CHAPTER IV

RESULT AND DISCUSSION

A. Results and Discussion Problem Based Learning Model of Multiple representation Approach

1. The observation result of the implementation of learning model

The observation result of the implementation problem based learning with multiple representation approach done using observation formats given to the observer. Table 4.1 the percentage of the implementation the learning model for each meeting.

Table 4.1 Percentage of Learning Model Implementation

No.	Learning Step	Meeting (%)		
		1	2	3
1	1st Step	100	100	100
2	2nd Step	100	100	100
3	3rd Step	100	100	100
4	4th Step	100	100	100
5	5th Step	100	100	100
Average		**100**	**100**	**100**

2. The discussion of implementation the learning Model

a. 1st meeting

First meeting, students learn about conduction. The learning objective of this meeting are : Students are able to understand how does the heat could be transferred using simple experiment, students are able to explain the conduction characteristics, Students are able to distinguish conductor and isolator, and

students are able to solve the problem of conduction phenomenon. The step of problem based learning has reached the learning objectives in the first meeting.

This meeting, teacher is able to finish the mission in problem based learning with multiple representation approach completely, 100% in whole step.

The learning process did well. Students learn the multiple representations very well. Student could listen the instruction carefully so when experimenting student did smoothly without asking too much to teacher. Sometimes, student too noisy when discuss to their peer group. The observer immediately rebuked students who noisier. Despite, Students has a great enthusiastic during teaching learning process.

The application of the model of problem-based learning approach in accordance with the statement multiple representation Mayer (2003), the learning approach can multiple representation strengthen students' understanding because of the formation of meaning between words, images and mathematical simultaneously. This is evident from the student's ability to answer various representations on worksheets and answer questions from the teacher to the student.

1) First step - giving the orientation

Figure 4.1 Orientation Step

In this step teacher motivate student starts with show the real pan. Student visualized that pan. Teacher start giving the problem to student choose the best material to make a pan, there is zinc, iron, and aluminum. Teacher trigger student to give the alternative opinion. Students give their opinion by verbally. Then teacher allow them to compare three of material to make a pan by mathematically. So, in the 1st step teaching learning, teacher guide student in different representations with the same focus.

2) Second step – Organize

The picture bellow shows teacher organize students make some groups that consist of 4-5 students for doing experiment.

Figure 4.2 Organize Step

Before come to experiment, teacher demonstrated to pour the hot water to plastic and metal glass. Teacher asks which glass did not make you comfortable when holding the glass. Student gives their answer verbally then teacher asks which hotter glass is. Students mention and explain the glass is hotter and the glass is not hotter by verbally and mathematically based on Picture 4.3

Figure 4.3 Teachers' demonstration

Then, teacher show the picture of iron and wood given toothpick and butter. Teacher leads student to get the conduction and isolator concept by simple demonstration regarding the picture based on picture 4.4

Figure 4.4 conductor isolator demonstration

3) Third step – Investigation

Teacher distributes the worksheet. This syntax, students have to find out the problem solution which material is the appropriate to make a pan using iron, zinc or aluminum. Student should do simple experiment to find out with their peer group. Then student discuss what they get from their experiment by verbally .after that students full fill the worksheet individually. In experiment, student proof their problem by their visualizing that the appropriate material to make a pan. Students interpret

the data on the table then they comparing each other which material fallen down first, second, and third by mathematically.

Figure 4.5 Students' Investigation

4) Fourth step - Communicating

This step, students try to present their result. Students communicate the result in front of the class. Students explain which the best material to make a pan and analyze why aluminum is the best material could be make a pan based on the heat transfer concept.

Figure 4.6 Communicating Step

5) Fifth step – Evaluation

This step, teacher gives clarification the concept behind on their experiment. Teacher show the conduction percentage. Students see that picture then students analyze and explain between conduction percentage and their result of experiment by verbally. Students compare three of metals with the percentage of conduction by mathematically.

b. 2nd meeting

Second meeting, students learn about convection and radiation. This meeting, teacher is able to finish the mission in problem based learning with multiple representations approach completely, 100% in whole step.

The step of problem based learning has reached the learning objectives in the second meeting. The learning objectives are Students are able to explain how the heat could be transferred through simple experiment, Students are able to explain the characteristics of convection and radiation, Students are able to identify the conduction, convection, and radiation phenomena, student are able to solve the problem from the convection, and radiation phenomenon. In addition, the appropriate implementation learning 3 characteristics of PBM models according to Eggen (2012), which is "learning to focus on solving the problem, the student is responsible for solving the problem and support the teachers when the students solve the problem". These three characteristics are already performing well during learning.

Learning convection and radiation can be delivered well as the use of PBM models has focused on issues of daily life, so that students are motivated to solve the problem with the application of the concepts being taught. When teaching learning process occurs on the orientation syntax, student has not interest response. It was proved when teacher asked the chimney set up vertically why did not set in horizontally. Students just silent. So, Teacher has to trigger with different questions with the same focus. But in the other syntax students has motivation during learning process. Student active to discuss with their friends, students very enthusiastic when identify and explain the heat transfer phenomena, and students did experiment well.

1) First step - orientation

Figure 4.7 Motivating students

First step, teacher starts the lesson with shows the picture to trigger students' motivation. Then teacher asks why chimneys set up vertically upwards? why does not be made horizontally? And asks what does the correlation with the topic today? Then students visualize that picture and try to explain by verbally by just 2-3 of students. Teacher asks the second picture about comparing two planets has the warmer or colder temperature from sun.

2) Second step - Organize

`This stage student listen two problems from teacher that the first is how could become hot water thoroughly even though the source of the fire in the bottom of the pan. Second question is arrange sitting position your friend when fire camp. Little bit of student express their thinking for the 1st picture. While, most of student answer the second problem with enthusiastic.

Figure 4.8 Giving problems

3) Third step - investigate

Teacher distributes the worksheet. This step, students have to find out the problem solution through two experiments. For the first experiment, students have to boil the water then drop 2 food coloring with different direction. Then observe what will happen with the direction of food coloring.

Figure 4.9 convection investigation

Students full fill the worksheet individually. From investigation, students visualize what they get then student have to draw the direction of red food coloring and green food coloring on worksheet. Students express the movement of fluid when boiling the water by verbally on their worksheet.

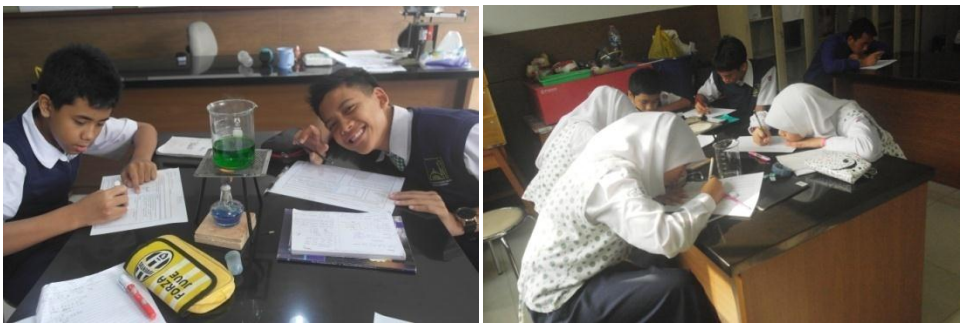


Figure 4.10 Students full fill the worksheet

Finding out the second problem, student should do experiment by using several wet tissues with different distance. Every group has different strategies to arrange those tissues.

Figure 4.11 Investigation second problem

Based on their experiment, they visualize what they did during investigation. Then student express their new knowledge on the worksheet. Student also could make the sitting arrangement in fire camp by that investigation. Student could give the value of the temperature based on the worksheet.

4) Fourth step - communication

This step, students try to present their result. Students communicate the result in front of the class. Student draw first the movement of fluid then students explain the direction of the fluid movement when water boiling

by verbally and using picture. The other group, try to present the 2nd problem. Student draw the sitting arrangement for Sherli, Ali, and Michael when fire camp. Then student explain it related to the experiment by verbally and mathematically.

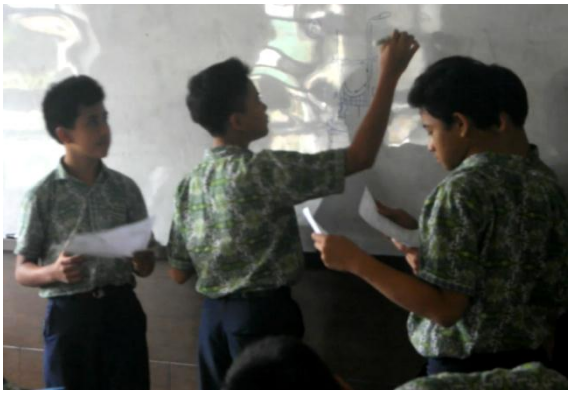


Figure 4.12 Communicate

5) Fifth step – evaluation

Teacher give emphasize the knowledge about convection and radiation to avoid misconception. In the end of session, the evaluation is formed by identifying the picture which conduction, convection, and radiation.

Figure 4.13 Identify the phenomena of heat transfer

Students not only identify the pictures are belong to but also students explain why the picture should be convection etc.

c. 3rd meeting

Third meeting, students learn about sea breeze and land breeze. This meeting, teacher is able to finish the mission in problem based learning with multiple representations approach completely, 100% in whole step.

The step of problem based learning has reached the learning objectives in the second meeting. The learning objectives are Students are able to apply the concept of heat transfer through sea breeze and land breeze phenomena.

Student has a higher motivation when student sticking, drawing, coloring their poster. Because the previous meeting, students only do several experiment. It was time to them to make a creation using their imaginations and creativity. Especially in this meeting, students looks has high emotion when they have to coloring just ten minutes for two posters.

With the approach of multi representation of almost all students have the drive of curiosity large and active role during learning, because learning is presented in a variety of forms of representation so as to stimulate students who are in the group of verbal intelligence, and mathematical images to be actively involved. Active students to ask and answer while learning in accordance with the functions of the approach according multiple representations based on Ainsworth (2006), to complement other representations. So, students can resume the concept being studied, build up a clearer understanding than just a representation only and is able to construct a deep understanding for the students to obtain information from various representations.

Teacher found just 1 group that is not correct to put the arrow of the wind direction. It is due to their team did not read carefully the guidelines on the worksheet.

1) First step - orientation

   The first lesson starts with the problem. Students have to find out the alternative opinions about design a ship without engines and how to sail and schedules go to the sea. Teacher leads student to express their opinion by verbally using several questions. Teacher draw the illustration then asks student to explain related with heat transfer. Some of students give their opinion. Teacher lead based on temperature, pressure, etc. Students try to answer with comparing temperature, pressure between land and sea.

2) Second step - Organize

   Teacher asks student to sit in group. Teacher lead student to find out the problem solve through worksheet. Students make a poster and the worksheet as the guideline.

3) Third step - investigate

   Student starts the investigation with discussion first to their peer group. Teacher provides the cartoon and envelope to students. Students have to make two posters; the schedule of fisherman on night and sunny day. Then students open the envelope to stick the arrow, moon, sun. Student starts to draw after that, stick the arrow, moon or sun on the poster. Students try to full fill the worksheet with discuss to peer group

Figure 4.14 Making poster

4) Fourth step - communication

Students present their work in front of the class. Students draw first the fisherman catches the fish on sunny day and come back on night. Students try to explain reviewed by the investigate comparing land and sea which as the high temperature, low temperature, low pressure, high pressure, etc.

Figure 4.15 sea breeze land breeze communication

5) Fifth step - evaluation

Teacher emphasizes the concept of land breeze and land breeze to student. Students write down those phenomena on their book.

B. The Result and Discussion of Scientific Consistency

1. Enhancement of Scientific Consistency on Heat Transfer Concept

Scientific consistency is the consistency of students answer questions correctly scientifically. The question is made by using a multiple representation test. Student could answer correctly 3 questions in different representation picture, verbal, and mathematic but it is still same theme.

After the whole learning activities on heat transfer concept and taking the data *posttest*, found the result of the average score of scientific consistency. The result of students' scientific consistency when *pretest* and *posttest* shown on table 4.2

Table 4.2 Students' Scientific Consistency on Pre Test and Post Test

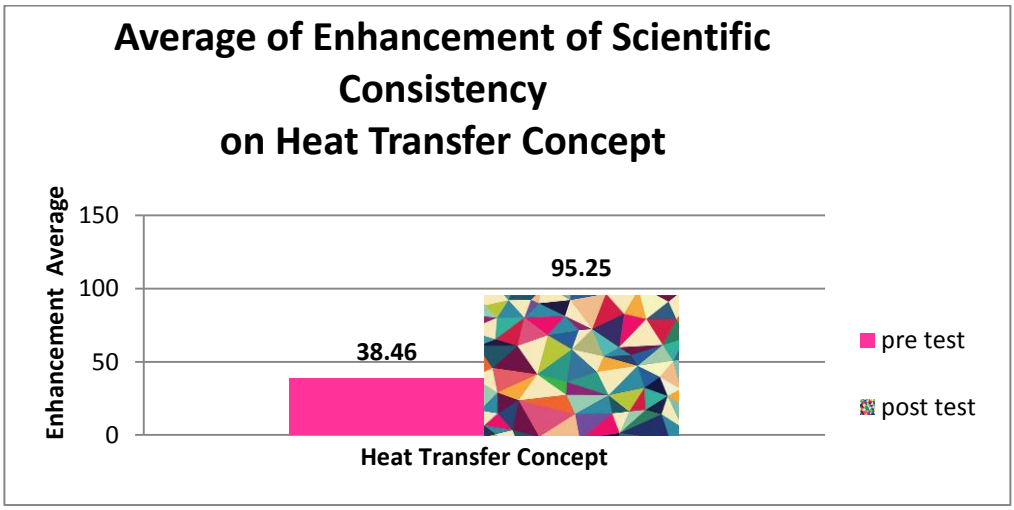
	Sum	Average	<G>	<g>	Category
PRE TEST	11.42	38.46			
POST TEST	28.57	95.25	17.15	0.92	HIGH

Based on table 4.2 describe some information that we get from the data. The sum of pre test score in scientific consistency is 11.42 while the sum of post test score is 28.57. The average of pre test score in scientific consistency is 38.46 while the average of post test score is 95.25. There is enhancement of students' scientific consistency in learning heat transfer concept. The average score of students' scientific consistency on *posttest* score is higher than *pretest* score. If

compare with the average of pre test and post test score is has gain normalized (<g>) is 0.92 which in the high category (Hake, 1999).

The data result of students' scientific consistency not only served in table but also in graph. The data could be seen clearer on this graph. The graph of result can be shown figure 4.16

Figure 4.16 Average of Enhancement of Scientific Consistency on Heat Transfer Concept



Based on the graph, we can see clearly there is enhancement significantly the average score of pretest and posttest in learning heat concept. The initial of average score is 38.46 after implementation problem based learning model with multiple representations approach occur significant enhancement of average score about 95.25. It means that most of students are consistent to answer multiple representations test. Students have been consistent in verbal, picture, and mathematically in learning heat transfer concept. Based on data recapitulation in pre test just one student in enough category of scientific consistency, while the other students are in inconsistent category of scientific consistency. For the post test is vice versa.

The enhancement on students' scientific consistency occur after giving the treatment problem based learning with scientific consistency approach, because student used to learn with it. Student could understand the concept in various representations and it is suitable with Kohl and Noah's (2003) state that teaching learning in class effect the multiple representation ability of students. Using multiple representations approach on PBL model, student used to various representation such verbal, picture, and mathematics. This multiple representations approach served on the syntax of problem based learning model and the questions on students' worksheet. Besides that, the enhancement of scientific consistency is supported on the previous research stated that after the treatment in the problem based learning model with multiple representations approach towards improving students' scientific consistency , obtained a normalized gain value by 0.58 in enough category (Sari, 2015). The scientific consistency could enhance due to the percentage of implementation is 100% means student get the multiple representation during class activity. Besides that, one of the function of multiple representations is using multiple representation in learning students integrate information from more than one representation (Nieminen, 2010). In the field, students are able to explain, analyze the phenomena heat transfer problem in different representation. For example in learning sea breeze and land breeze, students explain the wind flow from the picture and compare the temperature, pressure in the land and in the sea. Students not only think the wind flow abstractly but also using picture helps student master the concept.

2. N-Gain Scientific Consistency on Sub-Concept

After getting the scientific consistency gain normalized of heat transfer concept, the next calculation is the enhancement of scientific consistency on every sub concept. Based on table 4.3 describes the scientific consistency in sub concept in heat transfer concept. It is consist of conduction, convection,

radiation, sea breeze, and land breeze with comparing with pretest and posttest, which following on table 4.3

Table 4.3 Scientific Consistency N-Gain on Every Sub Concept

Sub Concept of Scientific Consistency	Amount of question	N	average		Gain	N-Gain	Category
			Pretest	Post test			
Conduction	9	45	1.42	5.73	4.3	0.93	High
Convection	9		1.19	5.69	4.5	0.90	High
Radiation	9		4.15	5.9	1.8	0.98	High
Sea breeze	9		2.23	5.53	3.3	0.86	High
Land breeze	9		2.3	5.6	3.3	0.87	High

Based on the result table, the sub concept of scientific consistency consists of 9 questions in every sub concept. The five sub concept involved in this research such as conduction, convection, radiation, sea breeze, and land breeze. Every concept in multiple representations test is about basic concept (picture, verbal, mathematic), application phenomena in daily life (picture, verbal, mathematic), solving problem (picture, verbal, mathematic).

The data result has enhancement of students' scientific consistency in every sub concept. The average score in post test is higher than average score in pre test. The enhancement can be seen clearly on this graph figure 4.17

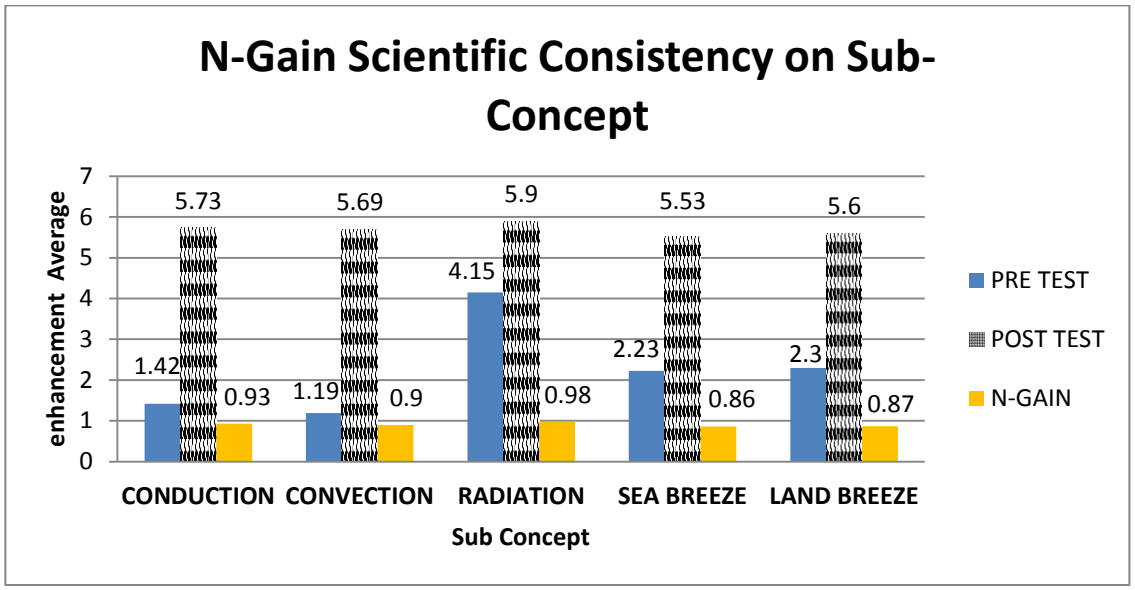


Figure 4.17 Enhancement Average of Scientific Consistency on Every Sub Concept

If we took a look the graph above based on gain normalized shows radiation has highest enhancement of scientific consistency on every sub concept, it is 0.98. Data shows the average score of pre-test on radiation about 4.15 and post test about 5.9. It means student more consistent scientifically than the other sub concept. Unfortunately, the sub concept has lowest enhancement of scientific consistency is sea breeze about 0.86. The second sub concept which has high enhancement of scientific consistency is conduction, it is 0.93. Data shows the average score of pre-test on conduction about 1.42 and post test 5.73. Then the third is convection about 0.90. Data shows the average score of pre-test on convection is 1.19 and post test is 5.69. The sub concept land breeze has low enhancement of scientific consistency is about 0.87.

Convection has significant enhancement pre test and post test average score than radiation. But convection has low gain normalized than radiation. It is due to most of students did not consistent about 1.19 average pre test score. After the implementation of PBL with multiple representations, student has significant enhancement of scientific consistency in post test about 5.69. Student could consistent

scientifically in verbally, picture, and mathematically. The result is suitable with the statement of Krishnayanti and Sari (2015) stated that there is enhancement of scientific consistency in every sub concept.

The enhancement on every sub concept displays with compare between *pre test* and *post test* on picture 4.17. Based on the picture 4.17 the average of scientific consistency is increase on every sub concept, concept which verbal, picture, and mathematics form.

In learning process in convection sub concept, student very enthusiastic to see the flow direction of food coloring, come to hot temperature or cold temperature. Student visualizes direction about the flow then students draw the flow of food coloring on their worksheet. After that they explain on words to emphasize their finding. So, student trained using multiple representations.

While, learning radiation sub concept, student have already had prior knowledge about radiation. When students are given the problem to arrange the sit position in fire camp, student have already known the result before they prove it through simple experiment. Student very corporate when did experiment of radiation, peer group have to hold the tissue at the same time but different distance. So the research result is not significant consistent scientifically.

Every sub concept, teacher guides students in different representations. Student give facilitate to student for learning diverse way by verbally, mathematic, and picture based on lesson plan. Multiple representation trains student able to understand the concept and able to solve physics problem (Krishnayanti, 2015). Student could solve physics problem with various representation. . By "representational skills" we refer to students' ability to appropriately interpret and apply various representations can include mathematics, verbal, graphical, and pictorial formats (Kohl and Noah, 2006). The lesson plan in teaching learning is very important to sustain the implementation of multiple representations. It is attached on instructional appendix. Every PBL step, the multiple representations has been trained to students.

3. Enhancement The amount of Students in Scientific Consistency Category In Every Sub Theme

Based on the data result, researcher found the amount of students has improvement in scientific consistency. The data like this table bellows:

Table 4.4 Amount of student has enhancement on Scientific Consistency

Sub concept	QUESTION INDICATOR	AMOUNT OF STUDENTS ON	
		PRE-TEST	POST TEST
CONDUCTION	T1: CONCEPT CONDUCTION	1	23
	T2: CONDUCTION APPLICATION	1	24
	T3: problem solving of CONDUCTION	2	24
CONVECTION	T1: CONCEPT CONVECTION	0	26
	T2: CONVECTION APPLICATION	0	23
	T3: PROBLEM SOLVING OF CONVECTION	3	24
RADIATION	T1: RADIATION CONCEPT	18	25
	T2:RADIATION APPLICATION	15	26
	T3: problem solving of RADIATION	11	26
SEA BREEZE	T1: SEA BREEZE CONCEPT	4	25
	T2: APPLICATION MECHANISM OF SEA BREEZE	1	24
	T3: SOLVING PROBLEM OF SEA BREEZE	9	24
LAND BREEZE	T1: LAND BREEZE CONCEPT	7	25
	T2: APPLICATION MECHANISM OF LAND BREEZE	2	25
	T3: problem solving of LAND BREEZE	11	23

Amount of students have significant enhancement in every theme. The picture shown none of student is consistent in convection especially on the theme (T1) and theme (T2) about concept convection and convection application. After students given the treatment, most of student is consistent. Amount of student who undergoes the enhancement of scientific consistency in every sub concept shown on these pictures bellow:

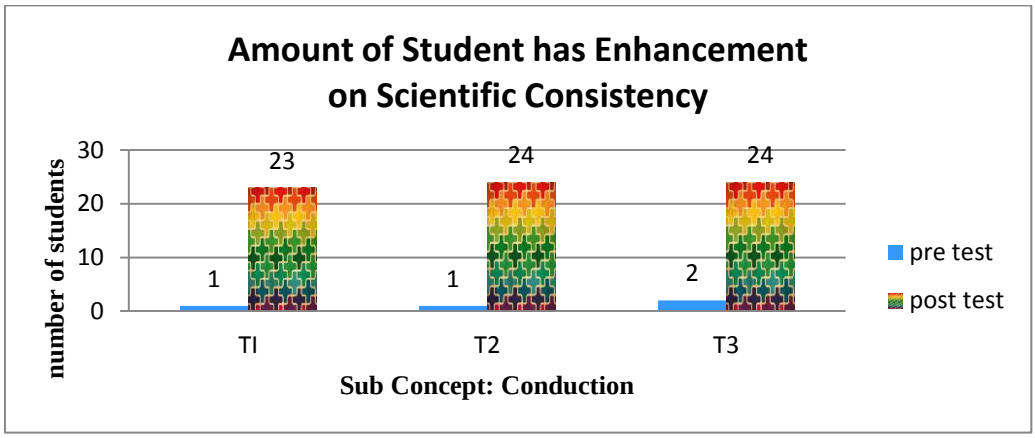


Figure 4.18 Amount of student has scientific consistency enhancement on conduction

Conduction divided into three themes:

T1 = concept conduction

T2 = conduction application

T3 = problem solving of conduction

Based on the picture, on pretest there is 1-2 students are consistent in answer the multiple representation test. After did a treatment, most of students 23-24 students who consistent scientifically.

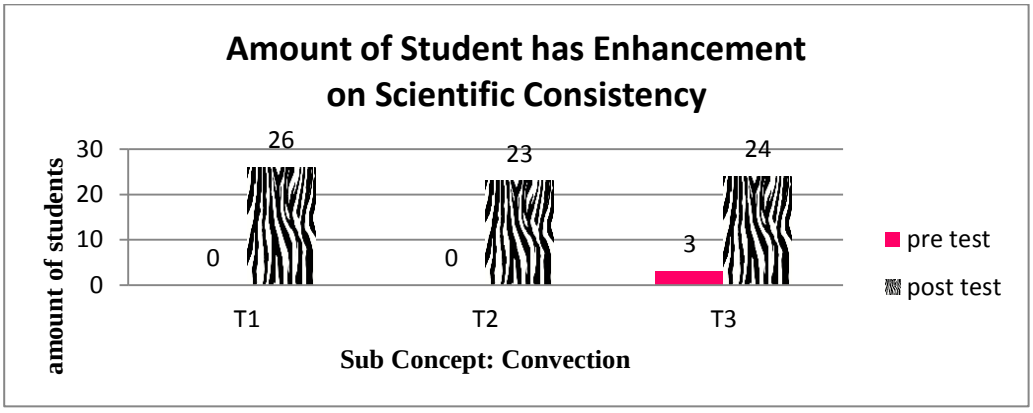


Figure 4.19 Amount of student has scientific consistency enhancement on convection

Convection divided into three themes:

T1 = concept convection

T2 = convection application

T3 = problem solving of convection

Based on the picture, on pretest there is 0-3 students are consistent in answer the multiple representation test. After did a treatment, most of students 23-26 students who consistent scientifically.

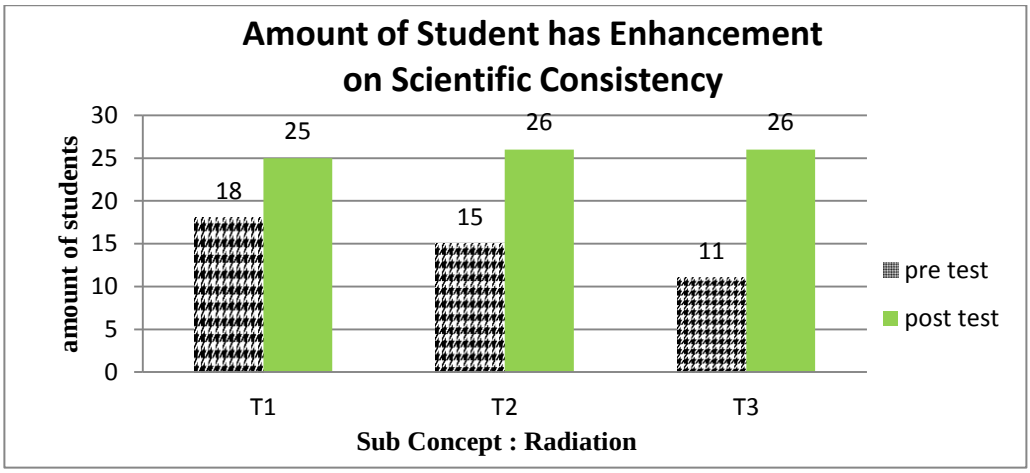


Figure 4.20 Amount of student has scientific consistency enhancement on Radiation

Radiation divided into three themes:

T1 = concept Radiation

T2 = Radiation application

T3 = problem solving of Radiation

Based on the picture, on pretest there 11-18 students are consistent in answer the multiple representation test. After treatment, most of students 25-26 students who consistent scientifically.

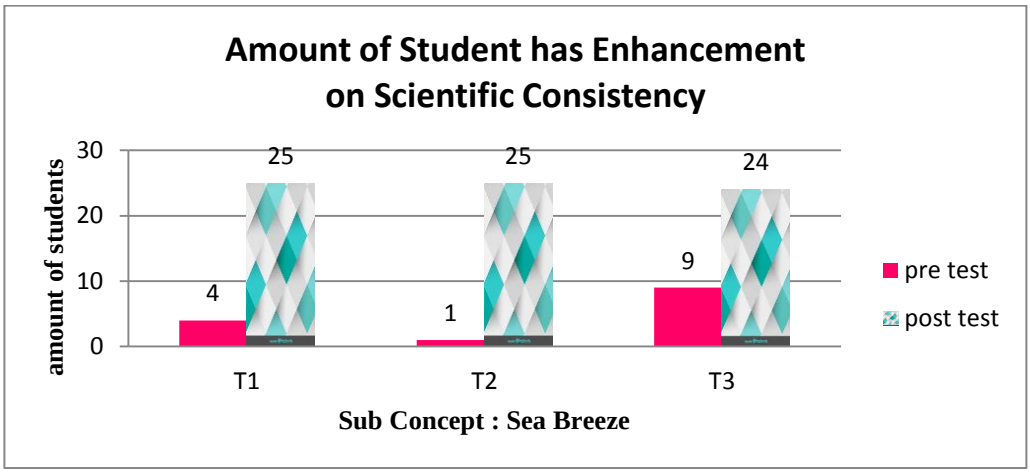


Figure 4.21 Amount of student has scientific consistency enhancement on sea breeze

Sea breeze divided into three themes:

T1 = concept sea breeze

T2 = application mechanism of sea breeze

T3 = solving problem of sea breeze

Based on the picture, on pretest there 1-9 students are consistent in answer the multiple representation test. After treatment, most of students 24-25 students who consistent scientifically.

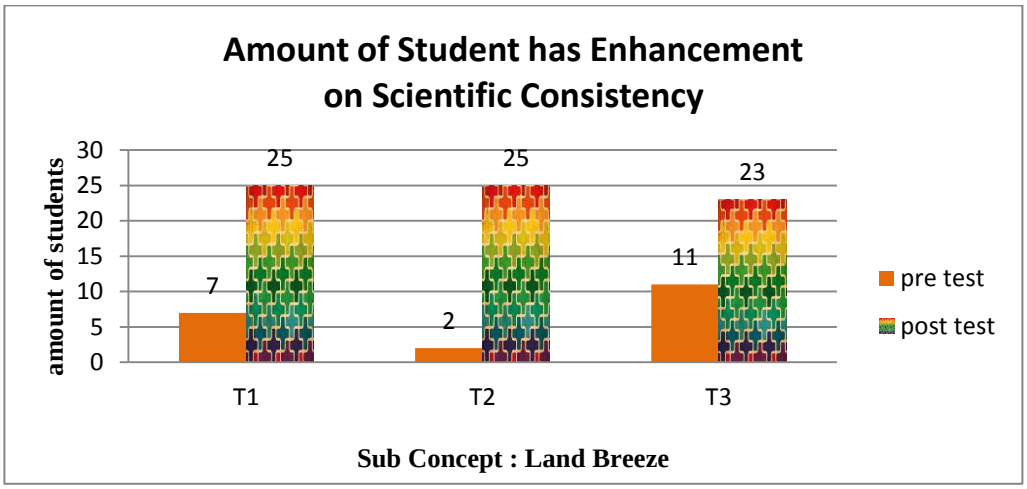


Figure 4.22 Amount of student has scientific consistency enhancement on land breeze

Land breeze divided into three themes:

T1 = concept land breeze

T2 = application mechanism of land breeze

T3 = solving problem of land breeze

Based on the picture, on pretest there 1-9 students are consistent in answer the multiple representations test. After did the treatment, most of students 24-25 students who consistent scientifically.

Resume those of graph; found there is significant enhancement the amount of students on scientific consistency in every theme. We can see in T1 and T2 concept of convection has highest enhancement the value amount of students on scientific consistency, especially on convection concept and convection application.

Before conducting the multiple representation approach in PBL, none of student has consistent to answer in convection concept. After post test, there is all of 26 students has consistent on their answer. It is due to already understand

about main concept of convection and the application of conduction during learning process. Student has been trained multiple representations during learning activity. The reason of convection has highest scientific consistency is student investigate by themselves to get information the water flow indicated by food coloring using simple experiment. Student draw by themselves to draw the water flow, then students explain the concept verbally regarding convection concept after that they compare the density on hot water and cold water to solve the food coloring flow phenomena. This strategy triggers students to learn and experience various representations.

Mean while, on radiation T1 and T2 there is little bit scientific consistency enhancement of the value amount of students. There is a correlation between the amounts of student with the lowest enhancement in every concept. The lowest enhancement of scientific consistency affects the number of student in scientific consistency. At the beginning, students have already known about the radiation as their prior knowledge, it would be affects the research result. Student have already known all about radiation because the radiation phenomena is very close with them

This research did not train many mathematics representations. Because basically the heat transfer topic did not use equation not like force topic. Heat transfers no need mathematic representation much. So, the implementation of representations should be applied in appropriate topics.