CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method and Research Design

3.1.1 Research Method

As this research is aimed to explore the effect of gender composition in grouping when applying STEM-Based Approach in learning process, then the method which will be implemented is 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.

Therefore, there is still a control class which is not given the treatment and an experiment class which is obviously given the treatment. This is done to get the data quantitatively. The treatment is about constructing some groups consist of single gender, either all members are boys or all members are girls. So, the control class has some groups as usual where a group will be consisted of boys and girls, while the experiment class will have groups where a group is consisted of either all are boys or all are girls. Besides, the teacher also has a video recording and observation to get data qualitatively.

3.1.2 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 and students'

collaboration and communication skill that is measured by questionnaire which is distributed to the students, while qualitative analysis focuses on students collaboration and communication based on video recording. The result of video recording is also involved to help the process of analysis separately based on its own indicator and then compared to produce a better interpretation regarding the impact of gender composition in grouping when STEM-based learning on is implemented in learning pressure and Pascal Law.

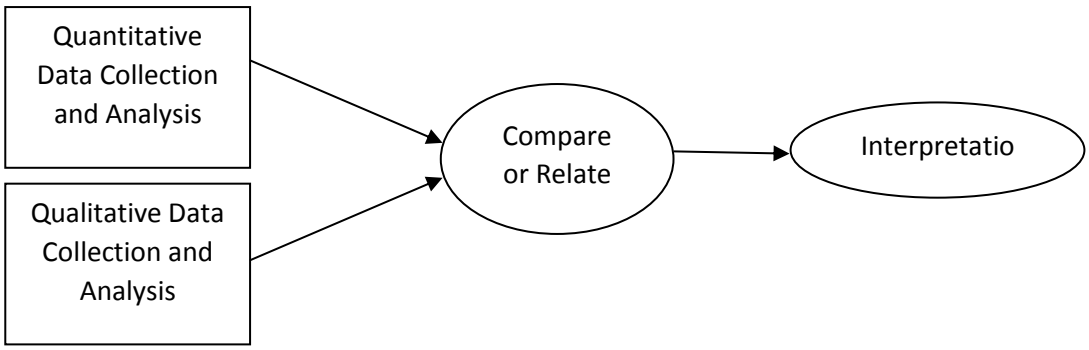

Figure 3.*1* Convergent Parallel Design
(Source: Creswell, 2012)

3.2 Population and Sample

The location of this research is an Islamic private school namely Al Azhar Syifa Budi Parahyangan (ASBP) Secondary School which uses National Curriculum of 2013. The instruction in classes is mainly conducted in Bahasa Indonesia. The population of this research is all students in ASBP. The sample are Al Muntaqim Class which consist of 26 students and Al Mutaaliy Class which consist of 13 students also. So, the number of all students is 52 students. All of students in both classes experience STEM Based learning in the topic of Pressure and Pascal Law. The subject of this research is defined under purposed of class which is used to implement STEM Based learning.

3.3 Operational Definition

In order to avoid misconception, some operational definitions are explained in this research. Those terminologies are explained as follow:

1. This research involves two classes in which each of class consist of 26 students. In both classes, there are six groups where students work collaboratively in the project. First class is experiment class and each of group here consists of similar gender member (single gender group), either all member are boys or all members are girls. In the second class which is control class and each of group here consists of different gender member (mixed gender group). Gender grouping composition which is constructed in this research is described clearly on Figure 3.2.

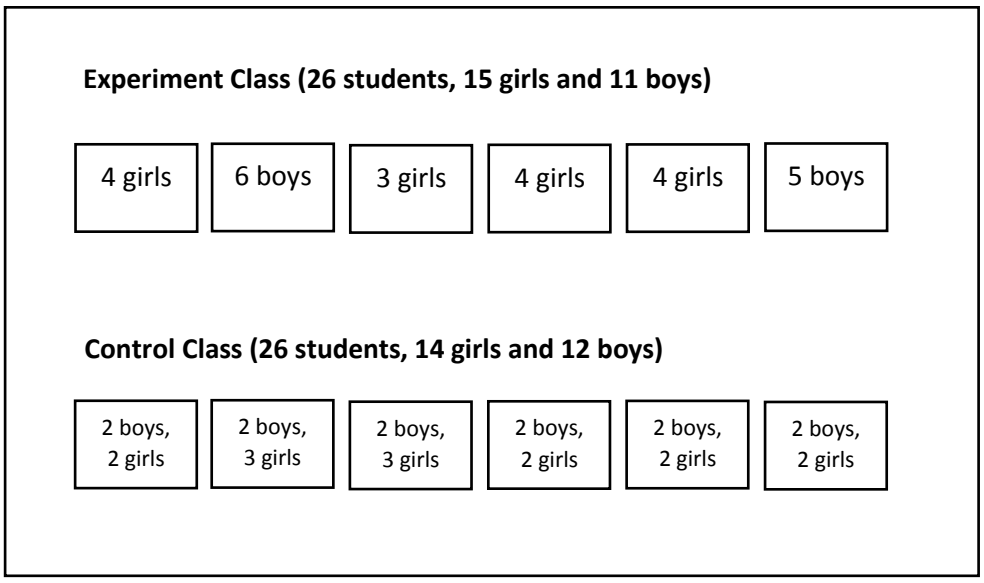

Figure 3.*2* Gender Grouping Composition in Research

2. Learning activity that is done in this research is STEM-Based Learning involving the project-based learning by George Lucas (2015). There are six steps which are done based on the syntax of the project-based learning which are: 1) starting with essential question, 2) designing a plan for the project, 3) creating a schedule, 4) monitoring students and the progress of project, 5) assessing the outcome, and 6) evaluating the experience. The description of STEM-Based Learning briefly is explained as follow:

   1) Science

      The topic which is delivered in this STEM Learning is pressure, especially in solid pressure and the Pascal Law. Introducing the concept of solid pressure to the students, teacher gives a demonstration using nail board

and balloon. Students then are stimulated to make a conclusion regarding to the concept of pressure based on their understanding after observing the demonstration. The Figure 3.3 shows the equipment of demonstration.

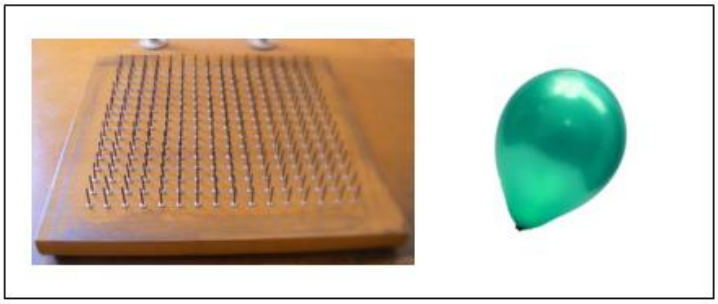

Figure 3.*3* Demonstration of pressure using nail board and balloon

2) Technology

In the learning process, technology involving in learning is the usage of video as media to deliver the concept of Pascal Law and the prototype of hydraulic bridge that is used by students. The Figure 3.4 shows the part of video itself.

Figure 3.*4* Parts of Video about Pascal Law

3) Engineering

Project-based learning in this research involves students to make a design of hydraulic bridge with some requirements such as it can be lifted to the maximum angle yet in minimum time. The students are expected to do some

engineering design process here. They should define three important material and equipment on the bridge that can fulfill the challenge or requirement. Those material and equipments are: 1) pair of syringe, 2) rubber pipe to connect syringe, and 3) kind of liquid filled to syringe. Teacher provides some different volume of syringe and three kind of liquid such as water, alcohol, and frying oil. Students should define which one is the most appropriate to lift the bridge with those requirements as well as the length of rubber pipe that is used to connect two syringes. The figure 3.5 shows the activities of students regarding to these activities.

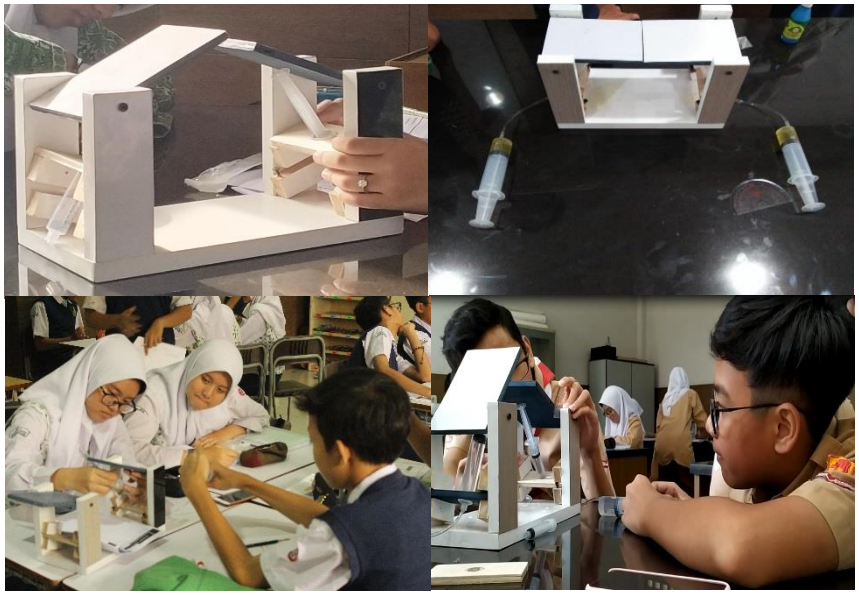

Figure 3.5 Hydraulic Bridge Project

4) Mathematics

Mathematics here in this research will lead student to calculate how Pascal Law works on the real objects. The students do the mathematical calculation when determining the syringes they use and the length of rubber pipe to connect syringe in order to result the best hydraulic bridge.

3. Collaboration that is described in this research is based on Valente (2016) in CO-LAB Guidelines for Assessing Collaborative Learning in the Classroom in which that collaboration is focusing in five aspects: engagement in

teamwork, motivation to do the task, relationship in teamwork, team leaderperformance, and team reporter performance.

4. Communication that is described in this research is based on Murdock, who developed an instrument called ‘Assessing Public Communication by Scientist’ in 2017. Murdock stated that public communications by scientist has 12 items of communication to require and has been elaborated and adopted with the permission from PSCR (Schreiber, et al, 2012). Those items starting from topic, introduction, organization, conclusion, voice, non verbal, relevance and importance, language, visuals, explaining science process, trusworthy and personable, and engagement. Similar to the collaboration, this instrument has been judged by some experts and also tested its validity and reliability in order to fit the needs of this research.

3.4 Research Instrument

In this research, researcher use three types of instruments. Since there are three aspects measured, so the instrument numbers will be three too. They are questionnaire for measuring collaboration and communication skill, and concept mastery test which is an objective test. Before the instrument is used, then the instrumen should be tested first.

3.4.1 Questionnaire of Collaboration and Communication Skill

Collaboration and communication questionnaires used in this research are based on CO-LAB Guidelines for Assessing Collaborative Learning in the Classroom by Valente (2016) and ‘Assessing Public Communication by Scientist’ by Murdock (2017) which are elaborated and modified by the agreement of some experts. Both of questionnaires are distributed to the sample of this research two times, as the pre-test and post-test questionnaire. Pre-test questionnaire is distributed before students experience STEM-Based Learning and post-test questionnaire is distributed after students experience STEM-Based Learning.

To make sure that both questionnaire is valid to be used in this research, they are firstly tested by using SPSS to see its validity and reliability before it is distributed to the students as the valid research instrument to measure collaboration

and communication skill. Collaboration questionnaire measure five aspect of collaboration itself such as engagement in teamwork, motivation to do the task, relationship in teamwork, team leader performance, and team reporter performance. There are 24 students as the respondent to test collaboration anad communication questionnare which consist of 30 statements related to the whole aspects. Table 3.1 shows the blue print of collaboration questionnaire. The questionnaire itself can be seen in the Appendix B1.

Table 3.1
The Blue Print of Collaboration Questionnaire

No	**Dimension**	**Number of Statement**
1.	Engagement in Teamwork	4,8,12,15,20,27
2.	Motivation to Do the Task	1,7,10,17,21,28
3.	Relationship in Teamwork	11,14,16,19,23,30
4.	Team Leader Performance	3,6,9,25,26,29
5.	Team Reporter Performance	2,5,13,18,22,24
	Total Statement	30

On the other hand, communication questionnaire measures six aspects such as clarity of message, giving response or feedback, questioning and answering, arranging non verbal and voice, introduction, and emphasis. Students again are given a questionnaire consist of 30 questions related to the aspects to test its validity and reliability. Table 3.2 shows the blue print of communication questionnaire. The questionnaire itself can be seen in Appendix B2.

Table 3.2
The Blue Print of Communication Questionnaire

No	Dimension	Number of Statement
1.	Clarity of message	1,6,16,26
2.	Giving response or feedback	3,9,20,30
3.	Questioning and answering	2,4,12,22,27,28
4.	Arranging non verbal and voice	5,10,17,23,24,29
5.	Introduction	7,11,13,14,18,25,
6.	Emphasis	8,15,19,21
	Total Statement	30

After 24 students fulfill the questionnaire, then the validity and reliability is tested by using SPSS. Table 3.3 shows the result of testing instrument in the aspect of collaboration skill.

Table 3.3
The Result of Validity Test toward Collaboration Questionnaire

Number of respondent	Item	Pearson Correlation	Sig. (2-tailed)	Validity	Status
24	1	0.538	0.007	Yes	**Used**
	2	0.657	0.000		
	3	0.495	0.014		
	4	0.784	0.000		
	5	0.688	0.028		
	6	0.677	0.031		
	7	0.719	0.019		
	8	0.643	0.045		
	9	0.677	0.031		
	10	0.685	0.029		
	11	0.653	0.001		
	12	0.590	0.072	No	
	13	0.711	0.000	Yes	
	14	0.632	0.001		
	15	0.408	0.048		
	16	0.765	0.000		
	17	0.380	0.067	No	
	18	0.769	0.000	Yes	
	19	0.496	0.014		
	20	0.745	0.000		
	21	0.475	0.019		
	22	0.357	0.087	No	
	23	0.641	0.001	Yes	
	24	0.621	0.001		
	25	0.464	0.022		
	26	0.554	0.005		
	27	0.620	0.001		
	28	0.773	0.009		
	29	0.824	0.003		
	30	0.650	0.042		

Then, after validity test, the reliability of instrument is measured. Table 3.4 shows the result of reliability test toward the questionnaire of collaboration skill.

Table 3.4
The Result of Reliability Test of Collaboration Questionnaire

Number of respondents	Number of Questionnaire Item	Cronbach's Alpha	Reliability	Status
24	30	0.730	Yes	Used

Based on the result of instrument test toward collaboration skill, so it is determined that the questionnaire may be used in the research since mostly item in

questionnare are valid and the reliability based on the Cronbach alpha is more than 0.7.

Similar with the questionnaire of collaboration, then the questionnaire of communication is also tested. Table 3.5 shows the result of validity test toward communication questionnaire.

Table 3.5
The Result of Validity Test toward Communication Questionnaire

Number of respondent	Item	Pearson Correlation	Sig. (2-tailed)	Validity	Status
24	1	0.773	0.009	Yes	**Used**
	2	0.695	0.026		
	3	0.768	0.010		
	4	0.617	0.001		
	5	0.590	0.072	No	
	6	0.805	0.000	Yes	
	7	0.705	0.000		
	8	0.573	0.003		
	9	0.383	0.065		
	10	0.621	0.001		
	11	0.805	0.000		
	12	0.705	0.000		
	13	0.573	0.003		
	14	0.436	0.033		
	15	0.520	0.009		
	16	0.603	0.002		
	17	0.473	0.020		
	18	0.676	0.000		
	19	0.604	0.002		
	20	0.447	0.028		
	21	0.651	0.001		
	22	0.485	0.016		
	23	0.452	0.027		
	24	0.688	0.028		
	25	0.588	0.074	No	
	26	0.677	0.031	Yes	
	27	0.650	0.042		
	28	0.768	0.010		
	29	0.685	0.029		
	30	0.740	0.014		

Then, after validity test, the reliability of instrument is measured. Table 3.6 shows the result of reliability test toward the questionnaire of communication skill.

Table 3.6
The Result of Reliability Test of Communication Questionnaire

Number of respondents	Number of Questionnaire Item	Cronbach's Alpha	Reliability	Status
24	30	0.722	Yes	Used

Based on the result of instrument test toward communication skill, so it is determined that the questionnaire may be used in the research since mostly item in questionnare are valid and the reliability based on the Cronbach alpha is more than 0.7.

According to the result of validity and reliability toward both questionnaires so that the instrument for measuring collaboration and communication skill can be used in this research.

3.4.2 Objective Test of Pressure Topic

This instrument is used to measure the concept mastery of students in the topic of pressure. The objective test is given to students twice, pre-test and post-test. Pre-test itself is done to know the prior knowledge of students on this topic while post-test is done to measure whether there is increment which indicates the improving of student's knowledge on this pressure topic.

The researcher then constructs the instrument which consists of some questions related to the solid pressure and Pascal Law. The blueprint of item specification for objective test instrument is presented on Table 3.7.

Table 3.7
The Blueprint of Item Specification for Objective Test Instrument

Sub-topic	Cognitive Level				Σ	%
	C2	C3	C4	C5		
Pressure on human body organ (heart)	-	-	Item no 1 and 2	-	2	10
Solid pressure	-	5, 10	3, 4	-	4	20
Main principal of Pascal Law	9	11,12,14, 19	8, 16, 20	-	8	40
Factors that affect pressure and Pascal Law	-	-	6, 15	18	3	15
Equipment that applies Pascal Law	7	-	-	-	1	5
The mechanical benefits of applying Pascal Law	-	13	-	17	2	10
Amount	2	7	9	2		
(%)	10	35	45	10	20	100

That package of questions in objective test then is consulted to the expert. From 20 questions, there are 18 questions which is taken to be involved in trial test to students of 9 grader. Two questions related to the pressure in human body are deleted. The trial test is conducted in grade 9 and followed by 39 students. The result of this trial test then analyzed by ANATES. This software is able to measure the validity, reliability, difficulty level, discriminating power, and distractor of each question item. The brief explanation of those aspects are:

1. Validity

Validity is the ability of an instrument to measure what it is designed to measure (Kumar, 2005). Anderson in (Arikunto 2010:65) revealed that " A test is valid if it measure what it purpose to measure". An instrument categorized as valid if it can measure something that will be masured and interpret data from variable of research exactly. The result of instrument validity indicates that the collected data is not deviating from the idea of the validity itself. The classification of interpretation about r_{xy} will be divided into different categories based on Guilford (Arikunto, 2010) and shown on the Table 3.8.

Table 3.8
Interpretation of Validity

Value of r_{xy}	**Interpretation**
$0.90 \leq r_{xy} \leq 1.00$	Very high validity
$0.70 \leq r_{xy} < 0.90$	High validity
$0.40 \leq r_{xy} < 0.70$	Medium validity
$0.20 \leq r_{xy} < 0.40$	Low validity
$0.00 \leq r_{xy} < 0.20$	Very low validity
$r_{xy} < 0.00$	Invalid/NAN

2. Reliability

Reliability is related with trust. A test which has a high level of trust then usually can give a consistent result in repeated trials. It means that the reliability of a test will be very related with the consistency of test results itself (Arikunto, 2013). The concept of reliability related with research instrument is consistent and stable, and hence, predictable and accurate, it is said to be reliable. The greater the degree of consistency and stability in a research instrument, the gretaer its reliability. The classification of interpretation reliability coefficient is shown on the Table 3.9.

Table 3.9
Interpretation Reliability Coefficient

Value of *r*	**Interpretation**
$0.90 \leq r_{xy} \leq 1.00$	Very high reliability degree
$0.70 \leq r_{xy} < 0.90$	High reliability degree
$0.40 \leq r_{xy} < 0.70$	Medium reliability degree
$0.20 \leq r_{xy} < 0.40$	Low reliability degree
$r_{xy} < 0.20$	Very low reliability degree

3. 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). Based on the answer of students either they answer correctly or not, the difficulty level is then defined. According to Arikunto (2013), the difficulty level is a term which show the level of question, whether it is easy to solve or hard to solve. Difficulty index is usually used as the number to show the difficulty level of question. Table 3.10 shows the classification of difficulty level.

Table 3.10
The Interpretation of Difficulty Level

Value of DL	**Interpretation**
IK = 0.0	Very difficult
0.0 <*IK*≤0.30	Difficult
0.30< IK≤0.70	Medium
0.70< IK<1.00	Easy
IK = 1.00	Very easy

4. 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 discriminatory. On the contrary, if it is not, so the item is qualified as item with low discriminatory. Item with high discriminatory is desirable, while the one with low discriminatory should be discarded.

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 3.11 as follow:

Table 3.11
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

5. 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.

Based on the trial test of 39 students of 9 grade, Table 3.12 shows the result of ANATES in term of its discriminating power, difficulty level, and validity.

Table 3.12
Recapitulation of Test Item for Students' Concept Mastery

Question Number	Discriminating Power	Difficulty Level	Sig	Status
1	54.55%	Medium	Significant	Used
2	45.45%	Easy	-	Revised
3	45.45%	Medium	Significant	Used
4	81.82%	Easy	Very significant	Used
5	63.64%	Medium	Significant	Used
6	54.55%	Medium	Significant	Used
7	54.55%	Medium	Significant	Used
8	54.55%	Medium	Significant	Used
9	-45.45%	Medium	-	Not used
10	63.64%	Medium	Significant	Used
11	63.64%	Medium	Significant	Used
12	90.91%	Medium	Very significant	Used
13	27.27%	Difficult	-	Not used
14	18.18%	Very easy	-	Not used
15	63.64%	Very easy	Very significant	Used
16	63.64%	Medium	Very significant	used
17	54.55%	Difficult	Significant	Used
18	45.45%	Difficult	Significant	Used

Based on the result of ANATES which is presented on Table 3.12, there are 15 questions which is decided to be used in the research. All of them has fulfilled the requirement as the worth and ideal questions to be used in this research.

This instrument is finally used in the pretest and posttest in this research. It is based on Bloom's Revised Edition and is used to measure students' concept mastery. Pretest is conducted to gather students' prior knowledge, while posttest is conducted to find out whether or not students' concept mastery increased significantly. The cognitive skill level that is tested in this objective test are C2 (understanding), C3 (applying), C4 (analyzing), and C5 (evaluating). Table 3.13

shows the blue print of pressure and Pascal Law objective test indicator which is used in this research.

Table 3.13
The Blue Print of Pressure and Pascal Law Objective Test Indicator

Number of question	Indicator	C1	C2	C3	C4	C5
1.	Determining the pressure of an object			✓		
2.	Analyzing the greatest pressure based on information provided.				✓	
3.	Determining the important aspects to construct hydraulic				✓	
4	Determining the area of an object based on information provided			✓		
5.	Determine the equipment which apply Pascal Law		✓			
6	Determine the statement related to the Pascal Law based on information provided				✓	
7.	Define the benefit of equiment which apply the Pascal Law		✓			
8.	Determine the minimum force required to lift the car up using hydraulic.			✓		
9.	Determine the mechanical benefit of hydraulic		✓			
10.	Determine the mass of an object which is lifted upby hydraulic pump			✓		
11.	Determine the pressure based on the application of Pascal law			✓		
12.	Determine the best syringe to be applied in hydraulic pump prototype					✓
13	Analyzing the condition that can handle pressure in certain number				✓	
14	Comparing two condition and determine the pressure				✓	
15.	Determine the basic principal of pressure		✓			
	Total test item		4	5	5	1
	Percentage (%)		26.7%	33.3%	33.3%	6.7%

3.5 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:

3.5.1 Preparation Stage

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

1. Formulate problem that is going to be investigated. It is actually started by the experience of researcher when conducting science learning and involve students in collaborative work. In time, the finding of this experience is the result of group which consist of all boys students are better than when they are separated and distributed to several group. On the other hand, the girls, they are very free when exploring themselves in some works together with other girl members. Moreover, the school where researcher conducts this study has the new rules that emphasize every teacher to reconstruct the mixed gender group into single gender group when having teamwork. So, to make sure that the new rules can be running as well as the school expects, this case then turns into a problem that should be solved.
2. Determine the focus of variable research. According to the problem that is stated in number 1, then the researcher finally decides gender grouping composition, collaboration and communication skill, and concept mastery as the variables in this research. The independent variable is gender grouping composition while the dependent variables are collaboration and communication skill, and concept mastery as well. The STEM-Based Learning which involve project based learning then is decided to be implemented in the learning process which involves all variables mentioned.
3. Conduct literature review of gender grouping composition, collaboration and communication skill, STEM-Based Learning, and project-based learning. This step defines the systematics of gender grouping composition, the measuring aspect of collaboration and communication skill, and also the

detail of STEM-Based Learning which integrates project-based learning implementation in research, such as the science concept delivering to students, the involvement of technology, the engineering process design that students will have, and the last is how students involve mathematics during project. The science concept delivering to the students is then adjusted with the national curriculum of 2013 of science subject.

4. Arrange the research proposal which will be presented in proposal seminar and consult it to the supervisor. The recommendation of supervisor then is highly considered to make the proposal clearer and more acceptable.
5. Present research proposal in proposal seminar.
6. Revise research proposal after having suggestions and recommendation from lecturers.
7. Arrange research instruments and ask expert to judge it. There are four experts who help in revising the instruments. Those instrument are questionnaire of collaboration and communication, and the last is the obejctive test to measure the students' concept mastery of solid pressure and Pascal Law.
8. Revise research instrument that has been judged by four experts.
9. Try out those three research instruments to some students. The objective test is tried to 39 students of 9 grader in Al Azhar JHS while the questionnaire is also tried to 24 students from 9 grade in the same school.
10. Revise research instrument based on the result of instrument try out analysis. The validity and reliability of both questionnaires are tested by using SPSS, while the ANATES is used to measure validity, reliability, discriminating power, and difficulty level of all items in objective test.

3.5.2 Implementation Stage

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

1. Determination of experiment and control class. It is defined randomly which class is the exeriment class and which one is the control class as students of both classes has almost similar ability in learning process.
2. Give pre-test to both classes. The purpose is to gain information of initial condition of students in terms of collaboration and communciation skill, as well as pressure concept mastery. Students have two questionnaires to fill and an objective test of pressure topic.
3. Analyze result of pre-test.
4. Conduct the main research activities by implementing STEM-Based Learning in the concept of pressure and Pascal Law. All of the syntax is run during the research. Students are all participating in the learning process by the guidance of teacher. Two observers are available during the research and some videos are take to record the activities.
5. Give post-test to class. The similar questionnaires and objective test are again given to all students of both classes. The purpose is to gain information of students' improvement in collaboration, communication, and concept mastery.

3.5.3 Completion Stage

The steps those are conducted in this final stage are:

1. Analyze the video recording as the qualitative data. This analysis is based on the indicator/aspect that is measured in this research.
2. Collect and analyze the result of the whole research quantitatively. The researcher collects the data of questionnaire as the result of peer assessment toward collaboration and communication skill of students. Besides, the researcher also check the result of objective test of students both in pretest and posttest. Generally, the researcher focuses the data analysis on gain number.

3. Discuss and conclude for the data analysis result. The researcher has the comparison between the qualitative and quantitative data to interprete the final result of this research. Then, the interpretation is used to draw the conclusionof this research. All of the interpretation basically are based on the valid resources to strengthen the result and conclusion.
4. Arrange the report of the research. This is the final step of the research to report all the findings and inform the conclusion of research.

3.6 Research Scheme

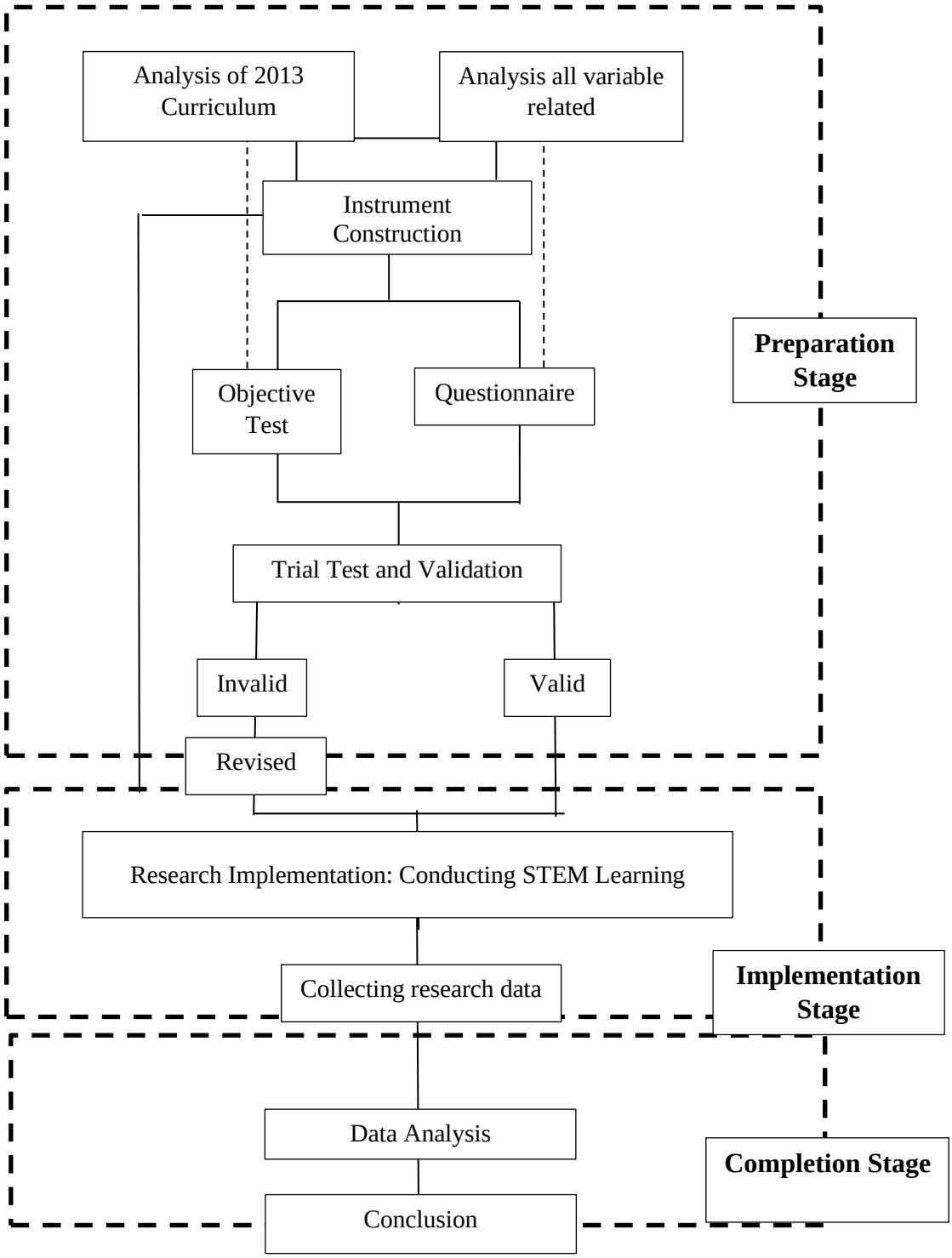

Figure 3.6 Research Scheme

3.7 Data Analysis

Data is actually obtained from both quantitative and qualitative data. Quantitative data was obtained from pre-test and post-test from three aspect such a collaboration, communication, and concept mastery. This data is used to measure the improvement of those aspects mentioned. Qualitative data was obtained from the video recording which is taken during the research. The data is called as video transcript. Explanation of data processing techniques were obtained as follows:

4.7.1 Quantitative Data Analysis

Quantitative data analysis is done by Microsoft Excel and SPSS in order to determine the score of pre-test and post-test on student' collaboration, communication, and concept mastery. The process of data calculation is explained as follows:

1. Scoring the Result of Peer Assessment

The first step to process data is by scoring the questionnaire of students. According to the questionnaire itself, students are faced to five options that indicate their frequency toward the statement given, which are "*Sangat sering*", "*Sering*", "*Kadang-kadang*", "*Jarang*", and "*Tidak pernah*". Table 3.14 presents the manual of item scoring in questionnaire.

Table 3.14
The Manual of of Item Scoring in Questionnaire

Category	Score for Positive Statement	Score for Negative Statement
"*Sangat sering*"	5	1
"*Sering*"	4	2
"*Kadang-kadang*"	3	3
"*Jarang*"	2	4
"*Tidak pernah*"	1	5

All of the result of peer assessment both in pretest and posttest then be inputed on Microsoft Excel. Since this research uses peer assessment to collect data, so each student is assessed by how many students are in their group. If all data has been inputed, then the average of each item is calculated. This average data then is used

in the follow up statistic test. The recapitulation of item scoring in peer assessment can be seen in Appendix D1 and D2.

The next step is categorizing item based on each aspect, both in collaboration and communication. Both questionnaires consist of 30 items which measure five aspects in collaboration and six aspects in communication. This categorization is done for both pretest and posttest result.

2. Scoring of Test Item in Objective Test

The first step to process data is by scoring the test item of objective test. The test item is provided in the 15 number of questions. The right answer is given 1 point, while the wrong asnwer is given 0 point. This checking answer is done to both pretest and posttest result. Then, summing up the result and the score of students' concept mastery result is got. The result of objective test scoring can be seen on Appendix D3.

3. Calculating the Gain Score

After the data of test item and all questionnaire is collected, the data was processed through gain score. According to Hake, gain score is obtained from differences between pre-test and post-test. It is assumed as the effect of the treatment given.

Hake (1998) suggested that formula to get gain score is:

$$G = S_f - S_i$$

Description:

G = Gain Score

S_f = Post test Score

S_i = Pre test Score

(Hake, 1998)

For collaboration and communication, the gain score is taken on each aspect measured, besides take the gain score as a whole. For example, in collaboration,

there are five aspects measured. So, the gain score will be gain of aspect 1, aspect 2, aspect 3, aspect 4, and aspect 5. Besides, in the end, the gain of collaboration as a whole can be taken from the average of those five aspects. This data analysis result can be seen on Appendix D.

4. Testing the Normality and Homogeneity of Data

Starting from this step, all analysis data is helped by software SPSS. By using SPSS software, the normality and homogeneity of all of the data pretest, posttest, and gain score on collaboration and communication skill, as well as concept mastery should be checked. This step is to determine the follow up statistic test that will be taken to know the effectiveness of the treatment given in this research.

The normality test used in this research is according to Shapiro-Wilk as the samples in this research is less than 50 samples. The data is normal distributed if α is more than 0.05 and vice versa. Then, the homogeneity test used in this research is based on Leveine Test. The data is homogen if *p* is more than 0.05.

5. Determining the effectiveness of treatment given in research through Statistic Test (The Independent Sample Test and The mann-Whitney Test)

If the data is normally distributed, then the parametric statistic is involved. The next statistic test can be following the Independent Sample Test. However, if the data is not normally distributed, then the non-parametric statistic is involved. The data is then analyzed quantitatively using The Mann-Whitney Test.

To know whether the result is significantly different or not, then the Sig. (2-tailed) or Asymp. Sig. (2-tailed) should be less than 0.05. The indicator Sig. (2-tailed) is found when the Independent Sample Test is involved, while the indicator Asymp. Sig. (2-tailed) is found when the Mann-Whitney Test is involved.

6. Determining the Effect Size

If the final data either posttest or gain data is significantly different, then the effect size can be calculated toknow the effectiveness level of the treatment given

in this research. The effect size is indicated by Cohen's score (d). To calculate the effect size, the formula is presented below.

$$d = \frac{m_1 - m_2}{\sqrt{\frac{{S_1}^2 + {S_2}^2}{2}}}$$

d : Cohen' score/coefficient

m_1 : average of experiment class

m_2 : average of control class

S_1 : Deviation standard of experiment class

S_2 : Deviation standard of control class

The category of Cohen' score/coefficient is shown below on Table 3.15

Table 3.15
Interpretation Cohen' Score (Effect Size)

Value of *d*	**Interpretation**
0.0 – 0.20	Weak effect
0.21 – 0.50	Modest effect
0.51 – 1.00	Moderate effect
>1.00	Strong effect

(Cohen, 2007)

4.7.2 Qualitative Data Analysis

Qualitative data in this research is done through video recording and audio recording toward student' collaboration and student' communication. This is aimed to have the clear description on how students learn pressure and Pascal Law through hydraulic bridge project in STEM-Based Learning. The result of this analysis then is compared to the result of quantitative data analysis and finallt make interpretations through these data and construct conclusion after that.

4.8 Hypothesis

Hypothesis that is tested in this study is as follow:

1. Students' collaboration skill

   H_o : There is no significant different on student' collaboration skill between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.

   H_a : There is significant different on student' collaboration skill between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.

2. Students' communication skill

   H_o : There is no significant different on student' communication skill between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.

   H_a : There is significant different on student' communication skill between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.

3. Students' concept mastery

   H_o : There is no significant different on student' concept mastery between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.

   H_a : There is significant different on student' concept mastery between students who worked in single gender group and mixed gender group when they experience STEM-Based Learning.