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The effect of ideal strategy with formative feedback on conceptual understanding and physics processing skill of XI graders senior high school

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Abstract: This research aims at identifying conceptual understanding and Physics scientific processing skill of students in IDEAL learning strategy with formative feedback and IDEAL learning only without formative feedback. It employed semi-experimental design using posttest only control group design. The sampling technique used random sampling. This research took two classes of XI graders of Natural Science classes from SMAN 2 Banjarmasin. The control class was taught by using IDEAL strategy only without formative feedback. While the experimental class was taught by using IDEAL strategy with formative feedback. There is a significant difference of conceptual understanding and Physics scientific processing skill of students between IDEAL strategy with formative feedback and IDEAL strategy without formative feedback. It further affirms that students' conceptual understanding in the class taught by IDEAL strategy with formative feedback is higher than the other. As well, students' scientific processing skill in the class taught by IDEAL strategy with formative feedback is higher than the other.

Key Words: conceptual understanding; formative feedback; IDEAL strategy; scientific processing skill

1. Introduction

Several learning strategies have been performed by teacher in classroom. However, in fact, conceptual understanding and scientific processing skills in students remain insignificant. If it is observed further, the strategies performed by teacher are available to be developed. Obstacles and hindrances during the implementation of certain strategy could be imrpoved by combining other appropriate strategy. One of the available alternatives to resolve the obstacles and hindrances in the existing learning strategy is by applying IDEAL strategy (abbreviated from Identify, Define, Explore, Act, and Look). This strategy offers students to have a more efficient thinking process in dealing with and solving certain problem. In addition to encourage more efficient thinking process to students, it provides an opportunity to improve social skill of students and improve student-teacher interaction in the classroom setting (Cengage Learning Australia, 2010). By applying IDEAL strategy in learning, it creates a student-centered learning which is more meaningful. Also, this offers more opportunity to encourage a creative thinking and active participation of students in learning. Innovation made in the classroom promotes a stimulating process of learning and encourages students' motivation in following learning process.

Basically, IDEAL learning strategy develops student's scientific processing skill and conceptual understanding. However, the arising issues in the conceptual understanding of student within each IDEAL

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step is somehow unpredictable. In addition, student cannot completery comprehend scientific processing skill within each IDEAL step. Thus, the above-mentioned issues will further be identified and resolved.

The shortcomings described above can be overcome by using formative feedback. The use of formative feedback in this research context is needed to determine students' understanding when learning takes place. Students with insufficient material experience during learning will obtain the opportunity to understand again before the teacher continues the material. Formative feedback is information that is communicated to students and is intended to change students' thinking or behavior to improve learning (Shute, 2007). By using formative feedback, the teacher can investigate student knowledge during the learning process and student experience (Buczynski, 2009).

Combining IDEAL strategies with formative feedback is expected to be able to overcome the shortcomings that exist in the learning process. By using this learning, researchers expect that the learning that takes place can be a learning that fosters an understanding of concepts and science process skills in studying Physics. Therefore, this learning can help students improving their understanding of Physics concepts and science process skills.

This study was conducted to determine the differences in conceptual understanding and students' Physical science process skills in IDEAL learning with formative feedback and IDEAL learning without formative feedback. The research hypothesis formulated is to prove that there are differences in conceptual understanding and students' Physical science process skills who learn by means of IDEAL strategies with formative feedback compared to IDEAL learning without formative feedback. Conceptual understanding of Physics among students who learn by using IDEAL strategies with formative feedback is higher than those who only learn with IDEAL strategies without formative feedback. Physical science process skills of students who learn by using IDEAL strategies with formative feedback is greater than those who only learn by usingIDEAL strategies without formative feedback.

The IDEAL strategies comprise of stages that begin from identifying the problem (identify), then defining the problem (define), exploring the problem (explore), acting on the problem (act), seeing and re-learning the problem (look). The stages of IDEAL strategy are an important part of thinking that is effective and efficient in problem solving (Asia E-University, 2009). Formative feedback is required to identify the conceptual understanding that have been obtained by students. By incorporating formative feedback at each IDEAL step, conceptual understanding acquired by students is observable and if students' understanding turns out to be lacking, the teacher can provide action directly before continuing the learning material.

2. Methods

This research approach was classified as semi-experimental research since not the entire findings obtained in this research are influenced by variables which are controlable apart from the treatment. It employed inly posttest group design as the research design. Therefore, both experimental and control classes in this research only obtained posttest at the end of the learning. Both classes did not obtained pre-test.

In this research there were two classes which were chosen randomly. To determine the classes, it employed cluster sampling method. This sampling technique was employed to determine the sample if the subject of the study is quite large (Salkind, 2006). One determined class was given a learning treatment, while the other one was not given the learning treatment. The class which obtained learning treatment is the experimental class and the untreated class is the control class. In the experimental class, students learn by using IDEAL strategies with formative feedback and in the control class, students learn by using IDEAL strategies without formative feedback.

The population of this research was the students of class XI IPA 2 of SMA Negeri 2 Banjarmasin which consists of five classes. Each class consists of 33 students and the total number of students is 165 people.

The research sample was two classes taken based on the teacher who taught the two classes. The research instruments in this study compiled by researchers were treatment instruments and measurement instruments. The treatment instrument consisted of lesson plan of learning by using IDEAL strategies with formative feedback and lesson plan of learning by using IDEAL strategies without formative feedback. While for measurement instruments, researchers used the posttest questions for students in the form of essay questions, student worksheets and observation sheets of students' science process skills.

Before the data was analyzed, to test the hypothesis that has been submitted, prerequisite test was done first. The prerequisite test consists of homogeneity test and normality test. To test the hypothesis which states the influence of IDEAL strategies with formative feedback on conceptual understanding and physical science process process skills of students, researchers used the t-test.

3. Results and Discussion

3.1. Results

3.1.1 Control Class Research Data Description

The data regarding student's conceptual understanding of Physics was measured by employing posttest given to students. The posttest was given at the end of the last meeting or on the fourth meeting to measure how far students acquired the conceptual understanding. The posttest consisted of nine items in the form of essay. The following Table 1 presents the obtained data pf students from the posttest.

Table 1. Posttest Results of Control Class on Conceptual Understanding

Total amount of students	32
Total score	2.031
Average score	69,41
Variance (s2)	178,45
Standard deviation (sd)	13,36

Table 1 shows that control class consisted of 32 students. The total score of students' posttest in control class was 2.031 with the average score of 69.41. also, the table shows that the variance obtained was 178.45 and the standard deviation obtained was 13.36.

As for the data regarding student's scientific processing skill, it was obtained by employing rubric. Student's scientific processing skill was assessed during the learning process when students performed experiment in the classroom. Table 2 below presents the data regarding student's scientific processing skill.

Table 2. Student's Scientific Processing Skill of Control Class

Total amount of students		32
Average score of components	Analyzing	3,31
	Defining	2,94
	Formulating Hypothesis	3,03
	Observing	3,56
	Concluding	3,13
	Communicating	3,75
Class average score		3,29

Table 2 presents the data obtained regarding student's scientific processing skill. It deals with the components of scientific processing skill as follows: analyzing, defining, formulating hypothesis, observing, concluding, and communicating to other students. It obtained the average score as follows: analyzing component obtained 3.31; defining component obtained 2.94; formulating hypothesis component

obtained 3.03; observing component 3.56; concluding component obtained 3.13; and communicating component obtained 3.75. The whole average score of student's scientific processing skill on control class obtained 3.29. The following Figure 1 illustrates the obtained score of student's scientific processing skill on control class.

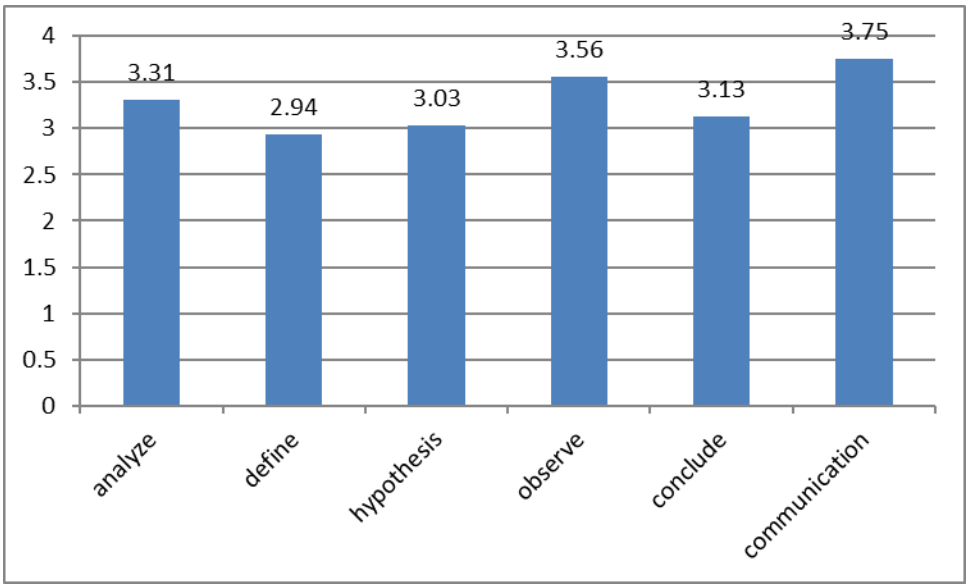

Figure 1. Student's Scientific Processing Skill on Control Class

3.1.2 Experimental Class Research Data Description

Similar to control class, in the experimental class, the students also taught by means of IDEAL strategy. But, in the experimental class, the learning was combined with formative feedback. To measure student's scientific processing skill in the experimental class, posttest was also employed. The posttest was given at the end of the last meeting or on the fourth meeting to measure how far students acquired the conceptual understanding. The posttest consisted of nine items in the form of essay. The following Table 3 presents the obtained data pf students from the posttest.

Table 3. Posttest Results regarding Conceptual Understanding of Students on Experimental Class

Total amount of students	32
Total score	2.363,33
Average score	73,85
Variance (s^2)	167,90
Standard deviation (sd)	12,96

Table 3 shows that the experimental class consisted of 32 students. The total score of students' posttest in the experimental class was 2.363 with the average score of 73.85. Also, the table shows that the variance obtained was 167.90 and the standard deviation obtained was 12.96.

As for the data regarding student's scientific processing skill, it was obtained by employing rubric. Student's scientific processing skill was assessed during the learning process when students performed experiment in the classroom. Table 4 below presents the data regarding student's scientific processing skill.

Table 4 presents the data obtained regarding student's scientific processing skill. It deals with the components of scientific processing skill as follows: analyzing, defining, formulating hypothesis, observing, concluding, and communicating to other students. It obtained the average score as follows: analyzing component obtained 3.78; defining component obtained 3.03; formulating hypothesis component obtained 3.16; observing component 3.97; concluding component obtained 3.19; and communicating

component obtained 3.81. The whole average score of student's scientific processing skill on control class obtained 3.49. The following Figure 2 illustrates the obtained score of student's scientific processing skill on the experimental class.

Table 4. Student's Scientific Processing Skill of The Experimental Class

Total amount of students		32
Average score of components	Analyzing	3,78
	Defining	3,03
	Formulating Hypothesis	3,16
	Observing	3,97
	Concluding	3,19
	Communicating	3,81
Class average score		3,49

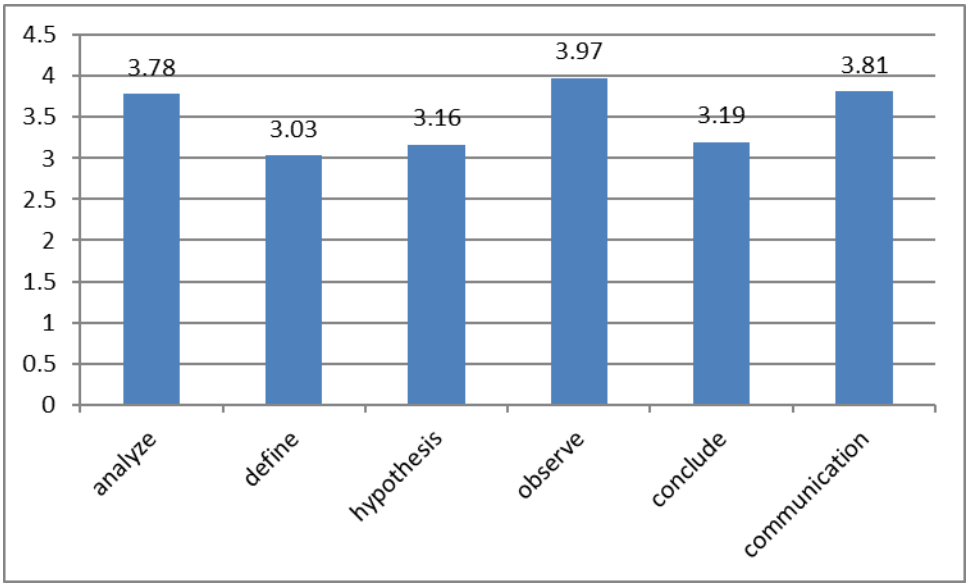

Figure 2. Student's Scientific Processing Skill on the experimental class

3.1.3 Pre-requisite Test Description

3.1.3.1 Normality Testing

Normality testing was performed to identify and assess whether distribution of the data obtained during data collection was normally distributed or not. The following Table 5 presents normality testing results of the posttest on the control class.

Table 5. Normality Testing of Control Class

Variance (s^2)	178,45
Standard Deviation (sd)	13,36
L Table	0,156624
L Count	0,1075
L Table > L Count	Normal

Table 5 presents the results of normality testing of the control class. In table, it is seen that the variance score obtained on the control class was 178.45, the standard deviaton obtained was 13.36, L Table obtained was 0.156624, and L count obtained was 0.1075. According to the normality testing, L Table is

higher than L count which means data distribution of the obtained dala by the researcher during observation in the control class was normalyy distributed. As for the results of normality testing of the experimental class, it is presented in the Table 6.

Table 6 presents the results of normality testing of the experimental class. In table, it is seen that the variance score obtained on the experimental class was 167.90, the standard deviaton obtained was 12.96, the L Table obtained was 0.156624, and the L count obtained was 0.11356. According to the normality testing, L Table is higher than L count which means data distribution of the obtained dala by the researcher during observation in the experimental class was normaly distributed.

Table 6. Normality Testing of The Experimental Class

Variance (s^2)	167,90
Standard Deviation (sd)	12,96
L Table	0,156624
L Count	0,11365
L Table > L Count	Normal

3.1.3.2 Homogeneity Testing

Homogeneity testing aimed at identifying whether the data obtained, initial ability of students, differs or not. This testing was performed to ensure both variance of data for further examination is homogenous. Both data from the control and experimental classes should be homogenous and should not have a difference on the student's initial ability. Table 7 presents homogeneity testing of the control and experimental classes.

Table 7. Homogeneity Testing Results

Variance (s^2) of the control class	178,45
Variance (s^2) of the experimental class	167,90
Total amount of the control class' sample	31
Total amount of the experimental class' sample	31
Combined Variance	173,1765
B	138,7863
x^2 Table (0,95;1)	3,81
x^2 count	0,028792
x^2 count < x^2 Table	Homogenous

Table 7 presents the results of the homogeneity testing between the control and experimental classes. The total variance obtained of the control class was 178.45, the variance of the experimental class was 167.90. Similarly, both the control and experimental class consisted of 31 student. The combined variance of both the control and experimental classes was 173.1765. In addition, it obtained the score of B unit of 138.7863, the score of x^2 Table, where the rate of 0,05, is 3.81, and the score of x^2 count was 0.028792. According to the homogeneity testing results, X^2 Table score is higher than X^2 Count. The result affirms that both data obtained regarding the initial ability on the control and experimental classes have no difference.

3.1.4 Hypothesis Testing Results Description

3.1.4.1 Student's Physics Conceptual Understanding

Student's Physics conceptual understanding is observable from the obtained results of posttest. Table 8 below presents the results of the average score difference on students' posttest between student

learnt by means of IDEAL strategy and student learnt by means of IDEAL strategy combined with formative feedback.

Table 8. Students' Posttest Results

Class	Average score
Experimental	73,85
Control	69,41

Table 8 shows posttest results obtained by students from both the control and experimental class. According to the table, the experimental class obtained 73.85 of the average score and it is higher than the control class which obtained 69.41. The findings confirm that student's conceptual understanding is greater when they were taught by means of IDEAL strategy combined with formative feedback than those who were taughtbby means of IDEAL strategy only without formative feedback. The Figure 3 below further presents the comparison of both the average score of the control and experimental classes.

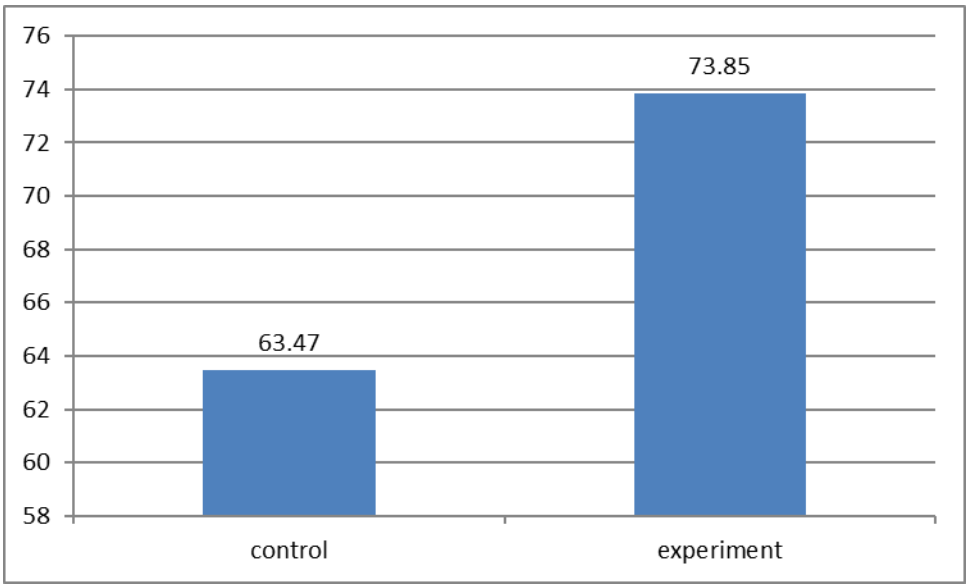

Figure 3. The Average Score of Student's Conceptual Understanding

3.1.4.2 Student's Scientific Processing Skill

To obtain data regrading student's scientific processing skill, it used rubric. The researchers obtained scientific processing skill of students during the learning processs when they performed a laboratory practicum. Figure 4 below presents the data regarding students' scientific proessing skil of both control and experimental classes.

Figure 4 above presents teh average score of students' scientific processing skill from both control and experimental classes. According to the figure, in the component of analyzing, the experimental class obtained higher score of 3.78 than the control class score of 3.31. Then, as for the component of defining, the experimental class obtained 3.03 of the average score and the control class obtained 2.94. The experimental class obtained 3.16 for the component of formulating hypothesis and the control class obtained 3.03. Dealing with the component of observing, the experimental class obtained the average score of 3.97 and the control class was 3.56. For the component of concluding, the experimental class obtained the average score of 3.19 and the control class was 3.13. The last, but not least, the experimental class obtained 3.81 for the component of communicating and the control class obtained 3.75.

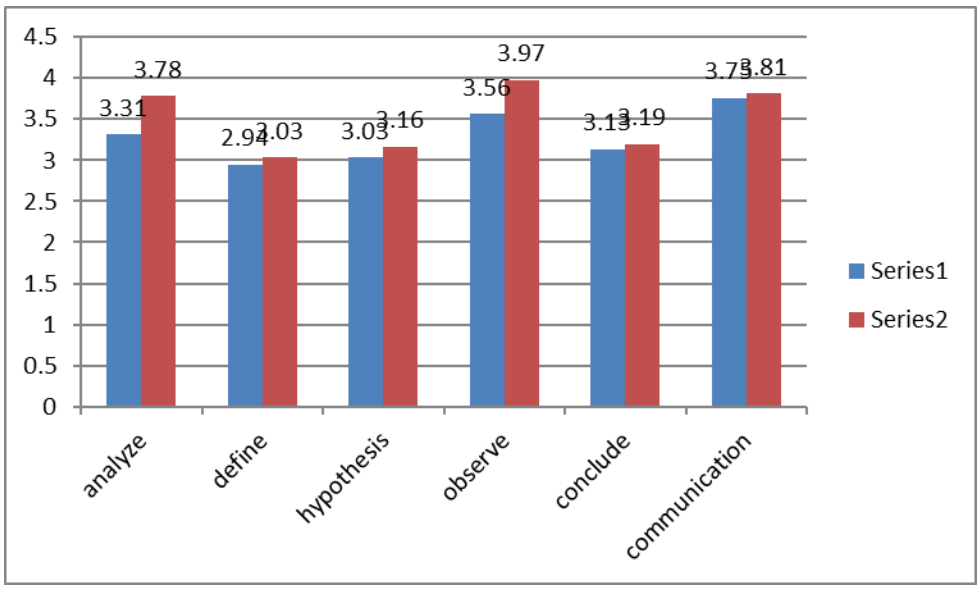

Figure 4. The Average Score of Student's Conceptual Understanding

Based on the obtained data, the average score of students' scientific processing skill of both classes are presented in the Table 9.

Table 9. The Average Score of Students' Scientific Processing Skill

Class	Average score
Experimental	3,49
Control	3,29

According to Table 9, the average score of students' scientific processing skill obtained by students in the experimental class is higher than students in the control class (the experimental class was 3.49 and the control class was 3.29). Therefore, students' scientific processing skill after employing IDEAL strategy with formative feedback is higher than students who learnt only by means of IDEAL strategy withouth formative feedback.

3.1.4.3 Difference between IDEAL strategy with formative feedback and IDEAL strategy without formative feedback

Furthermore, after obtaining the average score of conceptual understanding and scientific processing skill within student, t-test was performed. T-test was performed to identify and discover whether conceptual understanding and scientific processing skill within student in the learning process differed or not. Table 10 below presents the results of t-test of student's conceptual understanding.

Table 10. T-test results of Student's Conceptual Understanding

Class	t count	A
Experimental	3,115689	0,05 = 2,042
Control		0,01 = 2,750

According to Table 10 which presents the t-test results, t count of students' conceptual understanding was 3.115689. It was higher than the significance rate of α 0.05 which is worth of 2.042 as well as rate of 0.01 which is worth of 2,750. The number further proves that student's conceptual understanding between the exprimental and control classes significantly differs. Then, the t-test for student's scientific processing skill is presented in the following Table 11.

Table 11. T-test results of Student's Scientific Processing Skill

Class	t count	α
Experimental	2,895205	0,05 = 2,042
Control		0,01 = 2,750

According to Table 11 which presents the t-test results, t count of students' scientific processing skill was 2.895205. It was higher than the significance rate of α 0.05 which is worth of 2.042 as well as rate of 0.01 which is worth of 2,750. The number further proves that student's scientific processing skill between the exprimental and control classes significantly differs.

3.2. Discussion

3.2.1. The Effect of IDEAL Strategy with Formatve Feedback on Conceptual Understanding

According to the formulated hypothesis, student's conceptual understanding obtained after learning by means of IDEAL strategy with formative feedback is higher than students who learnt by means of IDEAL strategy without formative feedback. In this research, formative feedback serves as contributing factors. During the learning process in the experimental class, feedbacks were regularly given to students. Thus, it was possible to control part of lesson or learning which was not yet understood by students. Also, it provided more exepriences by giving more exercises to train problem-solving ability. During the learning process, feedbacks were given in the form of wirtten or spoken questions.

When the researchers gave an oral question, the researchers randomly assigned students to answer the questions asked. In addition to oral questions, the researchers also gave written questions and asked one of the students to solve the problem with the guidance of the researcher. Furthermore, the researchers also invited other students if there were those who have different answers or different approaches to solve the problem. At the end of learning, the researchers also provided homework to students. Therefore, before attending the class on the next meeting, students will learn further the material that has been presented by the researchers by doing the homework given.

The feedback given to students affects the posttest results of students' conceptual understanding and scientific processing skill. In the control class, students were difficult in working on the questions because they are not familiar with the exercises beforehand. Question exercises and discussion were only given to the experimental class hence the results of the posttest scores of the experimental class are better than the posttest results of the control class. This is in accordance with the objectives of the assessment in Oxford (Oxford Brookes University, 2002), which aims to assess students, provide motivation, create learning opportunities, provide feedback (both to students and teachers) to classes, and as a quality assurance mechanism (both for internal systems and external). Formative feedback is information that is communicated to students intended to change students' thinking or behavior for the purpose of improving learning (Shute, 2007)

Figures 5 and 6 show examples of the posttest results of the experimental class and the control class. There are different answers from each class. In the control class, it can be seen that students still cannot remember well the concepts of series and parallel constants. This is because the control class was not given feedback treatment. Students were not familiar with practice questions thus students do not remember the concepts that have been learned.

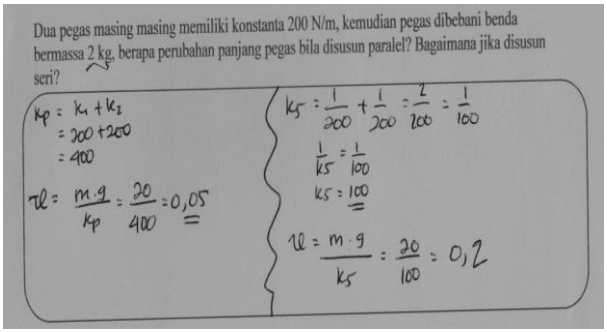

Figure 5. Student's Posttest in The Experimental Class

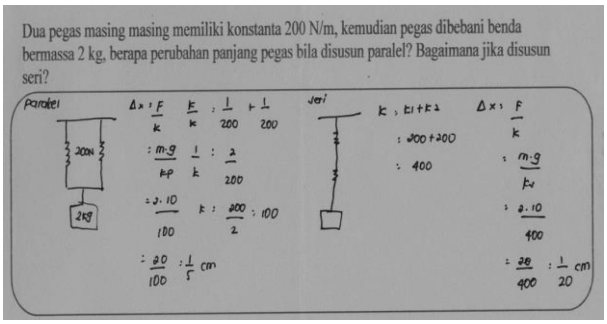

Figure 6. Student's Posttest in The Control Class

3.2.2. The Effect of IDEAL Strategy with Formative Feedback on Student's Scientific Processing Skill

Based on the researcher's hypothesis, the students' science process skills which were taught by using IDEAL strategy with formative feedback is higher than students taught only with IDEAL strategy without formative feedback. Not only related to the material studied by students, formative feedback on the stages of IDEAL strategy was also provided to improve students' scientific processing skills.

In the stage of identifying, the researchers guided students to identify the problems given in the form of images. Every student has their own perspective on problems. In the formative feedback, the researcher asked several students from different groups to show the results of the student's viewpoint on the picture. In this process, students were trained to understand the aspects of the problem, thus students can analyze and develop hypotheses to solve the problem. This ability is an important initial ability to determine the further measure taken. This was revealed in Kline's research, namely the ability to identify. The existence of a problem is an important characteristic to support the success of problem-solving process and offers an opportunity to generate creative solution.

In the stage of definition, the researchers guided students in developing an understanding of the problem after students are able to identify the problem. Students were guided to find various information that was in accordance with the problems given by the researcher. Then the researchers guided students in filtering out the information they have obtained and students can determine the problem statement. In the end to resolve the problem, students were guided to discuss with each other about what goals they want to achieve from the existing problems. With a variety of different objectives, different types of answers were be tried. That goal setting is very influential on an individual's ability to think and solve problems. After determining the goal, the researchers appointed one student to read the results of his/her work and invited other students to respond.

During the stage of exploring, after determining the goal of the problems, students were guided to find out the alternatives of solution. In this process, students discussed with their peers to decide the obtained alternatives. Different goal and objective promotes individual to explore more different strategies to solve problem (Nuun & McMahan, 2001). Based on the varied perspectives to solve problem, students

took one alternative which was appropriate to the problem in accordance with the goal. Students were guided in making work mechanism process for their practicum. One student was asked to read-aloud the results of group discussion, and other students were invited to provide a response. In addition, the researchers gave another case study and asked students to find it the alternative or stages in solving the problem.

During the stage of acting, students were guided to perform alternative steps of solve problem which were arranged before. In this stage, students performed working steps in the practicum. Students were stimulated to be active and encouraged to be well-cooperated with their friends. In addition, students' skill in preparing laboratory equipment, measuring, and arranging observation data were elevated. In the end of the practicum, one group of student was asked to deliver their practicum result and other groups were asked to give a response.

In the stage of looking, altogether, the researchers and students reviewed the steps performed in solving problems. Then, the researchers invited students to review the results of practicum as well as the hypothesis formulated. This is in accordance with the theory of look and learn suggested by Cengage Learning Australia (2010). It is important to look and re-learn after we obtain a result. Most people forget to take a look and learn again upon the problem-solving taken. When students are able to take a look and learn again, they are also able to evaluate their own approach in solving the problem.

When it came to the control class, each step in IDEAL strategy, formative feedback was not given. Therefore, students' scientific processing skill in the control class is lesser than the experimental class.

4. Conclusion

According to the obtained data and the hypothesis testing, this research conclude that there is a significant difference of conceptual understanding and Physics scientific processing skill of students between IDEAL strategy with formative feedback and IDEAL strategy without formative feedback. It further affirms that students' conceptual understanding in the class taught by IDEAL strategy with formative feedback is higher than the other. As well, students' scientific processing skill in the class taught by IDEAL strategy with formative feedback is higher than the other. To extend this research, it is important to include more students' response regarding the learning and should be related to the final result of students' learning. This research can also be extended by employing scientific working test in addition to direct observation, by enriching basic competence of learning, and by including more objectives in observing student's high order thinking skill or critical thinking skill.

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