CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Method

In this study descriptive analysis method was used to address the research problem. Descriptive analysis can stand alone as a complete research, particularly when findings focus on identifying undocumented phenomena, hidden patterns or diagnosing real-world needs (Loeb, et al., 2017). This type of descriptive study could be used to give information on basic understanding of a phenomenon. For instance when virtual classroom were first introduced in school, education policymakers, practitioners and researchers wanted to assess its effect on teaching and learning. Here, descriptive analysis was required to clarify basic understanding of the key aspects of that new phenomenon. Furthermore, Loeb et al (2017) described that descriptive analysis could be used to interpret why an intervention did or did not produce a particular effect through access to descriptive details that accurately and thoroughly characterized the conditions and context of a study. For instance thorough analysis was done to describe how implementation of particular instruction may have varied impact across settings or across populations.

Through the use of descriptive analysis method, this study describes middle school students' profile on collaborative problem solving skill, conceptual understanding and attitudes toward science and engineering career after learning blood circulation system with engineering design-project. The analysis also includes how students' diversity in terms of learning style is facilitated through such instruction so that they can develop the skill, understanding and attitudes aforementioned.

3.2 Location and Subject

This study took place in Bandung. The research subjects was a class of fourteen eight-grade students in one of private school in Bandung Barat. Prior to the treatment, the students have learnt about blood circulation system but not yet learnt about disease in blood circulation system.

3.3 Operational Definition

To avoid misinterpretation of terms used in this study, it is important to explain definition of those terms to make it effective and operational. Those terms are (1) Engineering Design Project (ED-P), (2) Collaborative Problem Solving, (3) conceptual understanding and (4) attitudes.

Engineering Design Project (ED-P) is defined as instructional strategy that incorporate engineering design process into the learning that embodies the stages of project based learning. This study used project based learning framework developed by The George Lucas Educational (2007) that consists of several stages namely: (1) start with essential question, (2) design a plan for the project; (3) Create a schedule, (4) monitor students and project progress, (5) assess the outcome, and (6) evaluate the experience. As the basis for project based learning activities, Engineering Everywhere engineering design process (Higgins et al, 2013) was used. The engineering design process includes: (1) identify, (2) investigate, (3) imagine, (4) plan. (5) create, (6) test, (7) evaluate, and (8) communicate. In this study the instruction is related to disease in human blood circulation system and the project is to construct the analogical model of blocked artery and medical tool to treat the disease.

Collaborative problem solving (CPS) is defined as a joint activity where dyads or small groups execute a number of steps in order to transform a current state into a desired goal state. Social domain of collaborative problem solving comprises of participation, perspective taking and social regulation skills that was measured through direct observation. Cognitive domain of collaborative problem solving consists of task regulation and learning and knowledge building skills that was measured through written test. CPS framework was adapted to be used as the basis for developing instruments to measure both social and cognitive domain of CPS.

Conceptual understanding refer to the ability to think with scientific ideas, apply, state it with one's own words, find metaphor or analogy for it or build mental or physical model of that ideas. In this study, the indicator of conceptual understanding adopt revised Bloom's taxonomy yet limited to C1 (remember), C2 (understand), C3 (apply), C4 (analyse) and C5 (evaluate) which is in line with students' learning experience within the lesson unit.

Attitudes refer to students' opinion about particular things which is obtained through learning experience that influence students action or behaviour. In this study the attitudinal domain that will be studied is attitudes toward science and engineering career that were measured through rating scale which includes several aspects such as eagerness to pursue career in science and engineering, science and engineering career preference as well as positive and negative opinion on career in science and engineering fields.

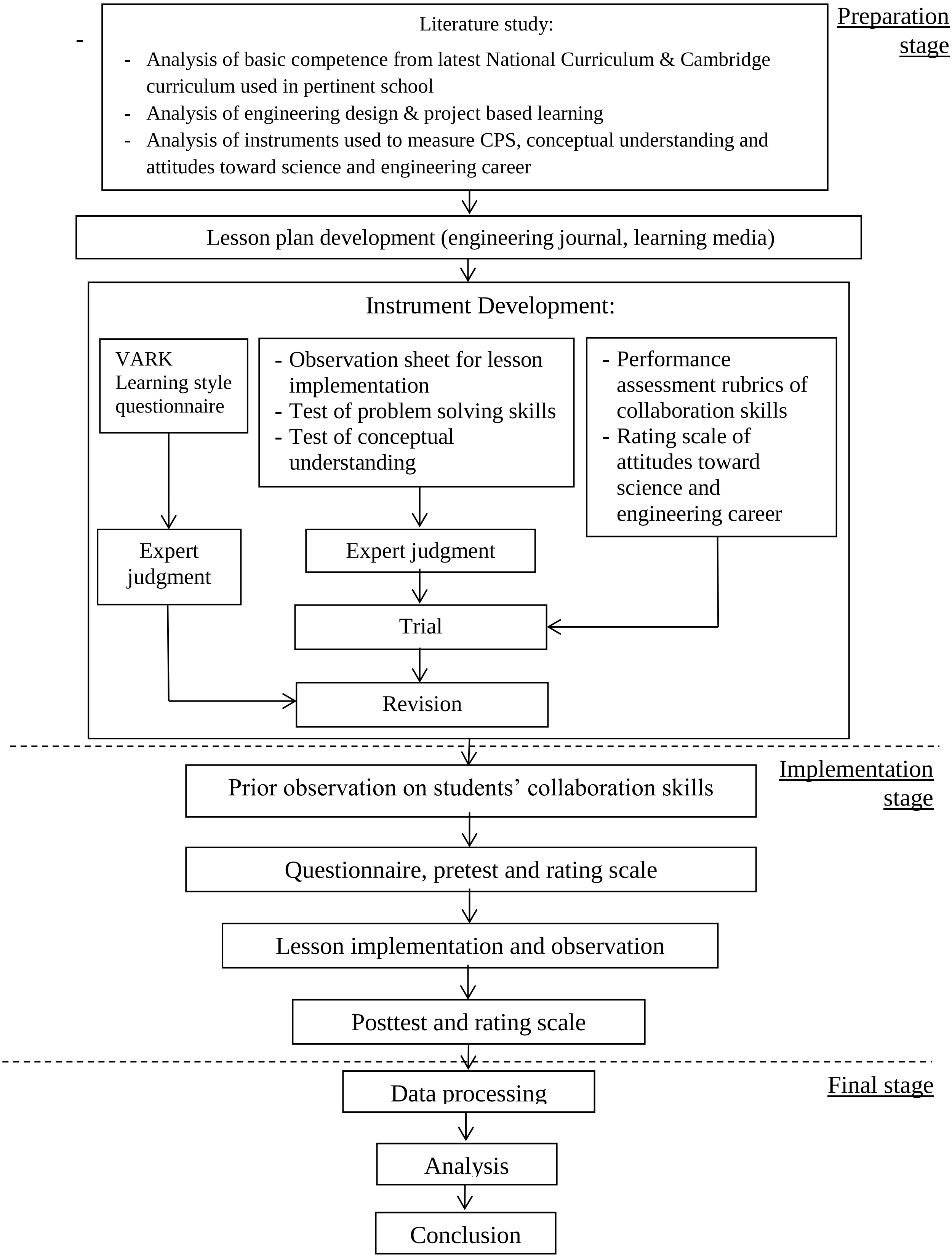
3.4 Research Procedure

This study was conducted through 3 stages which include preparation, implementation and final stages. The first step which is done during preparation is conducting preliminary study and needs analysis. Preliminary study and needs analysis were done by analysing of studies related to project based learning, engineering design, collaborative problem solving and attitudes toward science and engineering career as well as careful analysis of science curriculum applied in grade 8 secondary school. The second step is determining research subject and the lesson material that will be used as the context of learning. Furthermore, a set of lesson plan was designed based on the steps on engineering design project in regard to basic competence mandated by latest National Curriculum and Cambridge curriculum used in pertinent school. To obtain the data needed in this study several research instruments were constructed. Subsequently, the instruments administered trial prior to being used in the study. The trial was done by implementing the lesson in another class of eight grade students. At the same time, instrument for lesson observation and rubric for collaboration skills administered trials too. In the end of the lesson, instruments for problem solving skills and conceptual understanding as well as rating scale of attitudes on science and engineering career were tested. The results of trials were used to improve the research instruments.

The implementation stage was done to obtain data needed for the research, which include the data of lesson implementation, students' collaboration skills, students' problem solving skills, as well as students' attitudes toward science and engineering career. To obtain data of students' initial collaboration skill, the observation was done during science lesson involving collaborative activities. Prior to the lesson implementation, VARK questionnaire was administered to identify students' learning style. Furthermore, pre-test was done to assess students' initial problem solving skills, conceptual understanding and attitudes toward science and engineering career. Subsequently, engineering design project in disease of blood circulation system topic was implemented. In this process students were guided to construct an analogical model of blocked artery and medical tool to treat this disease. Along the lesson implementation students need to fill worksheet or engineering journal provided by the teacher. In addition, during the lesson, observation using collaboration skill rubric was done to measure students' collaboration skills. Observers used rubric of performance assessment developed from adaptation of CPS framework on social domain (Hesse et al., 2015). After lesson implementation, post-test was administered to assess students' problem solving skills, conceptual understanding and attitudes toward science and engineering career.

Activities which were done in final stage include collecting, processing and analysing data. Subsequently, the conclusion was drawn based on analysis of the findings from the study. The report was then made and revised.

3.5 Scheme of Research



3.6 Data Collection Techniques and Instruments

To answer the research problem, there are several data collection techniques used in this study as seen on Table 3.1.

Table 3.1 Research Instruments

No	Type of Data	Instrument	Resources
1	Lesson implementation	Observation sheet based on lesson plan and students' worksheets	Teacher and students
		Questionnaire adapting VARK (Visual, Aural, Read and write, Kinaesthetic) questionnaire for young learner version 7.1	Students
2	Collaborative problem solving skills	Social domain: Performance assessment using rubric adapting CPS framework of social domain	Students
		Cognitive domain: Written test containing structured questions that was scored based on marking scheme rubric adapting CPS framework of cognitive domain	
3	Conceptual understanding	Multiple choice question containing concept of disease in circulatory system in regard to revised Bloom's taxonomy C1, C2, C3, C4, C5	Students
4	Attitudes toward science and engineering career	Rating scale adapted from Attitudes toward Mathematics, Science and Engineering scale	Students

3.6.1 Lesson Implementation

The first data is obtained from lesson implementation. Lesson implementation was observed based on teacher and students activities during the lesson. Observation sheet was used to observe to what extent steps of engineering design project that has been planned is conducted. While doing the observation, observer are required to put check (✓) mark on appropriate score column and describe their observation on description column. The lesson took four meetings ranging from one to two periods of 40 minutes each.

The data of students' learning style is obtained through the use of questionnaire which is given to students. The questionnaire is adapting VARK

(Visual, Aural, Read and write, and Kinaesthetic) questionnaire for young learner version 7.1 that can be found on www.vark-learn.com. VARK questionnaire consists of 16 questions reflecting situation in everyday life. The questionnaire was limited to 16 questions to avoid respondent exhaustion when taking the questionnaire. Each question followed by four different option that correspond to one type of learning style either visual, aural, read and write or kinaesthetic. In taking VARK questionnaire, respondent might choose more than one answer for each question (Fleming, 2008). The VARK questionnaire was adjusted to make it more relevant for the research subject. Since the original version use English, the adjustment was made by translating the questionnaire into Indonesian language so that students can comprehend the questions and its options. Thus allowing them to give responds that really reflect their learning style. Based on the score on each learning style category, students will be assigned into two categories: single modal learner (either V, A, R or K only) or multimodal learner (have two or more learning styles).

3.6.2 Collaborative Problem Solving

The second data is students' collaborative problem solving skills on social domain. Students' collaboration skills were measured through direct observation with performance assessment rubrics. The rubrics were developed by adapting CPS framework on social domain (Hesse et al., 2015).

Table 3.2 Framework of social domain of collaborative problem solving

Element	Indicator	Low	Middle	High
Participation				
Action	Activity within environment	No or very little activity	Activity in familiar contexts	Activity in familiar and unfamiliar contexts
Interaction	Interacting with, prompting and responding to the contributions of others	Acknowledges communication directly or indirectly	Responds to cues in communication	Initiates and promotes interaction or activity
Task completion/ perseverance	Undertaking and completing a task or part of a task individually	Maintains presence only	Identifies and attempts the task	Perseveres in task as indicated by repeated attempts or multiple strategies

Element	Indicator	Low	Middle	High
Perspective taking				
Adaptive responsiveness	Ignoring, accepting or adapting contributions of others	Contributions or prompts from others are taken into account	Contributions or prompts of others are adapted and incorporated	Contributions or prompts of others are used to suggest possible solution paths
Audience awareness (Mutual modelling)	Awareness of how to adapt behaviours to increase suitability for others	Contributions are not tailored to participants	Contributions are modified for recipient understanding in the light of deliberate feedback	Contributions are tailored to recipients based on interpretation of recipients' understanding
Social Regulation				
Negotiation	Achieving a resolution or reaching compromise	Comments on differences	Attempts to reach a common understanding	Achieves resolution of differences
Self-evaluation (metamemory)	Recognizing own strengths and weaknesses	Notes own performance	Comments on own performance in terms of appropriateness or adequacy	Infers a level of capability based on own performance
Transactive memory	Recognizing strengths and weaknesses of others	Notes performance of others	Comments on performance of others in terms of appropriateness or adequacy	Comments on expertise available based on performance history
Responsibility initiative	Assuming responsibility for ensuring parts of task are completed by the group	Undertakes activities largely independently of others	Completes activities and reports to others	Assumes group responsibility as indicated by the use of first person plural

In this study, observed behaviour indicating particular elements in the three subs kills was rated ranging from 1 to 3 points. Prior to its use, the observers tried to read the observation rubric and did discussion about example of action indicating each element of collaboration skills. This was done to ensure that all observers have the same interpretation. The observation not only be done during students' learning using engineering design project but also be done on the previous lesson involving collaborative activities, thus allowing for analysis of initial and final profile of students' collaboration skill.

On the other hand, students' collaborative problem solving skills on cognitive domain was measured through written test consisting nine structured questions. The test was done before and after lesson implementation. The test items along with its marking scheme were developed based on adaptation of CPS framework on cognitive domain (Hesse et al., 2015).

Table 3.3 Framework of cognitive domain of collaborative problem solving

Element	Indicator	Low	Middle	High
Task Regulation				
Problem analysis	Analyses and describes a problem in familiar language	Problem is stated as presented	Problem is divided into subtasks	Identifies necessary sequence of subtasks
Goal setting	Sets a clear goal for a task	Sets general goal such as task completion	Sets goals for subtasks	Sets goals that recognize relationships between subtasks
Resource management	Manages resources or people to complete a task	Uses/identifies resources (or directs people) without consultation)	Allocates people or resources to a task	Suggest that people or resources be used
Flexibility and ambiguity	Accepts ambiguous situations	Inaction in ambiguous situations	Notes ambiguity and suggests options	Explores options
Collection of elements of information	Explores and understands elements of the task	Identifies the need for information related to immediate activity	Identifies the nature of information needed for immediate activity	Identifies need for information related to current, alternative and future activity
Systematicity	Implements possible solutions to a problem and monitors progress	Trial and error actions	Purposeful sequence of actions	Systematically exhaust possible solutions
Learning and knowledge building				
Relationships (Represents and formulates)	Identifies connections and patterns between and among elements of knowledge	Focused on isolated pieces of information	Links elements of information	Formulates patterns among multiple pieces of information
Rules: "If .... then ..."	Uses understanding of cause and effect to develop a plan	Activity is undertaken with little or no understanding of consequence of action	Identifies short sequences of cause and effect	Use understanding of cause and effect to plan or execute a sequence of actions
				Plans a strategy based on a generalized understanding of cause and effect
Hypothesis "what if ..."	Adapts reasoning or course of action as	Maintains a single line of	Tries additional options in light of	Reconstructs and reorganizes

Element	Indicator	Low	Middle	High
(Reflects and monitor)	information or circumstances change	approach	new information or lack of progress	understanding of the problem in search of new solution

Prior to its use, problem solving test instrument was validated by two research supervisors and analysed based on trial results. The test items fulfilling good criteria and test items requiring minor revisions was selected to be used in pre-test and post-test. The results of instrument trial was analysed by Anates V4 program prior to its use to measure validity, reliability, level of difficulty and discriminating power of test item.

a. Test Item Validity

Content validity was done through judgment by research supervisor. After validation with supervisor the instrument was administered to students and the results were analysed using Anates V4 program. Furthermore the result of Pearson Product Moment Correlations Coefficient (r_{xy}) obtained was interpreted based on test validity criteria as seen on Table 3.4.

Table 3.4 Criteria of test validity

r_{xy}	Category
0.80 – 1.00	Very high
0.60 – 0.80	High
0.40 – 0.60	Moderate
0.20 – 0.40	Low
0.00 – 0.20	Very Low

(Surapranata, 2009)

b. Reliability of test

Reliability of test was measured through Anates V4 program and the result obtained was interpreted based on test reliability criteria as it seen on Table 3.5.

Table 3.5 Criteria of test reliability

Reliability Score	Category
0.81 – 1.00	Very high
0.61 – 0.80	High
0.41 – 0.60	Moderate
0.21 – 0.40	Low
0.00 – 0.20	Very Low

(Surapranata, 2009)

c. Difficulty level

To produce a good test it is important to identify difficulty level of each item test which is indicated by the percentage of students who get the right answer. The difficulty level is expressed in term of difficulty index (Arikunto, 2006). The result of difficulty level obtained from Anates V4 program was interpreted based on difficulty level criteria on Table 3.6.

Table 3.6 Criteria of test item difficulty level

Percentage (%)	**Category**
81 – 100	Very easy
61 – 80	Easy
41 – 60	Moderate
21 – 40	Difficult
0 – 20	Very Difficult

d. Discriminating power

Discriminating power refer to how well the item could differentiate master students with non-master students which is indicated by discrimination index. The result of discrimination index obtained from Anates V4 program was interpreted based on discrimination index of test item criteria on Table 3.7.

Table 3.7 Criteria of test item discriminating power

Discriminating power (%)	**Category**
70 – 100	Very good
41 – 70	Good
21 – 40	Sufficient
0 – 20	Poor
Negative	Test item is not good

According to the results of validity obtained from Anates V4 program, it is found that among 10 items there are 3 items that were categorized as low, 3 items were categorized as moderate, 3 items were categorized as high and one item was categorized as not valid. Seven test items were appropriate to be used in the study while two test items need to be revised prior to being used in the study. One of the test items is rejected. The reliability of the problem solving test was 0.74 which is categorized as high reliability. One of the items were categorized as very difficult, two items were categorized as difficult while the rest were included into moderate criteria. A blueprint of problem solving test is provided in appendix (Appendix B.3). The recapitulation of problem solving instrument validation is provided on Table 3.8.

Table 3.8 Recapitulation of problem solving instrument validation

Item Number	Discrimi-nation Power (%)	Level of Difficulty		Validity		Significance of Correlation	Conclusion
		P (%)	Category	r_{xy}	Category		
1	33.33	16.67	Difficult	0.613	Moderate	Significant	Accepted
2	8.33	45.83	Moderate	0.328	Low	-	Revised
3	58.33	45.83	Moderate	0.702	Moderate	Significant	Accepted
4	66.67	41.67	Moderate	0.898	High	Very Significant	Accepted
5	41.67	45.83	Moderate	0.742	High	Very Significant	Accepted
6	0.00	0.00	Very Difficult	NAN	Not Valid	Not Significant	Rejected
7	83.33	41.67	Moderate	0.774	High	Very Significant	Accepted
8	41.67	37.50	Moderate	0.651	Moderate	Significant	Accepted
9	41.67	20.83	Difficult	0.443	Low	-	Revised
10	25.00	45.83	Moderate	0.589	Low	Significant	Accepted

3.6.3 Conceptual Understanding

The forth data is students' conceptual understanding on disease in blood circulation system. Written test is used to obtain this data. The test with 15 items of multiple choice questions was administered before and after the implementation of the lesson. Each question was developed based on indicators formulated from basic competence of latest National Curriculum combined with Cambridge curriculum used in pertinent school. To produce a proper instrument, the test was developed through four steps which includes instrument validation, analysis of test item, selection of test item and revision of test item. The instrument was analysed by Anates V4 program prior to its use to measure validity, reliability, level of difficulty and discriminating power of test item.

Based on the results of validity from Anates V4 program, it is found that among 15 items there is 1 item that was categorized as very high, 6 items were categorized as high, 8 items were categorized as moderate and one item was categorized as low. Based on the results of difficulty level, there were 2 items that were categorized as very difficult and the rest were categorized as moderate.

According to the analysis of item test validity, there were 12 test items that were appropriate to be used and 3 test items that need revisions prior to its use in the study. The reliability of the test is 0.89 that was interpreted as very high reliability which indicates that the test will have the same measures both in pre-test and post-test.

Based on the result of difficulty level, there are 2 test items which are categorized as easy, 11 test items categorized as moderate and 2 test items categorized as difficult. The discrimination powers for the test items were varied. 5 test items were categorized to have good discrimination power while 10 test items were categorized to have very good discrimination power. A blueprint of conceptual understanding test is provided in appendix (Appendix B.5). Recapitulation of conceptual understanding instrument validation is provided on Table 3.9.

Table 3.9 Recapitulation of conceptual understanding instrument validation

Item Num ber	Discrimi-nation Power (%)	Level of Difficulty		Validity		Significance of Correlation	Conclusion
		P (%)	Category	r_{xy}	Category		
1	75	73.33	Easy	0.713	High	Very Significant	Accepted
2	50	33.33	Moderate	0.546	Moderate	Significant	Accepted
3	50	40.00	Moderate	0.414	Moderate	-	Need revision
4	50	46.67	Moderate	0.426	Moderate	-	Need revision
5	75	66.67	Moderate	0.785	High	Very Significant	Accepted
6	50	73.33	Easy	0.531	Moderate	Significant	Accepted
7	75	53.33	Moderate	0.671	High	Very Significant	Accepted
8	75	40.00	Moderate	0.348	Low	-	Need revision
9	50	60.00	Moderate	0.506	Moderate	Significant	Accepted
10	75	66.67	Moderate	0.614	High	Very Significant	Accepted
11	75	20.00	Difficult	0.555	Moderate	Significant	Accepted
12	100	60.00	Moderate	0.834	Very High	Very Significant	Accepted

Item Number	Discrimination Power (%)	Level of Difficulty		Validity		Significance of Correlation	Conclusion
		P (%)	Category	r_{xy}	Category		
13	75	20.00	Difficult	0.676	High	Very Significant	Accepted
14	75	46.67	Moderate	0.522	Moderate	Significant	Accepted
15	75	40.00	Moderate	0.709	Moderate	Very Significant	Accepted

3.6.4 Attitudes toward Science and Engineering Career

The last data is students' attitudes toward science and engineering career which is measured through rating scale. In this study, the students were given a rating scale that is adapted from revised version of the middle school attitudes to Mathematics, science and engineering (AMSE) scale (Hirsch et al., 2007) consisting a number of statements regarding their attitudes toward science and engineering career. There are five categories that the student can choose ranging from strongly disagree (SD), disagree (D), do not know (DN) agree (A) and strongly agree (SA). The statements in rating scale includes several aspects such as eagerness to pursue career in science and engineering, science and engineering career preference as well as positive and negative opinion on career in science and engineering fields. Trial of rating scale was done prior to its use. 18 students of eight grade students were asked to fill in the rating scale to check readability of each statement. Minor revisions were made according to findings during trial. This is done to ensure that students were able to comprehend each statement and give response accordingly.

3.7 Data Processing and Analysis

The data collected before, during and after the implementation of engineering design project in blood circulation system topic were obtained from questionnaire, lesson implementation, observation, tests, and rating scale. These data were processed and analysed to answer the research questions.

3.7.1 Identification of Students' Learning Style

To determine the learning style of each student, the data obtained from VARK questionnaire is analyzed based on VARK questionnaire scoring guidance. Fleming (2008) described that firstly each score on V, A, R and K learning style as well as the total score for student response should be calculated. The scoring chart of VARK questionnaire can be seen on Table 3.10.

Table 3.10 Scoring chart of VARK questionnaire (www.vark-learn.com)

Question	A category	B category	C category	D category
1	K	A	R	V
2	V	A	R	K
3	K	V	R	A
4	K	A	V	R
5	A	V	K	R
6	K	R	V	A
7	K	A	V	R
8	R	K	A	V
9	R	A	K	V
10	K	V	R	A
11	V	R	A	K
12	A	R	V	K
13	K	A	R	V
14	K	R	A	V
15	K	A	R	V
16	V	A	R	K

Description:
V = visual; A = aural; R = Read/write; K = Kinaesthetic

Second, the score in V, A, R, K should be sorted from the highest to the lowest. Third, the difference of score among V, A, R, K is calculated. If the difference between score of the first preference with the second preference is more than tolerance limit, it means the student has single-modal learning style. On the other hand if the difference between score of the first preference with the second preference is less than or equal to tolerance limit, it means the student has multimodal learning style. The rules of tolerance limit can be seen on Table 3.11.

Table 3.11 Tolerance Limit for Learning Style Score

Total Score	Tolerance Limit
16-21	1
22-27	2
28-32	3
>32	4

3.7.2 Analysis of Lesson Implementation

The implementation of engineering design in blood circulation system project was observed through the use of observation sheets for both teacher and students' activities. The observation sheets comprise of lists of teacher's activity and expected students' activities. The observers were required to give score for each teacher and students activity by putting check mark (✓) on score column. The score is ranging from 1 to 5 points. The percentage of lesson implementation was calculated by using the following formula:

$$NP = \frac{R}{SM} x100\%$$

(Purwanto, 2010)

Description:

NP = expected percentage value (in this study refers to percentage of lesson implementation)

R = raw score (in this study refers to score of lesson implementation obtained from observer)

SM = maximum score (in this study refers to the total ideal score of lesson implementation)

Furthermore the results of lesson implementation were interpreted based on criteria on Table 3.12.

Table 3.12 Lesson Implementation Criteria

No	Lesson Implementation	Criteria
1	0-20	Poor
2	21-40	Fair
3	41-60	Good
4	61-80	Very Good
5	81-100	Excellent

(Riduwan, 2012)

3.7.3 Analysis of Students' Collaboration Skill

Prior to and during the implementation of engineering design project in blood circulation system topic, students' collaboration skills was measured by using rubrics adapted from CPS framework on social domain (Hesse et al., 2015). Observed behaviour indicating particular elements in the three sub skills was rated ranging from 1 to 3 points. 1 point refers to low level, 2 points refer to middle level and 3 points refer to high level of the skills.

The total score for collaboration skills of each student was calculated with the following formula:

$$Score = \frac{\sum raw\ score}{\sum maximum\ score} x100 \qquad ....(3.1)$$

To calculate the average score of collaboration skills in each element the following formula was used:

$$Score = \frac{\sum Students'score}{\sum number\ of\ students} x100 \qquad ....(3.2)$$

Further analysis is done by comparing students' initial and final collaboration skills. Transcribed audio records of students' discourse as well as observer notes during lesson implementation were used to confirm findings related to students' collaboration skill.

3.7.4 Analysis of Students' Score on Problem Solving Skill Test

Problem solving skill test, in form of structured questions, was administered before and after the implementation of engineering design project in blood circulation system topic. This was done to obtained data of initial and final profile of students' problem solving skills. Students' response on each item were scored using rubric adapted from CPS framework on cognitive domain (Hesse et al., 2015). The maximum score for each element of problem solving skill is 3 points which refer to high level of the skill, while the minimum score is 1 poin which refer to low level of the skill.

The total score for problem solving skill of each student was calculated by using Formula 3.1. Meanwhile the average score of problem solving skill in each element is calculated by using Formula 3.2. Further analysis is done by comparing students' initial and final problem solving skill. Transcribed audio records of students' discourse as well as observer notes during lesson implementation were used to confirm findings related to students' problem solving skill.

3.7.5 Analysis of Students' Score on Conceptual Understanding Test

Conceptual understanding test, in form of multiple choice questions, was administered before and after the implementation of engineering design project in blood circulation system topic. This was done to obtained data of initial and final profile of students' conceptual understanding about disease in blood circulation system. Students' correct answers on each item were granted 1 point, while wrong answers were granted 0 point.

The total score for conceptual understanding of each student was calculated by using Formula 3.1. Meanwhile the average score of conceptual understanding in each cognitive process dimension is calculated by using Formula 3.2. Further analysis is done by comparing students' initial and final conceptual understanding. Transcribed audio records of students' discourse as well as observer notes during lesson implementation was used to confirm findings related to students' conceptual understanding about disease in blood circulation system.

3.7.6 Analysis of students' response on rating scale

Students response for each statement were presented into 5 categories, those are Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D) and Strongly Disagree (SD). The data analysis for rating scale was done by calculating score of students' response in each statement. The students' response on each statement will be scored based on rules on Table 3.13.

Table 3.13 Scoring for students' response

Response	**Positive Statement**	**Negative Statement**
Strongly Agree (SA)	5	1
Agree (A)	4	2
Not Sure (NS)	3	3
Disagree (D)	2	4
Strongly Disagree (SD)	1	5

The data obtained from the rating scale is processed quantitatively by calculating score of each student. Furthermore, the average of students' score is calculated by using the following formula.

$$\bar{X} = \frac{\sum X}{N} \tag{3.5}$$

(Arikunto in Khaeroningtyas, 2016)

Description:

$\bar{X}$	:	Average score of students' response
$\sum X$	:	Total score of all students
N	:	Number of student

The average score of students' response was further interpreted based on criteria on Table 3.14.

Table 3.14 Criteria of Students' Response

No	Criteria	Category
1.	$\bar{X} \geq MI + 1.5\ SDI$	Very Positive
2.	$MI + 0.5\ SDI \leq \bar{X} < MI + 1.5\ SDI$	Positive
3.	$MI - 0.5\ SDI \leq \bar{X} < MI + 0.5\ SDI$	Somewhat Positive
4.	$MI - 1.5\ SDI \leq \bar{X} < MI - 0.5\ SDI$	Slightly Positive
5.	$\bar{X} < MI - 1.5\ SDI$	Less Positive

Description:

MI	:	Ideal mean score = ½ (maximum score + minimum score)
SDI	:	Ideal standard deviation = 1/6 (maximum score – minimum score)