Table 3.7 Blue Print of Questionnaire

No	Dimension	Number of Statement
1.	Students' impression toward facilitation of conceptual mastery in STEAM-based learning.	4
2.	Students' impression toward facilitation of creativity in STEAM-based learning.	4
3.	Students' impression toward STEAM-based learning implementation	4
Total Statement		12

D. Instrument Analysis Result

There are three instruments used by researcher in conducting this research. The three instruments has different way to be measured. The data collection techniques are explained as follows:

1. Data of Students' Cognitive Mastery

Students' cognitive mastery is the quantitative data of this research. The data has been collected through objective test in form of multiple choice questions consist of 10 questions. The result then be collected and analyzed by using the normalized gain.

Table 3.8 Test item specification

Indicator	Test Item
1) Remembering	1, 2, 10
2) Understanding	6, 7, 8
3) Apply	3, 4
4) Analyze	5, 9

The result then analyzed in term of its discriminating power, difficulty level and validity by using ANATES. The recapitulation of test item' analysis is shown in Table 3.9.

Table 3.9 Recapitulation of Test Item for Students' Concept Mastey

Question Number	Discriminating Power	Difficulty Level	Validity	Status
1	Mediocre	Medium	Validated	Revised
2	Excellent	Medium	Validated	Revised
3	Excellent	Medium	Validated	Revised
4	Excellent	Easy	Validated	Used
5	Excellent	Easy	Validated	Used
6	Excellent	Medium	Validated	Used
7	Excellent	Medium	Validated	Used
8	Excellent	Medium	Validated	Used
9	Excellent	Medium	Validated	Used
10	Excellent	Medium	Validated	Used

2. Instrument Non-Test Requirements
   a. Rubric of Creative Product Analysis Matrix (CPAM)

      Rubric of Creative Product Analysis Matrix was used to measure students' creativity in learning using STEAM-Based Learning. The product which is called *telolet* horn is assessed into some criteria that available in the rubric. The observer and teacher gave the score based

on the product they made. Beside the product, observer and teacher also analyzed students in each stages of learning.

b. Questionnaire

Questionnaire was used to getting know the response of the students towards implementation of STEAM-Based Learning in learning sound. The questionnaire was given to the students in the end of teaching-learning activity.

E. Research Procedure

There are three stages of this research procedure. The stages are preparation; implementation; and completion stages. Those three stages will be explained as follows:

1. Preparation Stage

In this stage, the researcher conduct several steps that support the research. The steps are:

a. Formulate problem that is going to be investigated.
b. Determine the focus of variable research.
c. Conduct literature review of *STEAM*-Based Learning, students' creativity and students' concept mastery.
d. Arrange the research proposal which will be presented in proposal seminar.
e. Consult to expertise and lecturer.
f. Present research proposal in proposal seminar.
g. Revise research proposal after having suggestions and critics from lecturers.
h. Arrange research instrument and ask expert to judge it.
i. Revise research instrument that has been judged.
j. Try out research instrument.

k. Revise research instrument based on the result of instrument try out analysis.

2. Implementation Stage

This stage explains steps of how research will be implemented. The steps consist of:

a. Determination of experimental class.
b. Give pre-test to class. The purpose is to gain information of initial condition of class.
c. Analyze result of pre-test.
d. Conduct research activity by implementing *STEAM*-Based Learning in learning sound.
e. Give post-test to class. The purpose is to gain information of students' improvement in creativity and concept mastery.
f. Give questionnaire to know students' impression towards implementation of *STEAM*-Based Learning.

3. Completion Stage

The steps will be conducted in this final stage are:

a. Analyze the result of the whole research.
b. Discuss and conclude for the data analysis result.
c. Arrange the report of the research.

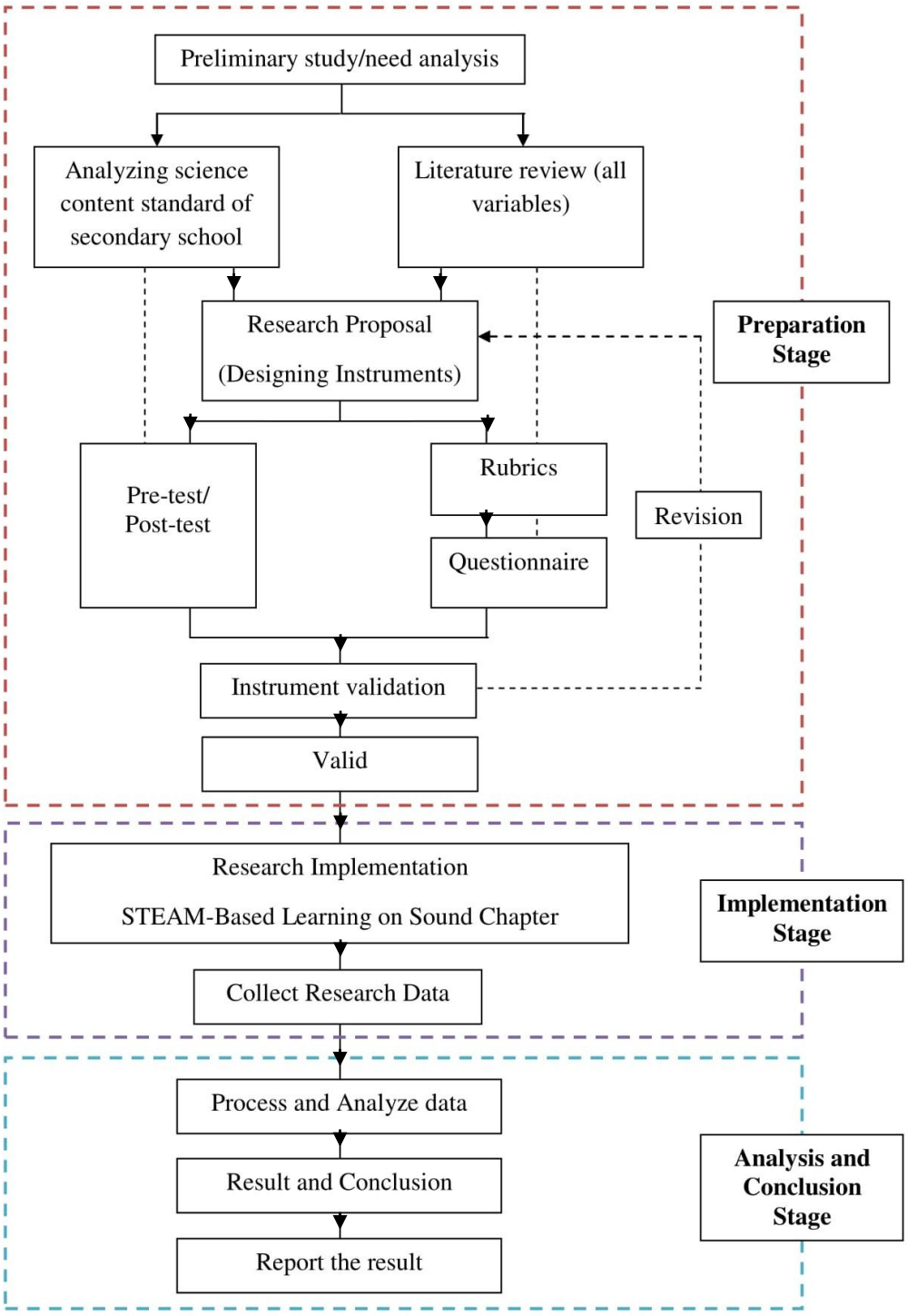

Figure 3.2 Diagram of Research Procedure

F. Data Analysis

Data was obtained from both quantitative and qualitative data. Quantitative data was obtained from pre-test and post-test. This data is used to measure improvement of students' cognitive mastery. Qualitative data was obtained from the Rubric of CPAM to measure students' creativity and questionnaire that is used to gain students' impression toward STEAM-Based Learning. Explanation of data processing techniques were obtained as follows:

1. Quantitative Data Analysis

   Quantitative data analysis was done by Microsoft Excel calculation, in order to determine the score of pre-test and post-test. The process of data calculation is explained as follows:

   a. Scoring of Test Item

      The first step to process data was by scoring the test item. The test item was provided in the 10 number of questions.

   b. Calculation of Gain Score and Normalized Gain

      After the data of test item was gained, the data was processed through gain score and normalized score. According to Hake, gain score was obtained from differences between pre-test and post-test. It was assumed as the effect of the treatment given. Normalized gain test was to determine the categories of students' cognitive mastery improvement. Hake (1998) suggested that formula to get gain score is:

$$G = S_f - S_i \tag{3.6}$$

      Description:

      G = Gain Score

      S_f = Post test Score

      S_i = Pre test Score

(Hake, 1998)

The effectiveness of STEAM-Based Learning approach in increasing students' cognitive mastery of sound concept was observed from the result of normalized gain that achieved by students during learning process. The equation used to calculate normalized gain regarding to Hake (1998) is:

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

(3.7)

Description:

<g> = Normalized gain

G = Actual gain

Gmax = Maximum gain possible

S_f = Post test score

S_i = Pre test score

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

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

(3.8)

Description:

<g> = Normalized gain

<G> = Actual gain

<G>max = Maximum gain possible

$<S_f>$ = Average of post test score

$<S_i>$ = Average of pre test score

(Hake, 1998)

The value of normalized gain that has been gained is interpreted using interpretation Table 3.10 as follows:

Table 3.10 Interpretation of Normalized Gain

Value	Classification

$\langle g \rangle \geq 0.7$	High
$0.7 > \langle g \rangle \geq 0.3$	Medium
$\langle g \rangle < 0.3$	Low

(Hake, 1998)

2. The qualitative data was obtained from CPAM rubric and questionnaire. The technique of converting score into percentage is used as follows:

$$NP = \frac{R}{SM} x100\% \quad (3.9)$$

Note:

NP = percentage

R = raw score

SM = maximum score

(Purwanto, 2008)

The interpretation of score percentage of students' creativity is categorized into certain criteria according to Purwanto (2008) as shown in Table 3.11.

Table 3.11 Interpretation of Score Percentage

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

(Purwanto, 2008)

The other data that was analyzed qualitatively was from questionnaire result. Qualitative result describe real situation of the research result and also the result of students' impression in learning sound toward STEAM-Based Learning.

The questionnaire is using the likert scale. It is calculated into score then converted into percentage. The percentage becomes the review and

evaluation for the next research. The scoring guideline is shown in the Table 3.12.

Table 3.12 Scoring Guideline

	Strongly Agree	Slightly Agree	Not Sure	Slightly Disagree	Strongly Disagree
Positive Statement	5	4	3	2	1

The percentage of likert scale in each indicator determines the students' impression toward STEAM-Based learning implementation.

G. Assumptions

The assumptions as the foundations of this research are as follows:

1. Arts-based learning has emerged as an experiential and interdisciplinary approach to STEM education that is increasingly seen to offer a distinctive new set of tools to advance creativity and engagement among STEM learners (Seifter, 2014).
2. STEAM leads to processes that result in creativity, innovation, and continued growth and exploration of the world (Zhao, 2012).
3. STEAM improved learners' active inquiry learning capacities, motivation and interest (Ahn & Choi, 2015)
4. STEAM process help students to easily grasp various knowledge related to the educational principles included in the curriculum. (Ahn & Choi, 2015)
5. STEAM improves students' content mastery from 30% to 40%. (Presley, Carroll and Gorbet, 2016)

H. Hypothesis

Hypothesis that is tested in this study is as follow:

1. Students' concept mastery

   H_0: There is no significant improvement of students' concept mastery in learning sound using STEAM-Based Learning.

H_1: There is significant improvement of students' concept mastery in learning sound using STEAM-Based Learning.

I. Operational Definition

1. STEAM-Based Learning is an approach that integrates Science, Technology, Engineering, Art and Mathematics. Learning process is conducted by asking students to make a creative product that can be used to overcome current problem. The stage of STEAM-based learning that is used in this research is referred to suggestion of KFTAC (Korea Foundation for The Advancement of Science and Creativity) in Baek and Yoon (2016).
2. Students' Creativity that is mentioned in this research is measured from the product they made. It will be measured by using Creativity Product Analysis Matrix (CPAM) developed by Besemer and Treffinger (1981). CPAM consists of three dimensions which are novelty, resolution and elaboration and synthesis.
3. Students' Concept Mastery that is mentioned in this research is measured by using multiple choice question based on Bloom's Revised Edition on students' Pre-Test and Post-Test.
4. The concept is referred to Cambridge Curriculum with the framework code: 8Ps1 and 8Ps2.