CHAPTER III

METHODOLOGY

A. Location and Research Subject

This research is conducted at one of private school in Bandung which is implementing Cambridge Curriculum. The school is determined based on consideration where the school is regularly dealing with curriculum reflecting problem solving skills in its structure.

Moreover, the subject of research is 16 students of secondary 2 in high achiever class. Sampling technique of research subject is determined by using purposive sampling. Accordingly, educational research is often utilized quota/ purposive sampling in difficulty to take probability (McMillan, 2012). Yet, High Achiever Class is taken as the consideration from preliminary study where student's cognitive achievement is excell as the effort to prevent cognitive load during the implementation.

B. Research Method

Research method used in this research is descriptive quantitative as the purpose if the research is appropriate with this method. Descriptive quantitative method is utilized to describe the phenomena or the condition of certain variables (Arikunto, 2002).

C. Operational Definition

In order to prevent missinterpretation and missconception in understanding some of the term used in this research, therefore some of the terms need to be explained as the following explanation:

1. Problem based experiment is the type of laboratory activity which is adapted from problem based learning approach. Problem based experiment provides laboratory

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activity where the process runs based on problem proposed. The implementation problem based experiment in this research is regarding to the syntax of problem solving process which includes (1) formulating problem, (2) defining the problem, (3) problem analysis, (4) present the information techniqally and theoritically, (5) analyse the parameter to solve the problem, (6) Elaborate the alternatives, (7) choosing the procedures and experiments, (8) conducting alternative experiments, (9) validating experiments by group, (10) Judging the best procedures, (11) reporting data from each group (12) discussion of experimental result, (13) report of discussion ,(14) Determine the conclussion, (15) reconsideration of experiment results.

2. Problem solving skill as cognitive ability is defined as the process of understanding, analysing, and identifying problem which has no obvious solution method , then transform it into alternate solution with basic prior knowledge consideration. The information of students' problem solving skills is gained by using problem solving test for those domain in which including problem analysis, problem solving planning, and problem solving evaluating. Moreover, performance test is conducted to gain data about students' problem solving skills in domain of conducting problem solving. Its improvement is seen from normalized gain of pretest and posttest according to Hake (1998).

D. Research Procedure

There are several procedures that are conducted in the implementation of this research. Therefore, the procedure is generally classified into three stages which is note as preparation stage, implementation stage, and analysis and conclusion stage. Each of stage consists of several activities which are conducted during the experiments.

1. Preparation Stage

The steps are including the following activities below:

- a. Literature review was conducted in analyzing the information about: 1) problem based experiment, 2) problem solving skills, and 3) learning indicator in the topic of separation method.
- b. As the result of literature review, research problem is identified and continuously research questions were arranged.
- c. According to the needs in answering research questions, instruments were arranged as tools to obtain data. Arrangement of instrument arrangement including 1) problem solving test, 2) performance test rubric, 3) observation sheet, and 4) students' questionnaire.
- d. Instructional tools which are including lesson plan and experiment module and worksheet was arranged to help the implementation of problem based experiments.
- e. Judgment of instruments was conducted by experts.
- f. Trial test of problem solving test instrument was conducted to identify the quality of instrument.
- g. The result of problem solving test trial was analyzed.
- h. Revision of instruments was done based on judgment result and test item analysis.

2. Implementation Stage

These activities below are conducted in the implementation stage which consists of four main activities. The activities are:

- a. Pre-test was conducted to identify students' preliminary skills
- b. Treatment was conducted in three meeting, including:
 - 1) 1st meeting : problem solving analysis and procedure designing
 - 2) 2nd meeting : experiment activities and 1st performance test
 - 3) 3^{rd} meeting : data reporting
- c. Post-test was conducted
- d. 2nd performance test was implemented.

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3. Analysis and Conclusion Stage

Analysis and conclusion stages consist of four stages, which are enlisted as follows:

- a. All of data which is obtained was calculated
- b. The result of data calculation was analyzed
- c. Discussion was done to elaborate the result of analysis
- d. Conclusion was obtained based on the result

In a way of analyzing the plot of the procedure above, it is represented in the following chart which illustrates the framework of research.





Figure 3.2 Research Plot

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E. Instructional tools

Instructional Tools that is used in the implementation of this research is enlisted as follows:

1. Lesson Plan

Lesson plan is the design of instructional arrangement that will be used in the implementation. These arrangement is set in every unit of class meeting implemented by the teacher. The arrangement of lesson plan refers to the syntax of problem based experiments proposed by Gallet (1998). There are mainly seventeen syntaxes that should be conducted in one cycle of problem based experiments. However, the implementation of problem based experiments in this research is arranged for only one cycle which syntaxes are divided into three meeting.

Lesson plans were also arranged according to the learning objective stated in the scheme of work of Cambridge IGCSE curriculum for the concept of separation method. The objective are 1) describe methods of separation and purification, and 2) suggest suitable purification techniques. Those objectives were developing while learning indicators were arranged to measure the fulfillment of objectives. The scope of separation method concept includes four technique of separation, there are: 1) Filtration, 2) Crystallization and Evaporation to Dryness, 3) Separation Funnel, and 4) Magnetic Separation. Accordingly the arrangement of lesson plan can be seen in appendix A.1 page 69.

For further description of syntax implementation for each meeting related with learning indicators, the table below is arranged.

Table 3.1 Syntax Arrangement of Problem based Experiment in Each Meeting

Meeting	Indicators	Problem based Experiment Syntax		
1^{st}	1. Analyze the problem	1. formulating problem,		

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Meeting	Indicators	Problem based Experiment Syntax				
Meeting	in daily life related	2. defining the problem,				
	to separation method	3. problem analysis ,				
	2. Construct suitable	4. present the information technically and				
	separation method	theoritically,				
	based on the	5. analyse the parameter to solve the				
	information of	problem,				
/	problem analysis to	6. Elaborate the alternatives,				
12	solve the problem	7. choosing the procedures,				
16	proposed	8. choosing the experiments				
2 nd	3. Conduct separation	9. conducting alternative experiments,				
Meeting	method based on	10. validating experiments by group,				
	problem solving	11. Judging the best procedures,				
	procedure	12. Data collection in the way to solve				
7		problem				
3 rd	4. Evaluate the the	13. reporting data from each group				
Meeting	problem solving	14. discussion of experimental result,				
	steps of separation	15. report of discussion,				
	method proposed	16. Determine the conclusion,				
		17. reconsideration of experiment				

2. Experiment Module

Experiment module is the additional tools that helps the implementation of lesson plan in real activity. Experimental Module is used to be students' guidance during experiments. The module consists of the question and problem that should be solved by students.

Experiment Module consist of both group and individual worksheets which respectively arranged based on syntax and the scope of learning objective of separation method. There are four modules which were arranged based on daily life problem. The problems were synthesized regarding to the concept scope of separation method. The problems are including:

- a. Kitchen Tragedy Problem: Involve the concept of separation funnel separation method in separating two substances with different density.
- b. Iron Mining : Involve the concept of magnetic separation method in separating paramagnetic-diamagnetic heterogeneous mixture
- c. Pure it! : involve the concept of filtration method in purifying heterogeneous solution
- d. Salt Farming Problem: involves the concept of crystallization and evaporation to dryness in separating homogenous solution with different evaporation and solubility.

Experimental modules were given in all three meetings as students' guidance. Each of part were arranged accordingly with syntax and partially given to students. In order, group worksheets were given during group work. On the other hand, individual worksheet was given when the activity is emphasized on individual work. Further, draft of experimental module can be seen in appendix A.2 page 74.

F. Research Instrument

The analysis of problem based experiment implementation in improving problem solving skill is conducted by using several instruments. The instruments will be elaborated as the following explanation.

1. Problem Solving Skill Tests

Problem solving test is test instrument which is arranged to measure problem solving skills which is categorized as cognitive process. The arrangement of problem

solving test is according to problem solving domain proposed by Mettes (1981) which include 1) problem Analysis, 2) problem solving planning,3) conducting problem solving, and 3) problem solving evaluating. However, in line with consideration that conducting problem solving domain is analyzed as technical, thus, this domain is uninvolved in this test.

There are six questions proposed which is arranged in open-ended essay type questions. According to Nitko &Brookhart (2007) essay is compatible to measure thinking skill such as Higher .Each domain is represented in two questions that is arranged according to problem passage give. The arrangement of problem solving skill test can be seen in Appendix B.1 and B. 2 page 82 and 85.

Moreover, the arrangement of Problem Solving Test is illustrated in the following table.

			CO
Problem Solving	Indicators	Торіс	Question
Domain			Number
Problem Analysis	Analyze the problem in	Separation Funnel	1
	daily life related to	Method	
	separation method	Water Filtration	3
Problem Solving	Construct suitable	Water Filtration	4
Planning	separation method to solve	Crystallization and	5
	the problem proposed	Evaporation method	
Problem Solving	Evaluate the problem	Crystallization and	2
Evaluating	solving steps of separation	Evaporation method	
	method proposed	Magnetic Separation	6

Table 3.2 Blueprint of Problem Solving Skill Test

This test is conducted into two phases including pre-test and post-test. Pre test is conducted before students engange into the experiment activity. The objective of pre test is to investigate basic knowledge and students skill so that Students' problem solving skill can be identified. On the other hand, post test which is conducted after students already have enganged the experiment activity. The purpose of conducting post test is to measure how far is the development of problem solving skill skill after experiment conducted. Similar to pre-test activity; the type of question used is also essay question.

2. Rubric of Performance Test

Rubric of performance test is arranged as the effort to analyze problem solving skill in domain of conducting problem solving. This domain has different characteristics compare to others where it involves technical skill mastery in separation method.Hence, different instrument is arranged to analyze the improvement of students' skill in this domain.

In this research, performance test is used to identify problem solving domain of conducting problem solving. There are three technical skills

indicators were assess in this test, the indicators involve students technical aspects in separation method which is needed in conducting problem solving which is arranged based on experimental skills and investigations indicator of IGCSE curriculum (UCLES, 2010). The aspects are 1) preparing tools and apparatus, 2) following procedure of problem solving planning, 3) technique of using apparatus during and after the experiments. Those aspects are assessed by using performance rubrics that will be filled by the observers and teacher. Each of aspects was given score in between 5 to 8 in which the consideration of scoring is arranged based on scoring indicator. For complete arrangement of performance rubric can be seen in appendix B.3 page 98.

In general, the rubrics of performance test regarding to the arrangement of technical skills is described in the table below.

Learning	Technical Skills	Scoring Indicator					
Indicator							
	1. preparing	5 = Apparatus incomplete					
	tools and	6 = Apparatus complete					
15	apparatus	7 = Apparatus complete, and clean & dry					
0-		8 = App <mark>aratus complete, clean</mark> and dry, and					
		arranged correcity					
	2. following	5 = Students is not following the procedure					
\geq	procedure of	6 = Student is following the procedure and					
7	problem	product is not formed					
Conduct	solving	7 = Student is following the procedure,					
separation	planning,	Mixture is separated in small amount					
method based on		8 = Student is following the procedure,					
problem solving		Mixture is separated in big amount					
procedure	3. technique of	5 = Incorrect technique in using separation					
	using	tools, some of tools are broken					
	apparatus	6 = Incorrect technique in using separation					
	during and	tools, nothing is broken					
	after the	7 = Correct technique is using separation					
	experiments.	tools, some of tools are broken					
		8 = Correct technique is using separation					
		tools, nothing are broken					

Table 3.3 Blueprint of Performance Test Rubrics

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During performance tests, students were ordered to do experiment activity according to problem solving design that has been arranged before. The tests were conducted two times. The first test was conducted during the implementation of problem based experiment. In this way, students' prior skill of conducting problem solving can be analyzed. During this test, students were used design of problem solving experiment that they arrange by themselves according to their own problem in group module. On the other hand, the second test was conducted after the implementation. In this test, teacher used performance test draft which is arranged based on problem solving design.

The tests were conducted two times, while the first test was conducted during the implementation of problem based experiment. In this way, students' prior skill of conducting problem solving can be analyzed. On the other hand, the second test was conducted after the implementation. Furthermore, the result of both 1^{st} and 2^{nd} performance test is analyzed to identify students' improvement in conducting problem solving skill domain. The result is elaborated further in the following explanation.

3. Observation Rubrics

The analysis of teacher and students activity is conducted to identify implementation quality which is appeared from teacher's activity coherence with the syntax of problem based experiment which has been arranged before. In obtaining data, observation rubrics of students and teacher activity were arranged. The arrangement of observation rubrics is in line with syntax sequence and teaching and learning activities arranged in lesson plan. The observation sheet is used to analyze the quality of implementation according to the syntax of problem based experiment.

Observation rubrics as completed by observer which have obligation to analyze and observe the whole implementation and judge whether the implementation is in line with the syntax of problem based experiment. The result of observation was recorded in the observation sheet which is available by giving score between 0 until 4. Each of score represents the quality of implementation. Further the arrangement of observation sheet can be seen in Appendices C page 102.

4. Questionnaire

In the way to identify students' response toward the implementation of problem based experiments, questionnaire of students' response is used to meet the need. The questionnaires were distributed to 16 students whom the implementation has been treated.

The Indicators of students' response are classified into two main indicators, those are: 1) students response toward science instruction through experiment activity, 2) student response toward problem solving skills,. The first indicator is generally including statements about students' response toward science instruction and through experiment activity in science classroom activity. On the other hand, the second indicator is emphasized on students' response toward the activity of problem based experiment and the advantage of problem based experiment for the students.

The questionaire is arranged by using Likert Scale where each indicator consists of positive and negative statements. In the arrangement of questionnaire response, students are requires to choose appropriate response in one of category including: 1) Strongly Disagree, 2) Disagree, 3) Agree, 4) strongly Agree. The complete arrangement draft and blueprint can be seen in appendix C.3 page 114.

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G. Instrument Development

According to Suherman (2003), it is explaind that qualified instrument of evaluation requires some criterias. The quality of test item can be identified by concerning the following criteria, such as: validity, reability, objectivity, practibility, difficulty index, discrimination power, option effectivity, and effeciency. As the

form of instrument used is in essay form, thus the calculation is only done to identify validity, reability, Difficulty index, and readibility.

1. Instrument Validity

In the term of measurement procedure, validity is the ability of an instrument to measure what is measured. The validity of the instrument itself is depened on the effectiveness of its function in measuring data that is supposed to be collected for the needs of reseasch. There are various type of validity measurement. In this research, constructive validity is used in evaluating instrument. Meanwhile, to calculate the validity of test item, it is proposed to used the formula of correlation of Pearson Product-Moment Correlation in Sudjana (2005: 144). The interpretation of validity is classified into some catogories. The categories is arranged based on Guilford (Suherman, 2003).

2. Reliability

Reability is the degree of concistency and stability of the instrument .Thus, the concept of reability has the meaning where the research tools is consistence and stable, and hence predictable and accurate. In other words, reliable instrument is the tool that gives same result when the measurement is given into the same subject whenever ,wherever, and whoever it is implemented (Suherman, 2003)

In particular, the test is considered as single test as it consists of one set test applied in one group of sample in particular time. The reability is determined by the value of reability coefficient by using K-R 20 formula (Sugiyono, 2008 : 132). Furthermore, The interpretation of reability coefficient is classified into some categories. The categories is arranged based on Guilford (Suherman, 2003).

3. Difficulty Index

The difficulty of an item is understood as the proportion of the persons

who answer a test item correctly. Difficulty level represent the difficulty degree of test item that is implemented. This index will determine whether the test is classified into easy or difficult. Difficulty index for essay test is calculated by the formula of difficulty level (Sudjana, 2005: 137).Further , the classification of difficulty index is represented according to the criteria of difficulty level in Suherman (2003).

4. Discrimination Power

Discrimination Power of item test represent how strong the test item in differenciating between the sample that able to proposed right answer and wrong answer or blank answer (Suherman,2003). If the test and an item measure the same ability or competence, we would expect that those having a high overall test score would have a high probability of being able to answer the item. We would also expect the opposite, which is to say that those having low test scores would have a low probability of answering the item correctly. Thus, a good item should discriminate between those who score high on the test and those who score low.

Indeed ,discrimination power is supposed to give verification that the test item can be used to differenciate between high achiever and low achiever. In obtaining discrimination power, the formula of discrimination power stated in Tinambunan (1988: 140) is used. Likewise, the classification of Discrimination Power coefficient is described by using the category in Suherman (2003).

In identifying the quality of problem solving test, instrument a trial was conducted by applying the test into 25 samples of secondary 2(8th grade) of students which already learnt about separation method topics. The calculation of test item analysis was helped by using software Anates 4.0. In summary, the result of problem solving test quality is presented in the following table below:

Test	Validity		Difficulty Index		Discrimination Power		Note
Item	Value	Category	Value	category	Value	Category	
1	0.66	Significant	81.25	Easy	0.25	Satisfactory	Used

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Table 3.5 Recap of Instrument Analysis

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2	0.80	Very	65.63	Medium	0.69	Good	Used
		Significant					
3	0.88	Very	71.88	Easy	0.56	Good	Used
		Significant					
4	0.66	Significant	53.13	Medium	0.44	Good	Used
5	0.92	Very	43.75	Medium	0.87	Excellent	Used
		Significant					
6	0.43	Insignificant	68.75	Medium	0.12	Poor	Revised

According to the table above it is identified reability value of instruments is as much as 0.91 which is categorized as very high. In conclusion, it is determined that the instruments are qualified to be used in the research.

H. Data Analysis Procedure

1. Analysis of Problem Solving Test

Problem solving test is conducted two times as pre-test and port-test. Both of the result of test gain data which is advantageous to analyze domain of problem solving skills in cognitive aspects. The process of data analysis is enlisted in the following explanation.

a. Scoring process

Scoring process is initiated by analyzing right answer based on scoring rubrics stated in blue print. Each of questions is given score from the interval between 0-4. After all of the question analyzed, the total score is calculated and transformed into percentage value by using the following formula

$$Score \ percentage = \frac{total \ of \ student \ score}{maximum \ score} \ x \ 100\%$$

b. Analysis of average skill of Problem solving

The analysis of problem solving is determined by calculating average value from total score in problem solving skill test. The calculation is arranged based on formula stated in Arikunto (2006)

c. Determine problem solving profile in each domain

Determination of score percentage in each domain is conducted in a way of analyzing students profile in each domain. The result of analysis can be used as supporting information of improvement in each domain. The calculation of domain average uses the formula of average value calculation stated in Arikunto (2005).

In identifying problem solving profile, the percentage that has been calculated is categorized by level of problem solving category arranged by Syah (1999).

d. Significance test

To analyse the correlation of pre-test and post-test result, the determination of normalized gain index is conducted. Normalized gain is calculated by using the formula proposed by Meltzer (Wardhani, 2006 :39)

Moreover, to identify the quality of problem solving skill improvement, normalized gain index is interpreted. The criteria used for interpretation process is criteria proposed by Hake (1999).

2. Analysis of Performance Test Rubric

a. Determining Average Score of Performance Test

Performance test generally was conducted by evaluating performance of student in conducting experiment by using performance rubrics as scoring guidance. The calculation is conducted by using average formula calculation (Arikunto ,2005)

b. Significance test of Conducting Problem Solving Domain

Normalized gain Index is calculated to analyze the improvement of students' skill in conducting problem solving during 1st performance test and 2nd performance test. The identification of normalized gain index of this test is conducted by using same steps as significance test in problem solving test analysis (see part I.1.d)

3. Rubrics and Student Worksheet analyses

Rubric analysis is conducted by converting the raw score of rubric into presentage form.Raw score is determined by rubric guidance provided befor. Later on , the presentage represent can be analysis by using intrepetation data.The technique of converting score into presentage is used formula as follows :

$Score = \frac{Raw Score}{Maximum Score} \ge 100\%$

The interpretation of score precentage is categorized into certain level according to Kunjaraningrat (Suherman,2001:6).

5. Questionnaire Analysis

Analysis of students questionnaire is used by classifying data based on alternative answers given. In the time of data analysis, the result of questionnaire is identified by calculating the percentage of response:

$\mathbf{P} = \frac{f}{n} \ge 100\%$

Keterangan :

- P : Precentage
- f : frequence of the answer

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n : total of the respond.

Similar to students worksheet analysis, the precentage will be interpreted by using similar criteria according to Kunjaraningrat (Suherman,2001:6).

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