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Student's higher order thinking skills on problem solving based on jumping tasks

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Student's higher order thinking skills on problem solving based on jumping tasks

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Abstract. Most of the students' Higher Order Thinking Skills (henceforth, HOTS) are still weak in term of complex problem solving and thus to face this condition a research about problem solving learning by giving jumping tasks to the ninth grade students of junior high school under the subject Power of numbers and form of root is conducted to know their Higher Order Thinking Skills. This research employed mixed method combining Thiagarajan 4D model to develop the learning instruments and experimental research design to know the effect of the learning instruments implementation on the students Higher Order Thinking Skills. The students of SMPN 2 Balung were the subject of this research and three classes were chosen as the sample of the research consisting of two classes as the experimental class and one class as the control class. Learning material was not only developed to make the students able to solve problem but also provide jumping task exercises which designed for the students to solve problem in order to improve their Higher Order Thinking Skill. The research sample was given an essay test to measure their HOTS. The learning instruments developed fulfilled the criteria of valid, practical, and effective. The result of normality and homogeneity tests showed that the data were normally distributed and homogeneous, One-way ANOVA showed the value of sig. 0,000 ($p<0,05$) which can be concluded that the implementation of jumping task –based problem solving learning had significant positive effect on the students' Higher Order Thinking Skill (HOTS)

1. Introduction

21st century learning has four competences namely 4C consisting of communication, collaboration, critic, and problem solving as well as creative and innovative [1,3]. The achievement of those competencies is the objective of curriculum 2013 to make Indonesia education capable to face various 21st century challenges. To answer the 21st century challenges, the students are expected to have Higher Order Thinking Skills so that they have thinking level of analyzing, evaluating, and creating which is not only limited on remembering, understanding and implementing [2,4]. The main objective of HOTS is improving the students thinking ability into a higher level. With HOTS, the students are able to relate their prior knowledge with new knowledge to think critically in solving problem to get appropriate solution.

The selection of appropriate learning model by the teacher is one of the factors influencing the learning success. The learning model that can be used to elicit the students' HOTS which is problem-oriented is problem solving learning. Problem solving is an attempt to find solution of every obstacle

to reach the goal by applying solving steps [5]. Problem solving in mathematics learning is a set of cognitive process as the effort to solve problem [6]. One of the problem solving models is Polya. There are four steps in solving a problem proposed by Polya, namely (1) understand the problem in which by understanding the problem given by the teacher, the students are able to solve the problem correctly, (2) plan solving strategy in which the students ability in arranging the plan depends on their experiences, so the more they have exercises the more creative they arrange the solving plan, (3) implement the plan where the students solve the problem based on the plan they think as the most effective and correct, (4) recheck in which requires the students to recheck their work from the beginning to the third step [5].

Jumping task in the element of LSLC (Lesson Study for Learning Community), it consists of four elements: (1) collaborative learning, (2) caring community, (3) community-based learning implementation, (4) jumping task-based learning implementation [7]. Jumping task is a task that is challenging or beyond the level of the curriculum order requirement given to the students [8,9,10,11]. There are four things that should be paid attention in giving jumping task (1) what has been understood after doing jumping task question and how to implement it, (2) jumping questions are analyzed based on the recent sources, (3) jumping question is used to interpret a phenomenon/event/incident, (4) relating knowledge and concept that have already learned is needed in solving jumping question [5]. Giving jumping question to the students is intended to make them think critically, creative, and innovative through a group discussion [7,10]. Furthermore, the advantage of giving jumping question is to create an active and effective learning atmosphere where an interaction among groups occurred [7,3]. Through an active group learning in solving jumping question which is challenging, the students higher order thinking skill will be triggered [5,7,8,10].

Based on the interview with mathematics teacher at SMPN 2 Balung, the students' higher order thinking skill is still low especially on the lesson of Power of numbers and form of root. The problem that happens during the time is that there is no collaborative learning among students so that they are individual and has no care to their friends who are low achiever. The learning activities in the classroom are still teacher-centered so that the students have less exposure to practice problem solving independently. Therefore, the lesson of Power of numbers and form of root was chosen by the researcher as the material of the research and it was developed within a problem solving learning by providing jumping task designed to make the students able to solve problem and thus gives an effect to their higher order thinking skill.

2. Research Method

This research employed mixed method which was the combination of qualitative and quantitative methods [7]. In qualitative research, the development model applied was Thiagarajan model called 4D model consisting of define, design, develop, and disseminate [7]. This research aimed at developing learning instruments of jumping task-based problem solving to know its relationship with students higher order thinking skills, the instruments developed were learning implementation plan, students worksheet, and students achievement test. The instruments were then tested to determine its validity, and reliability [7]. While the quantitative method used a quasi-experimental design of post-test only control group which was analyzed by using SPSS Software version 19 with One Way ANOVA test. Normality test was carried out using Kolmogorove Smirnov, while homogeneity test used Levene Statistic with significance level (P>0,05). One Way ANOVA test would be conducted if the data obtained were normally distributed, and if the data were not, non-parametric test would be conducted by using Mann-Whitney test.

2.1. Sample

The research was carried out to the ninth grade students of SMPN 2 Balung Jember in the odd semester in the 2019/2020 academic year. The sample of the research consisted of three classes chosen by using cluster random sampling. IX B class as the control one with 28 students, IX F as the experimental class 1 with 28 students, and IX E as the experimental class 2 with 28 students.

2.2. Research Instruments

The instruments used were validation and observation sheets. The validation sheet covered validation sheet for lesson plan, student worksheet, and achievement test. The observation sheet covered observation sheet for teacher activities in the class, students activities and students response questionnaire.

2.3. Research Procedures

Qualitatively, the model developed was Thiagarajan known as 4D model consisted of define, design, develop, and disseminate [7]. While quantitative method used a quasi experimental design consisted of the experimental and control classes. In this research, the researcher used 2 classes as the experimental one consisted of experimental 1 and 2. In IX D class, the model teacher implemented problem solving learning with sharing task, sharing task is finishing the task is reachable by the students ability to finish it [10]. While in IX E class, the model teacher used problem solving learning based on jumping task. The control class was given a conventional learning which was the common learning model implemented in the school, that was direct learning. The design of this research used post-test only group design. In the last meeting, post-test was given in the form of essay to analyze whether the jumping task-based problem solving learning had an effect on the students HOTS.

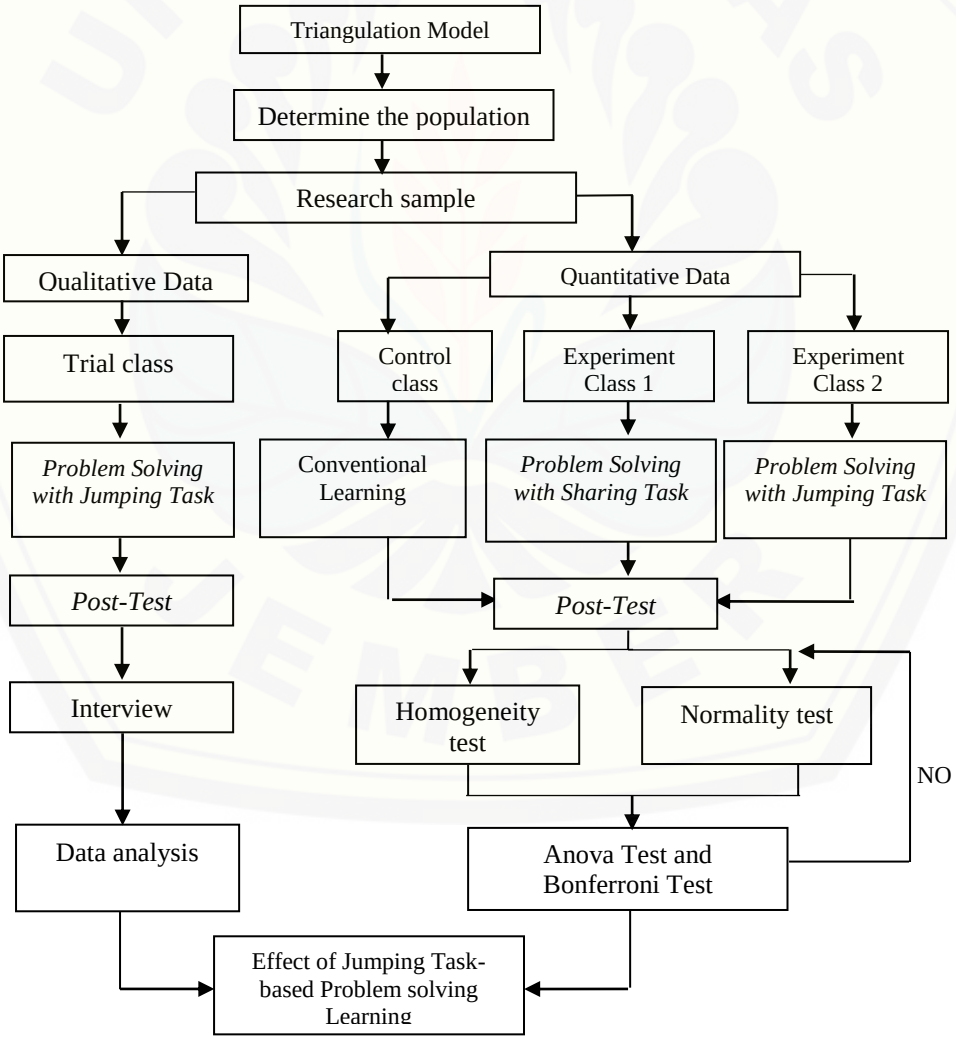

Figure 1. The model of triangulation of mixed method.

2.4. Questions

In this research the students were given two types of questions that were sharing and jumping questions on Power of numbers and form of root material. It can be seen on Table 1.

Table 1. Sharing and jumping questions on power of numbers and form of root material.

Question Type	Task (Bloom's Taxonomy)	Description
Sharing Task	The bacterial population that is spread out in a rectangular container is 4.2×10^7. If the length and width of the container are 10 cm and 7 cm respectively, what is the density of bacteria in the container?	Students cannot directly use the information that was known to solve problems; Different information were needed to solve it. In this problem, the students must first determine the area of the rectangle (p × l) and use it to determine the density of bacteria ($\frac{total\ bacteria}{rectangle\ area}$)
Jumping Task	In one study, it is discovered that amoeba S reproduces by splitting itself 2 times every 15 minutes. How many Amoeba S during the day if there are 4 Amoeba S?	There were information that were not written on the problem, the students must be able to find the missing information and use it to solve problems. The students were able to determine how many hours in one day, then determine the amount of amoeba in one hour, then determine the amount of amoeba in one day if there are 4 amoebas

3. Research Finding

3.1. Validity of learning Instruments

The learning instruments developed in this research were lesson plan, student worksheet, and achievement test. Before the implementation, the learning instruments developed were validated by validator consisting of two lecturers of mathematics education of University of Jember and a mathematics teacher of SMPN 2 Balung. The validators also validated the research instruments consisted of the observation sheet of teacher and students activities and the observation sheet of HOTS development as well as students response questionnaire. Each of the criteria was calculated and recapped to determine the mean score. The result in the form of validation score on the learning instruments are presented on Figure 2 and Figure 3

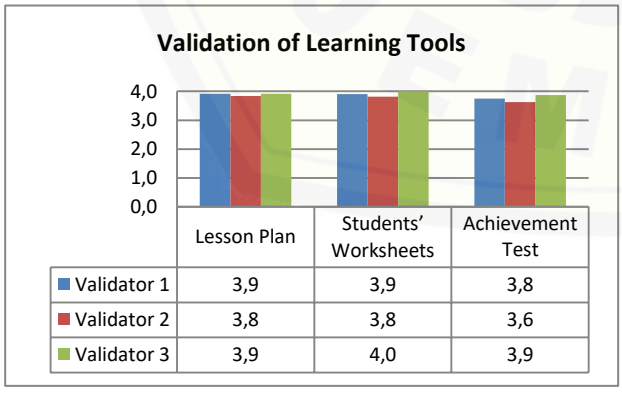

Figure 2. Results of validation of learning instruments.

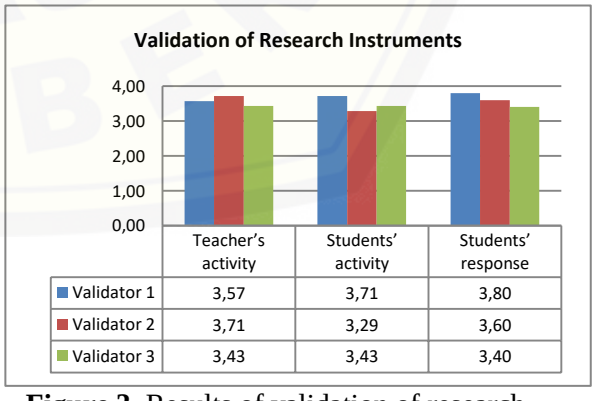

Figure 3. Results of validation of research instruments.

The learning instruments that had been validated in the figure 2 showed the mean scores of the validations of lesson plan, students' worksheets and results of achievement test that were 3.86; 3.93

and 3.76, this revealed that the score of validation of the learning instruments was in the interval $3<Vr\leq 4$. Based on the validity criteria, the learning instruments developed fulfilled the valid criteria. Similarly in the figure 3, showed the results of validation of the research instruments covering the teacher's activity of 3.57, students' activity of 3.47 and students' response of 3.6, this revealed that the validation score was in the interval $3<Vr<4$. Therefore, the research instruments fulfilled the validity criteria. Thus, the learning instruments and research instruments fulfilled the validity criteria and were appropriate to use

3.2. Implementation of Jumping Task-based Problem Solving Learning Instruments

The further stage was determining the research samples through the homogeneity test by using Anova SPSS 19, the data used as the homogeneity test were the scores of even semester 2018/2019. Based on the homogeneity test done in the class IX of SMPN 2 Balung obtained the significance value was 0.246. Due to the significance value > 0.05, therefore the ability of class IX was homogeneous. The research samples were taken by using random cluster sampling and obtained the research samples were class IX B as the control class with 28 students, class IX D as the first experimental class with 28 students and class IX E as the second experimental class with 28 students. The control and experimental classes consisted of 4 meetings with the details of the first meeting discussed about the concept of power of numbers, the second meeting discussed about the operation of power of numbers, the third meeting discussed about form of root and scientific notation and the fourth meeting conducted the students' achievement test.

In the learning processes that lasted for 3 meetings, the observer conducted the observations on the teacher's activity during the learning to gain the data which were used to analyze the practicality of the learning instruments. The aspects assessed were the learning stages started from the introduction activity, main activity and closure activity. After conducting the observation on the teacher's activity during 3 meetings showed the score percentage as shown on the figure 4 below

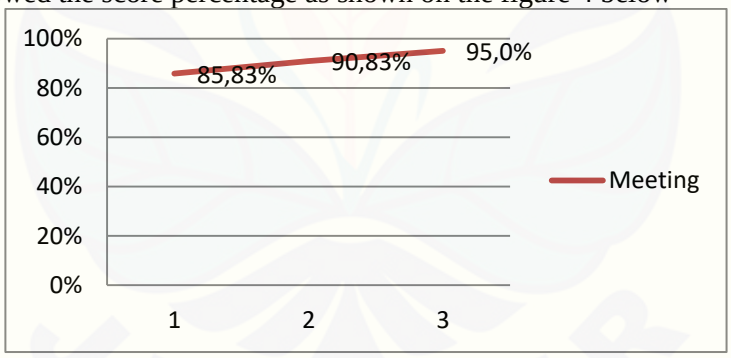

Figure 4. Teacher's activity during 3 meetings.

After the observation on the teacher's activity during 3 meetings done, it was found the mean score of implementation was 90.5%, this showed that the learning implementation run well. Therefore, the jumping task-based problem solving learning instruments fulfilled the practicality criteria.

3.3. Students' Activity during the Learning

The learning process in the experimental class was done in groups consisting of 7 groups and each group consisted of 4 students. This learning was done in 3 meetings by using 4 stages of Polya's learning. In the first experimental class, the model teacher used problem solving learning through sharing tasks. While, in the second experimental class, the model teacher used jumping task-based problem solving learning instruments. In the class IX D as the first experimental class, this learning was done in 3 meetings, as follows

The first meeting in class IX D (First Experimental Class)

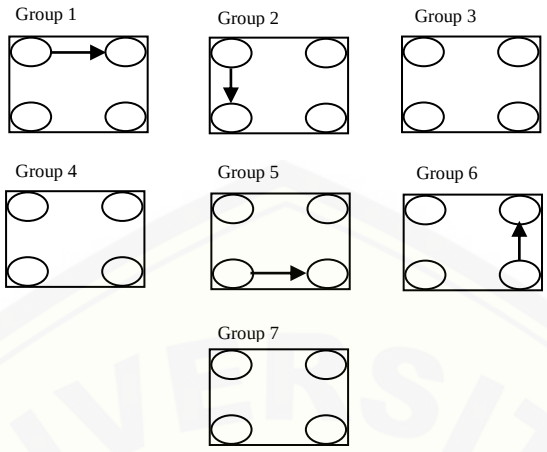

Figure 5. Students' activity in the first meeting in the first experimental class.

Descriptions: ⟶ : the students asked
⇢ : the students expressed their answers or guided their friends

From the results of observations in the groups 1, 2, 3, 4, 5 and 6 found the cooperation activity in groups although only one student who asked his friend in the group. While in the groups 3, 4 and 7, there was no cooperation activity in the groups. This happed because the question given by the teacher belonged to quite easy question for the students so every student was able to do it themselves without cooperating with other friends in the groups.

The second meeting in class IX D (First Experimental Class)

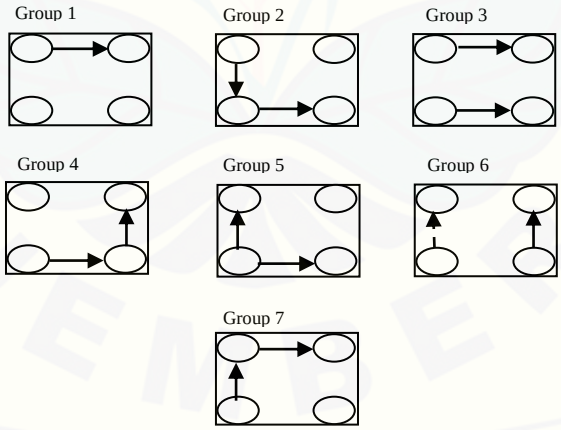

Figure 6. Student's activity in the second meeting in the first experimental class.

Descriptions: ⟶ : the students asked
⇢ : the students expressed their answers or guided their friends

From the results of observations on all groups, found the cooperation activity in the group. In contrast with the first meeting, this showed that in the second meeting, the difficulty level of the question was more difficult than in the first meeting so some students needed other students, even though there were some students who still did it individually

The third meeting in class IX D (First Experimental Class)

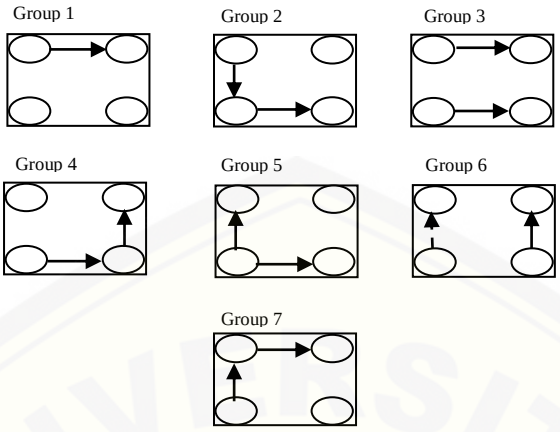

Figure 7. Students' activity in the third meeting in the first experimental class.

Descriptions: ⟶ : the students asked
⇢ : the students expressed their answers or guided their friends

From the results of observations on the students' activities during 3 meetings, all groups conducted the cooperation activity in the group. The group cooperation in the third meeting was more active than in the second meeting, this showed the difficulty level of the question in the third meeting was more difficult than in the second meeting so there were some students who needed others, even though there were some students who still did it individually with less number than in the second meeting.

In the second experimental class, jumping task-based problem solving learning. The learning material was developed to make the students able to solve the problem in the jumping question so it influenced their higher order thinking skills. During the learning activity, the observer observed the implementation of learning done by the model teacher and observed the students' activity. In the class IX E as the second experimental class, this learning was done in 3 meetings, as follows:

The first meeting in class IX E (Second Experimental Class)

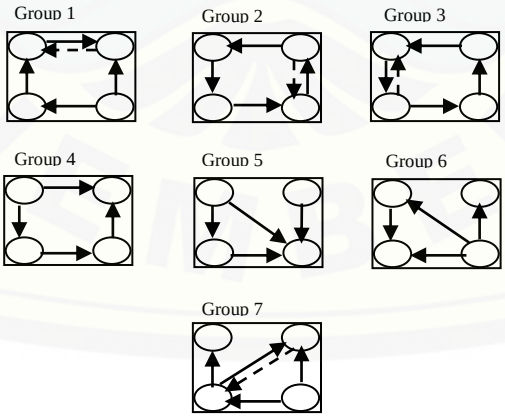

Figure 8. Students' activity in the first meeting in the second experimental class.

Descriptions: ⟶ : the students asked
⇢ : the students expressed their answers or guided their friends

The students' activity in the second experimental class was very good, in the discussion activity, all groups were enthusiastic and active so the students with low ability were excited to do the jumping task through the discussion with their friends in the group. So, the cooperation in groups run actively and stimulated the students' higher order thinking. The problem solving learning process in

the second experimental class contained the higher order thinking components consisting of analysing, evaluating and creating.

The second meeting in class IX E (Second Experimental Class)

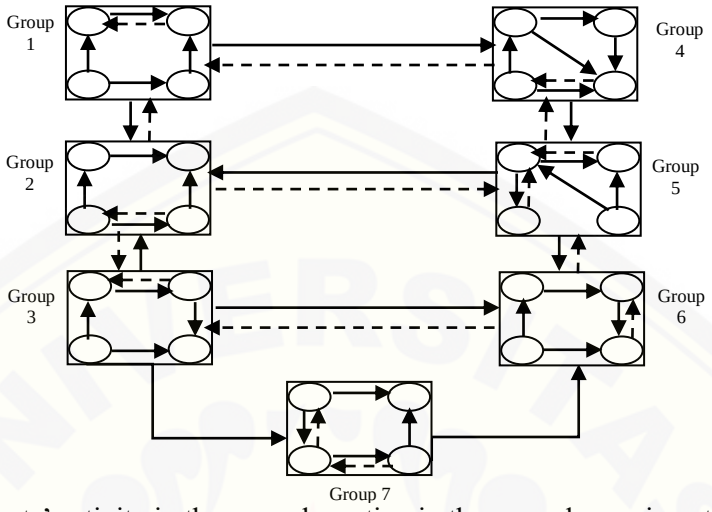

Figure 9. Students' activity in the second meeting in the second experimental class.

Descriptions: ⟶ : the students asked
⇢ : the students expressed their answers or guided their friends

On the 2nd (second) meeting, the students' activities were more interactive since there was a discussion between groups. Thus, each group worked hand-in-hand to solve the problem with agility and enthusiasm. Each group was more active in doing his activity, so that they also encouraged the low-ability students to give it a try on jumping task by discussing with their friends within group

The 3rd (third) meeting in Class IX E (Second Experimental Class)

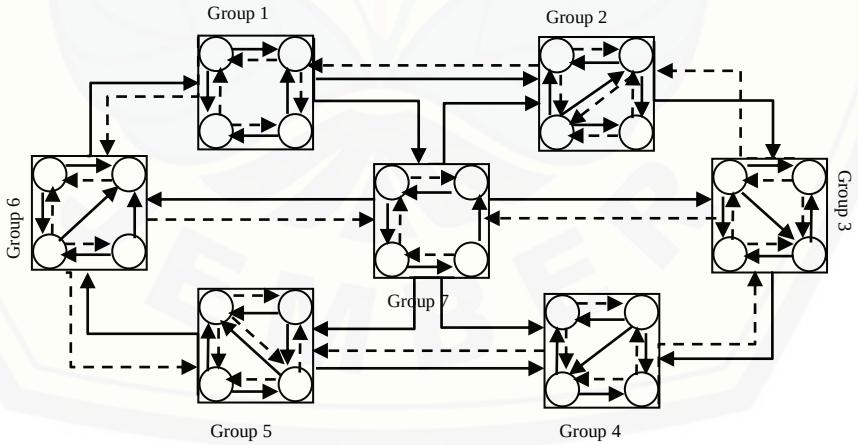

Figure 10. Students' activities on the 3rd (third) meeting 3 in the experimental class 2.

Description: ⟶ : the student asking
⇢ : the student revealing his answer or helping his friends

On the 3rd (third) meeting, the teacher arranged the seats in the classroom to make each group easier in communicating with each other and the classroom's atmosphere became conducive. Each student on the 3rd meeting got used to working on the jumping task question through the discussion done within the members of his group of other groups. So that, each group built effective communication, worked hand-in-hand to solve the problem with agility and enthusiasm

During the learning process in the control class, 4 meetings were conducted by using Direct Instruction as conventional technique in which the teacher as the center in delivering the material and giving the sharing questions ro avoid the boredom in learning. It gave an impact to the students as there were many of them who did not want to give it a try in working on the questions given by the teacher, they tended to copy their friends' answers so that they had no effort and enthusiasm to work on problems and the monotonous atmosphere in classroom did not show the students' participation

Based on the observation, the students' activities during 3 meetings are drawn on Figure 11

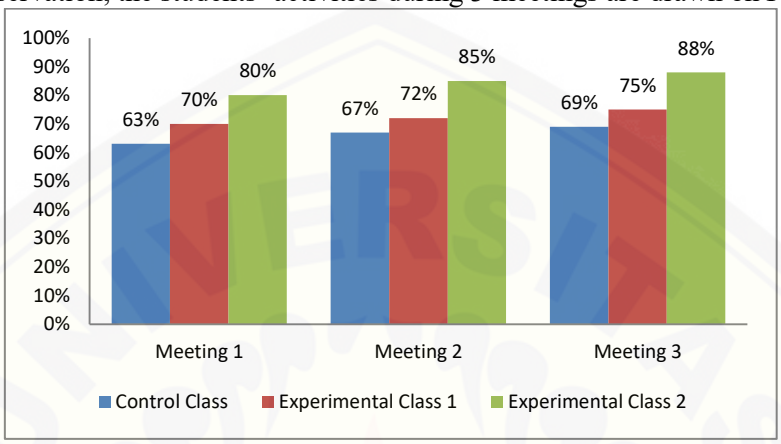

Figure 11. The recapitulation of students' activities during 3 meetings.

Figure 11 shows that during three meetings, the average of students' activities in the control class was 66%, in the experimental class 1 was 72% while in the experimental class 2 was 84%. The students' activities in class IX E (experimental class 2) showed that the students were active during the learning process; it proved that jumping task-based problem solving learning reached the effectiveness criteria

The syntax of jumping task-based problem solving learning was carried out in experimental class 2. The following table 2 presents the syntax of jumping task-based problem solving learning:

Table 2. The syntax of *jumping task*-based *problem solving*.

Stages	Description
The stage of understand the problem (*understand the problem*)	1. The students discussed the problems given by the teacher, they were able to know the most important parts of the problem so that they could determine the objectives they wanted to achieve. Through this process, they were expected to give questions about what was known and asked. 2. One of the most important parts on this process was the students were capable in explaining the questions by using their their own sentences. The teacher gave them time to reflect any facts which they thought relevant to their objectives and solutions of the problems.
The stage of devise a plan (*devise a plan*)	At this stage, the students were in a discusiion of devising a plan to solve the problems based on the information or data by linking them to previously studied-facts in various ways; they involved guessing, sketching diagram, making table, identifying pattern, making analogy.
The stage of carry out the plan (*carry out the plan*)	At this stage, the students carried out what they already planned by interpreting the information provided in mathematical form, implementing all strategies during the calculation process to produce the final solution of the problem.

Stages	Description
The stage of looking back (*looking back*)	At this final stage, the students re-examined the obtained results by looking back to all important information that were identified as well as all calculation that were done before. At this stage, the students were also expected to be able to find out other alternative solutions.

3.4. The Questionnaire of Students' Responses

Learning instruments were considered effective if the number of students who gave positive responses were ≥80% of the number of tested subjects [7]. The recapitulation results of students' responses are shown on Figure 12

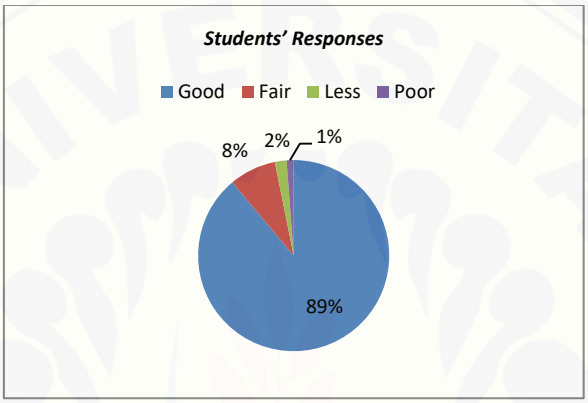

Figure 12. The Questionnaire Results of students' responses.

According to the analysis of each question item on the questionnaire of students' responses on Figure 12, the overall percentage which revealed positive responses was 89%. It showed that the students' responses on the developed learning instruments were positive. In relation to the predetermined criteria, it can be said that the learning instruments were effective.

Based on the results of the students' activities which were classified as effective, the syntax implementation of problem solving learning was under good criteria, the students' responses to the learning which were developed brought up positive responses so that the developed learning instruments in this research fulfilled the effective criteria.

3.5. The effect of the implementation of jumping task-based problem solving learning on the students' higher order thinking skills

On the 4th (fourth) meeting in each class, the learning outcomes test was carried out, so the data shown on Figure 3 were obtained

3.5.1. The students' higher order thinking skills based on post-test done in the control class

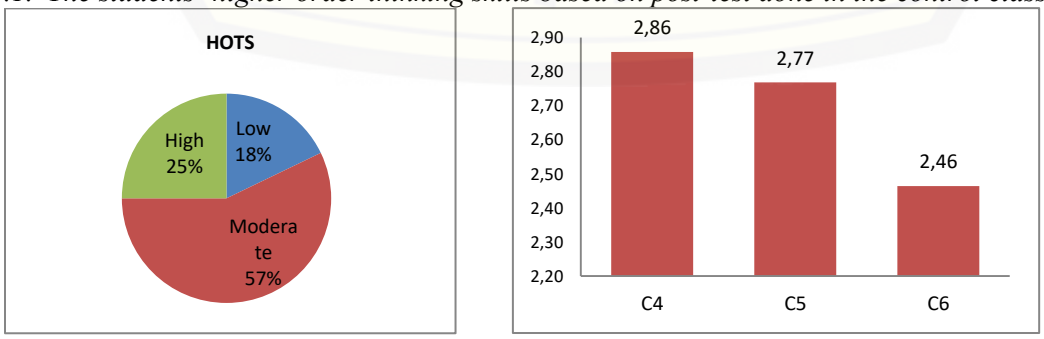

Figure 13. HOTS in the control class.

As shown on Figure 13, the percentage of HOTS in the control class was 18% in which it belonged to low category, 57% belonged to moderate category and 25% belonged to high category. On Figure 13; based on the analyzing ability (C4), the mean score was 2.86; based on the evaluating ability (C5) the mean score was 2.77; based on the creating ability (C6), the mean score was 2.46

3.5.2. The students' higher order thinking skills based on post-test done in the experimental class 1

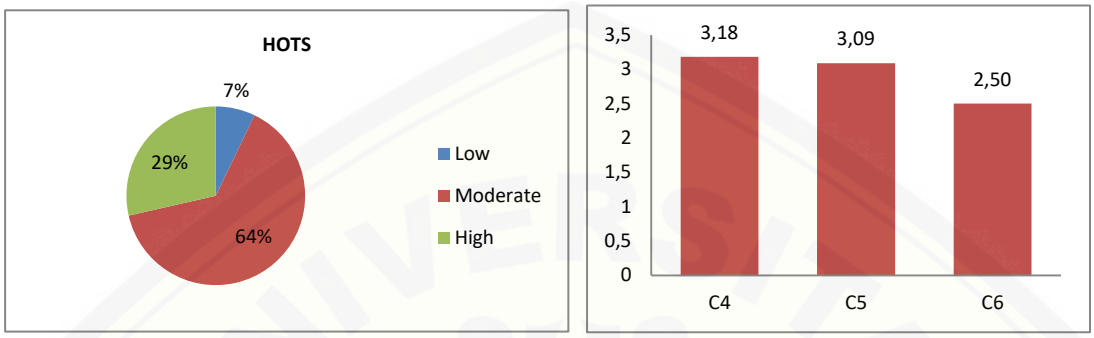

Figure 14. HOTS in the experimental class 1.

As drawn on figure 14 above, HOTS obtained in the control class was 7% in the low category, 29% was in the moderate category and 64% was in the high category. On Figure 14 regarding the analyzing ability (C4), the mean score was 3.18; regarding evaluating ability (C5), the mean score was 3.09 and on the creating ability (C6), the mean score was 2.5

3.5.3. The students' higher order thinking skills based on post-test done in the experimental class 2

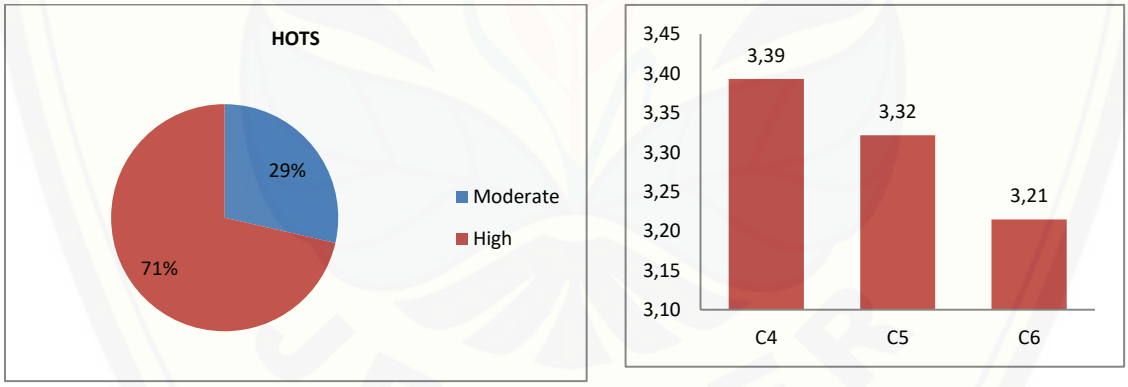

Figure 15. HOTS in the experimental class 2.

As seen on Figure 15, HOTS obtained in the control class was 29% which belonged in the moderate category, 71% was in the high category, and 0% was in the low category. Whilst on Figure 15 concerning the analyzing ability (C4), the mean score was 3.39; on the evaluating ability (C5), the mean score was 3.32 and on the creating ability (C6), the mean score was 3.21

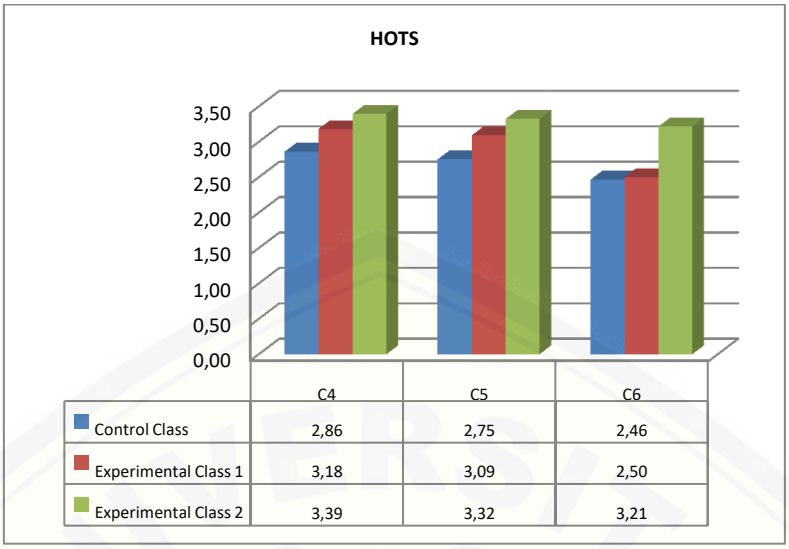

Figure 16. The students' higher order thinking skills.

The aspects and indicators of students' higher order thinking skills consisted of analyzing, evaluating and creating [6,9]. Figure 16 shows that there were some differences found in the control class, experimental class 1 and experimental class 2. In the experimental class 2, it was proven that there was a significant effect compared to the other two classes

Data analysis is used to determine the effect of jumping task-based problem solving learning on higher order thinking skills preceded by a prerequisite test. It was the first step taken before the hypothesis test which included tests for normality and homogeneity. The normality test used the Kolmogorov-Sminov statistics which summarized in the table below;

Table 3. Normality test using the kolmogorov-sminov.

		Kolmogorov-Smirnov		
	Class	Statistic	df	Sig.
Post test	Control	.155	28	.081
	Experimental 1	.163	28	.056
	Experimental 2	.150	28	.109

The data came from populations that were normally distributed whenever the probability value (p-value) was greater than the significance value of 0.05. Table 4.14 shows that the significance value of the higher order thinking skills in the control class was sig = 0.081, in the experimental class 1 sig = 0.056 and in the experimental class 2 sig = 0.109. Based on these results it can be concluded that the three classes were normally distributed.

Table 4. Homogeneity test using levene's test.

	Levene Statistic	df1	df2	Sig.
HOTS	1.182	2	81	.312

The results of the post-test homogeneity test are summarized on table 4 above. Levene's Homogeneity Test showed the value of sig. for higher order thinking skills, which was 0.312. So it can be concluded that the assumption of homogeneity of variance was fulfilled. Since the significance value obtained was >0.05, then the data had the same or homogeneous variance. Thus it can be

assumed that the differences that occurred in this research due to the treatment given was the application of learning instruments of jumping task-based problem solving.

Based on the prerequisite test, obtained that post-test data were normally distributed and had the same or homogeneous variance. Therefore the data analysis used parametric test which was one-way ANOVA test. The results of data analysis are shown on the following table.

Table 5. One-way ANOVA test.

HOTS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	111.452	2	55.726	13.757	.000
Within Groups	328.107	81	4.051		
Total	439.560	83			

The one-way Anova test results showed the value of sig. 0,000 ($p < 0.05$) so that it is concluded that there was a significant influence between the control class and the experimental class 2.

Table 6. Bonferroni test.

HOTS
Bonferroni

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Experimental 1	-.64286	.52477	.672	-1.9258	.6401
	Experimental 2	-2.42857*	.52477	.000	-3.7115	-1.1457
Experimental 1	Control	.64286	.52477	.672	-.6401	1.9258
	Experimental 2	-1.78571*	.52477	.003	-3.0686	-.5028
Experimental 2	Control	2.42857*	.52477	.000	1.1457	3.7115
	Experimental 1	1.78571*	.52477	.003	.5028	3.0686

*. The mean difference was significant at the 0.05 level.

Based on Table 6, it can be seen that the higher order thinking skills in the three classes was significantly different (indicated by *). The experimental class 2 had an average difference of 1.78571 with the experimental class 1 and 2.42857 with the control class. The experimental class 1 had an average difference of -1.78571 with the experimental class 2 and 0.64286 with the control class.

From these results, it can be concluded that the experimental class 2 has more significant influence than the experimental class 1 and the control class and experimental class 1 has a more significant effect than the control class. The conclusion from this result can be written with the ability to order higher in experimental class 2> experimental class 1> control class

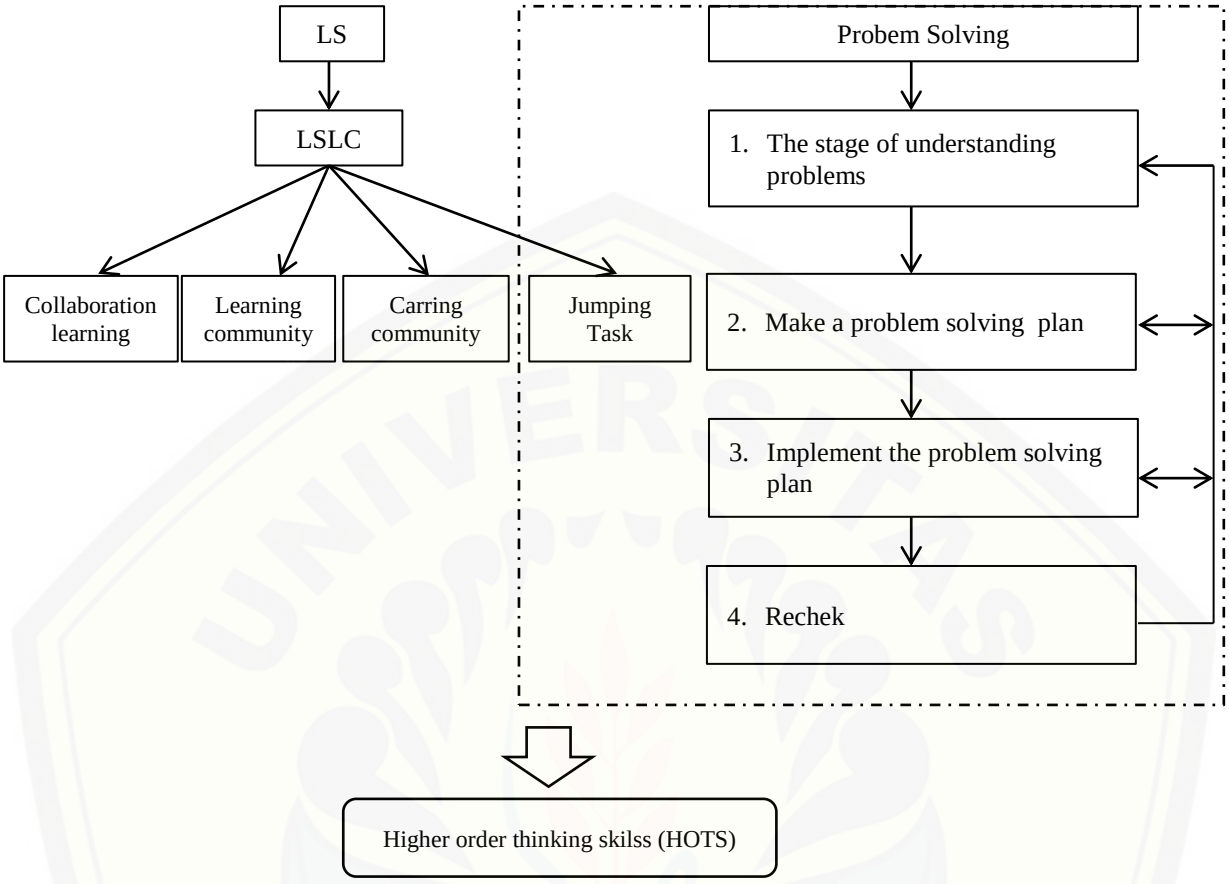

Figure 17. The application of jumping task-based problem solving had an effect on the students' HOTS.

Description: ——→ : divided into/stages
---------- : Jumping task-based problem solving
⇨ : The application of jumping task-based problem solving had an effect on the students' HOTS

Based on observations from observer and teacher, at each meeting was made as a finding in the process of learning activities. The teacher and the observer discussed the findings related to the improvements in learning. In learning activities, jumping task-based problem solving affected the activities and ways of thinking of students who initially tended to be individuals by ignoring their friends, turned into active students in learning with mutual care and sharing knowledge possessed, so that stimulating students to be more active in class. With this learning model, the teacher's role was only as a facilitator and students played the main role by group learning and discussion [4]. This is in line with Hobri's research, the application of student worksheets combined with the concepts of collaborative learning, learning communities, caring communities, and jumping assignments, student activities were very good, and overall students' learning achievement were very high [4,5].

In relation with HOTS, after the students applied jumping task-based problem solving learning with Polya steps, it affected the students' thinking processes because students felt challenged to study harder so they were able to solve problems correctly. The jumping task had a positive impact, in which students felt more challenged and motivated to be more active in learning independently and discuss with friends, increased confidence and improved creative and critical thinking [12]. HOTS made

students manage their knowledge to come up with new ideas/knowledge as a solution for solving problem correctly [14]

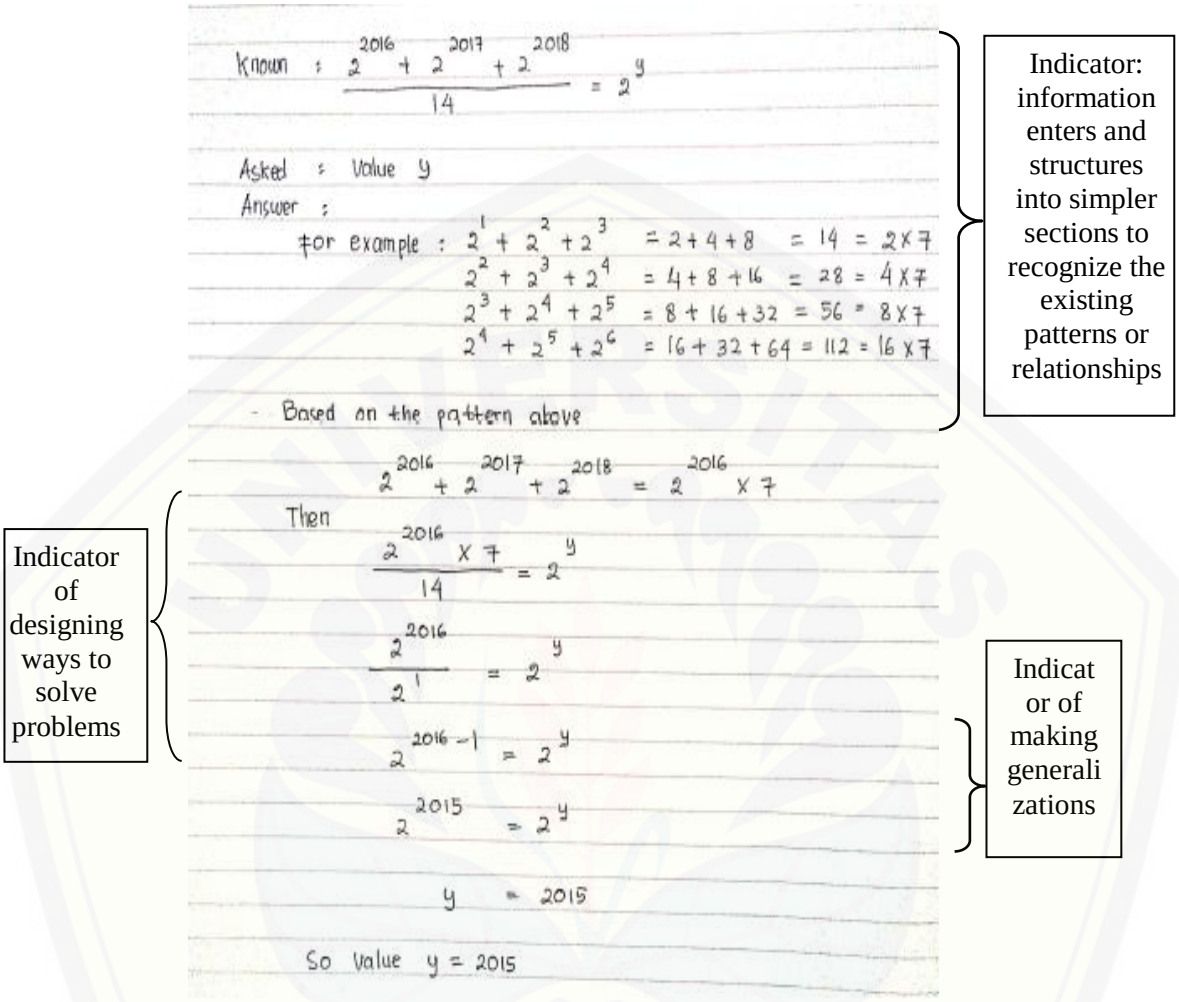

Figure 18. The results of students' answers on higher-order thinking skills.

From the students' answers on Figure 18, it can be seen that these students had higher order thinking skills because they met 3 indicators. In analyzing indicator, the students were able to analyze questions by dividing information into simpler parts so as to obtain the existing patterns or relationships. In evaluating indicator, the students were able to make decisions based on the existing patterns. In creating indicator, the students made generalizations so that the right answers were obtained. Thus these students had higher order thinking skills [6,9].

Students with lower order thinking skills had not been able to show the three indicators of the ability to create as the answers presented on the following figure.

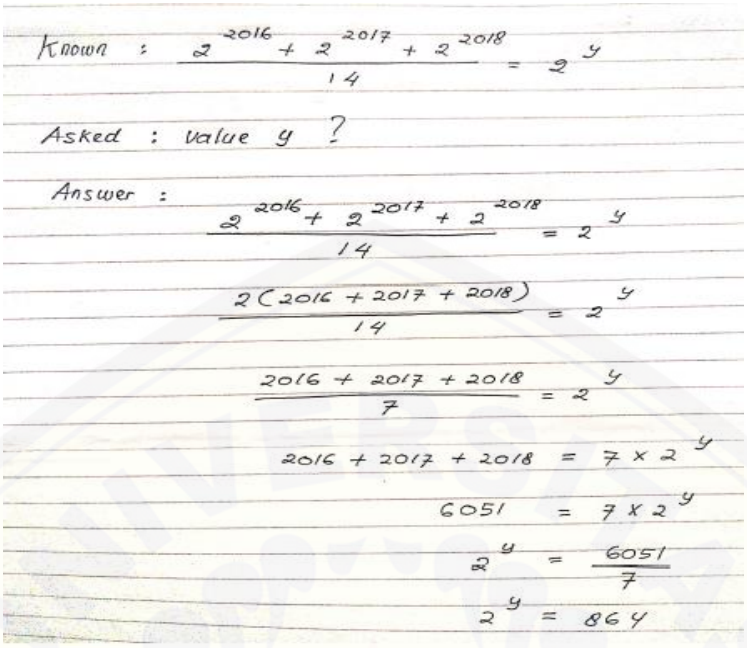

Figure 19. Students' answers with lower skills category.

Following are the results of the teacher and student interviews with the answers on Figure 19

Teacher : Did you know how to determine the value of y?
Student : Yes, I did Ms.
Teacher : Can you please explain how to determine the value of y based on the results of your work?
Student : The numerators were divided into 2, so 2 (2016 + 2017 + 2018) then crossed out with 14 Ms.
Teacher : Why were the numerators divided into 2?

The student seemed confused by the answer. After the teacher gave an explanation, the student realized that the answer was wrong. Thus it can be concluded that these students did not have the ability level C6 yet. They had not been able to analyze the information came in and structured it into simpler sections to recognize the existing patterns or relationships.

In Indonesia, the thinking skills of most students were still low in solving complex problems. Therefore, to deal with such conditions, the researchers referenced jumping task-based problem solving learning so that the learning process went actively and fun so that it affected HOTS.

4. Discussion

Mathematical learning findings using jumping task-based problem solving had been fulfilled. This was indicated by: (1) the post-test results showed a classical completeness of 89%. (2) during learning, the students were active and students' higher order thinking skills improved compared to the control class (3) there was a significant effect on the higher order thinking skills in the experimental class 2. Based on the observations, the learning process went very well with an average percentage of 90% in each meeting. The results of the questionnaire responses of students showed an average of 84% which indicated that the students gave positive responses. In the control class found indicators C4, C5 and C6 respectively 61%, 66% and 58%, in experimental class 1 indicators C4, C5 and C6 were 78%, 75% and 72% while in experimental class 2 were 85% , 82% and 88%. The one-way Anova test results showed a significant value of 0,000 ($p \leq 0.05$), this showed a significant effect on the experimental class 2.

5. Conclusion

Based on the results of the data analysis, the researchers concluded that the learning tool of jumping task-based problem solving on Power of numbers and form of root material in class IX of Junior High School was valid, practical, and effective. In addition, the application of jumping task-based problem solving learning had a significant influence on the students' higher order thinking skills. In the experimental class 2, obtained that the students' higher order thinking skills reached 85% on the indicator of analyzing, 82% on the indicator of evaluating and 88% on the indicator of creating. Positive responses from students and teachers toward the jumping task-based problem solving learning affected the students' higher order thinking skills.

The application of jumping task-based problem solving learning significantly affected the students' higher order thinking skills, especially on Power of numbers and form of root material. It can be suggested that jumping task-based problem solving learning and student worksheets based on higher order thinking skills indicators is one alternative learning model that is useful for classroom learning.

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References

[1] Hobri, Ummah I K, Yuliati N and Dafik 2020 The Effect of Jumping Task Based on Creative Problem Solving on Students' Problem Solving Ability *International Journal of Instruction*, **13**(1)

[2] Harisudin L 2019 April The development of mathematics learning tools through the bridge games based on lesson study for learning community and its relationship with the higherorder thinking skills in probability theory In *Journal of Physics: Conference Series* **1211**(1) 012075

[3] Hobri 2016 Lesson Study for Learning Community : Review of Short Term Results on Lesson Study V in Japan 2016 National Seminar Proceedings on Mathematics Education Study Program FKIP Madura University

[4] Romlah S, Prihandoko A C, Safitri J, and Nazareth E 2018 September Students' metacognitive ability in mathematical problem-solving learning based on lesson study for learning community (LSLC) In *Journal of Physics: Conference Series* **1088**(1) 012064

[5] Hobri and Susanto 2016 Collaborative Learning, Caring Community, and Jumping Tasks Assisted by Student Worksheets Based on Scientific Approach: One Alternative to Mathematics Learning in the MEA Era *Proceedings of the National Mathematics Seminar and Learning* 7–17

[6] Hobri, Septiawati I and Prihandoko A C 2018 High-order thinking skill in contextual teaching and learning of mathematics based on lesson study for learning community

[7] Hobri 2010 *the Methology of Research and Development* Jember Pena Salsabila

[8] Jonassen, D H 2000 Toward a design theory of problem solving *Educational Technology Research and Development* Desember 2000 **48**(4) 63-85

[9] Krathwohl, D R 2002 "A revision of Bloom's Taxonomy: An overview"*Theory into Practice*, **41**(4)

[10] Nofrion 2012 The improving of learning activity through jumping task in Geografi Learning *Jurnal Geografi* **9**(1), pp 11-20

[11] Kusumawati R and Hadi A F 2019 April Implementation of integrated inquiry collaborative learning based on the lesson study for learning community to improve students' creative thinking skill In *Journal of Physics: Conference Series* **1211(1)** p 012097 IOP Publishing

[12] Saiful, Susanto, Hobri 2019 The Students' Metacognition Analysis Through Jumping Task

Based On Lesson Study For Learning Community *Journal of Physics: Conference Series* **1265**

[13] Sugiyono 2017 Combined Research Methods (Mixed Methods) (Bandung: Alfabeta) 17

[14] Ridlo Z R, Dafik, Prihandini R M, Nugroho C I W, and Alfarisi R 2019 April The effectiveness of research-based learning with computer programming and highly interactive cloud classroom (HIC) elaboration in improving higher order thinking skills in solving a combination of wave functions In *Journal of Physics: Conference Series* **1211**(1) 012049