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Pattern of Problem Solving Skill Reviewed Based on Student Cognitive Style After Experienced Problem Based Learning Model with Ethnomathematics Nuances

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Abstract

The 4Cs in 21st century skills consist of critical thinking, creativity, communication and collaboration. The skills are very importance in solving problem should be owned by students to face current century global advancement. This research aims to describe problem solving skill pattern of students based on cognitive style after being taught by Problem Based Learning (PBL) model with Ethnomathematics nuances. This mixed method research used sequential explanatory design. The qualitative research part was conducted first and then continued by quantitative research part. The qualitative research used technic and source triangulation. This study consisted of 23 subjects. They were selected based cognitive style test by using Matching Familiar Figure Test (MFFT) at fifth grade of Public Primary School Citimun I, Sumedang. Techniques of collecting data were observation, test, interview, and documentation. Reflective and Impulsive students could understand problems, design solution, and promote problem solving although they were incapable of accurately rechecking. Slow-Inaccurate students could understand problems but they were incapable to plan solution and solve problem. They also could not do rechecking accurately. It could be concluded that Reflective - Impulsive cognitive style typed students had more dominant in problem solving skill than Slow-Inaccurate cognitive typed students. Thus, PBL model with ethomathematics nuances can improve students' problem solving skills.

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INTRODUCTION

21st skill century becomes the direction of current educational development. According to Fadel, as quoted by Ubay & Rosdiana (2018), stated that 21st skill consists of critical thinking, creativity, communication, and collaboration. Thus, students will not only learn basic science but also they should think critically, communicate, collaborate, and creativity. In critical thinking problem solving is needed. It is in line with Ulya (2015) whom stated that problem solving skill should be mastered by students to habituate them facing various problems. Prabawa & Zaenuri (2017) found that student's problem solving skills in Wates residence, Yogyakarta were not excellent because they could not master mathematics notations. Lintang, *et al.,* (2017), found that problem solving skill of students in Public Primary School Nguter, Sukoharjo municipality were low.

From those previous studies in various regions, it was found that mainly faced problems embodied into low students' skills to solve problems. It is in line with observational result at Public Primary School Citimun I, Sumedang municipality, which showed that students' problem solving skills were still low.

In fact, according to Mulyati (2017) that problem solving skill had not become main attention of teachers. Jannah & Zuliana (2014) found that students were seldom to have problem solving skill training since their teachers frequently gave questions to work on as based on the given examples. Students were not trained to solve problems by themselves.

In another study, it was found that students' cognitive skills could influence problem solving skills of them (Ulya, 2015). It was strengthened by Panjaitan (2016) that effective learning process could be influenced by individual differences among students. The difference dealt with cognitive styles. Cognitive style is tendency of students to utilize their cognition or reasoning ways consistently (Kozhevnikov, 2007). According to Rozencwajg & Corroyer (2005) cognitive styles are grouped into four groups namely Reflective (slow and conscientious), Impulsive (fast and inaccurate), fast-accurate, and Slow-Inaccurate. Therefore, students are demanded to find solution in solving problems in which the solutions may be varied due to different cognitive styles one to another. It is in line with Vendiagrys, *et al.,* (2015) whom stated that cognitive style differences could be an alternative to solve problem.

One of learning models which could improve problem solving skill reviewed based on student cognitive style is Problem Based Learning (PBL) model. It is due to the model uses real factual problem as learning context with purpose to improve problem solving skill and thinking pattern of students in obtaining knowledge and main concept of a material (Utami, 2013). Besides, the model uses problem as learning principle in which students learn from a factual problem (Supiandi & Julung, 2016). To make PBL implementation more contextual, learning mathematics should be correlated to Ethnomatematics. Hidayati & Restapaty (2019) stated that problem based learning model based ethnomatematics was effective to student problem solving skill.

Sirate's findings (2012) showed that ethnomatematics implementation could be a medium to motivate students, stimulate them, and solve saturation or difficulty in learning mathematics. It is due to ethnomatematics is a part of daily lives owned by students from their social cultural environment as initial science conception. Thus, mathematics teaching for anyone should be adjusted to that individual's environment because mathematics could be taken from surrounding cultures of students. It could be used as actual learning source for students (D'Ambrosio, 1985). As stated by Kencanawati & Irawati (2017) that learning mathematics and culture could make students figuring out the benefits of learning mathematics within cultural perspective. In addition, conveying material in learning with ethnomathematics must be specifically designed with the growing culture of the surrounding environment. Thus learning mathematics

becomes a special attraction for students. (Farda, *et al.,* 2017).

SDN Citimun I is one of Primary Schools in Sumedang. Sumedang various cultures from customs, languages, arts, crafts, special foods, place of tourism, and historical heritage. One example of Sumedang historical heritage is *Kereta Kencana Naga Paksi* (Dragon Paksi Wagon), while for tourism it consists of the *Tampomas* Tourism Bus, *Mahkota Binokasih* Statue Roundabout, *Alamsari Sumedang* Roundabout, *Jatigede* Lake, *Cigorobog* Waterfall, etc. From those cultures, there is something in common which a medium in learning mathematics be.

Kerata Kencana Naga Paksi and *Tampomas* Tourism Bus can be used to explain the concepts of velocity, travel time and distance because both cultural objects can move or walk. In addition, the *Mahkota Binokasih* Statue Roundabout can be used to explain debit, volume and time, because the *Mahkota Binokasih* Statue Roundabout has a pool containing water and has a volume of water.

The research formulations of this research is how problem solving skill pattern of the students reviewed based on cognitive style after being intervened by PBL model with Ethnomathematics nuances is. The purpose of this research is to find out the pattern of the students' problem solving skills reviewed from cognitive styles after being intervened by PBL with Ethnomathematics nuances is.

METHODS

This mixed method used research sequential explanatory design. Analysis of problem solving skill was done by Polya (1973) and the indicators were based on National Education Department as quoted by Wardhani (2008). The analysis consists of (a) understanding problem stage in which students could (1) perform problem solving skill and (2) organize data, select relevant information to solve problems; (b) planning problem stage in which students could (3) select appropriate problem solving approach and method; (c) solving stage in which students could (4) present problems mathematically in various forms; and (5) develop problem solving strategy; (d) rechecking stage in which students could (6) interpret mathematics model of a problem, and (7) solve irregular problems indicated by creating alternative answers.

The research population consisted of 8-fifth graders in Cluster 4, Cimalaka district, in academic year 2019/2020. The technique of sampling was cluster random sampling. The techniques of collecting data were observation, problem solving skill test, interview, and documentation. To determine cognitive style, Matching Familiar Figure Test (MFFT) was used as the instrument (Al-Silami, 2010).

Quantitative data analysis was initially done before the learning. It was obtained from problem solving skill test which consisted of: (1) average similarity test with Minimum Passing Grade (MPG) score of 68; (2) classical passing grade 75%, (3) proportional difference test, and (4) variance test. The qualitative data analysis was done by reducing, presenting, and concluding data on the selected research subjects based on their cognitive styles.

RESULTS AND DISCUSSION

Quality of PBL Implementation with Ethnomathematics Nuance

Quantitative research examined how implementation of PBL quality with Ethnomatematics nuance was. An excellent learning quality could be determined by learning success. Learning success in this research could be seen from problem solving skill of experimental group students in which obtained 77.61%, higher than the control group with 67.95%. The effectiveness was supported by several stages started from planning, implementing, and assessing learning.

Planning learning in this research could not be separated from research instrument made by the researcher, validation of experts about the research instrument and teaching instruments, such as syllabus, lesson plan, learning material, worksheet, problem solving skill test, observational sheet of teaching and learning,

and interview guideline which obtain average score 4.31 with maximum score of 5, categorized very excellent. Dealing with PBL model implementation with Ethnomatematics nuances done within 4 meetings, it was found percentage average 82.12%, categorized excellent.

Dealing with learning outcome score in this research, it was measured by hypothesis tests, consisting of average test, classical accomplishment test, proportional difference test, and variance test. This test was taken from the final problem solving ability test. Problem solving ability test consists of 6 problem solving items form description. The test was followed by 49 students consisting of 23 students of Class V SDN Citimun I (Experiment Class) and 26 students of Class V SDN Cilimbangan (Control Class). In Table 1.

Table 1. Results of Tests for Final Problem Solving in Experiment and Control Classes

Description	Class Experiment	Class Control
Lots of Students	23	26
Average Value	77.61	67.95
Maximum Value	88	80
Minimum Value	52	47
Variance	61.32	50.29
Standard Deviations	7.83	7,.09
Mastery Learning	22	15

Before promoting the test, final problem solving skill data test was examined to ensure it was normal and homogeneous. The significance score of the final data normality of experimental group: 0.200 > 0.05 and was significant for final data homogeneity: 0.904 > 0.05. Thus, it could be concluded that final problem solving skill data was from normal and homogeneous population.

On problem solving skill average test, MPG was used to find out whether the average of the skill could pass the MPG or not. The MPG of problem solving skill was 68. Hypothesis test used one sample t-test. The results are presented in Table 2.

Table 2. Average Test Result

	Score Test = 68		
	t	df	Sig. (2-tailed)
Experimental Group	5.887	22	0.000

The average test obtained significance (α) = 0.000 < 0.05. Then H_0 was denied. It meant the average of experimental group students' problem solving skill reached MPG score of 68.

The classical accomplishment test could be seen from proportion of the students passing the MPG whether it surpassed 75% or not. It was obtained data that students passing MPG (68) consisted of 22 students from all 23 experimental group students (n). Thus, from the data, it was obtained z count = 2.29. Since the score of z = 2.29 > $z_{0,475}$ = 1.95, H_0 was denied. It meant the proportion of students' accomplishments taught by PBL with ethnomatematics nuances was 75%.

Proportional comparison test was used to find out difference of students' numbers passing minimum passing grade of problem solving skill taught by PBL with ethnomathematics nuances and the numbers of students reaching minimum passing grade on PBL model. The used criterion was H_0 for $_{z < z\alpha.}$ The score of z_α was obtained from z table with significance level 5%.

Based on final problem solving skill test, it was obtained the data that z count = 3.24. Score of $z_\alpha = z_{0,05}$ = 0.12. Since score of z = 3.24 > $z_{0,05}$ = 0.12, thus H_0 was denied. It meant the proportion of the students' problem solving skills taught by PBL with ethnomathematics was higher than those taught only by PBL.

The average test was used to find out problem solving skill difference between groups taught by PBL with ethnomathematics to group taught by only PBL. The test used independent sample t-test. The results are presented in Table 3.

Table 3. Average Comparison Test Result

	Result of t-test for average difference test		
	t	df	Sig, (2-tailed)
Final Data	4.524	47	0.000

Based on the average comparison test result, it was obtained significance score 0.000 < 0.05. Thus, H_0 was denied. It meant the average of the students' problem solving skills taught by PBL model with ethnomathematics was than those taught only by Learning PBL model.

Concerning with quantitative research which had been done, it was obtained information that: (1) average of the students' problem solving skill taught by PBL with ethnomathematics nuances had passed MPG with MPG of mathematics problem solving skill was 68; (2) proportion of the students' accomplishment taught by PBL with ethnomathematics nuances was higher than 75%; (3) proportion of problem solving skill accomplishment taught by PBL with ethnomathematics was higher than proportion of the students' problem solving skill taught by PBL; (4) average of problem solving skill taught by PBL with ethnomathematics nuances was higher than problem solving skill of students taught by PBL.

During learning with PBL with ethnomathematics nuances, the students were active because they had experienced and seen their own cultures. Thus, their prior knowledge about the presented problems was stronger. Thus, students became interested in adjusting the problems. It is in line with Nisak & Istiana (2017) stating that PBL model could provide chances for students to develop their mathematics problem solving skills.

Besides that, during learning, students were enthusiastic to respond what was asked by the teacher. As for example, in the beginning of teaching, the teacher showed an icon of Sumedang legacy in the form of a tourism monument - *Mahkota Binokasih* Statue Roundabout. It was known by almost all students. Then, when a question session was done about the Roundabout, the students responded well.

While the teacher connected *Mahkota Binokasih* Statue Roundabout picture to problem solving with velocity material, students had prior knowledge from their daily experiences. It is in line with Vygotsky theory as quoted by Ristiani (2014). Students have spontaneous knowledge from their daily lives and scientific knowledge from classroom. Thus, problem solving dealing with debit on *Mahkota Binokasih* Statue Roundabout picture was generally taken by the students spontaneously from their daily lives.

While discussing in their teams, the students seemed actively participating in their group by discussing on the given worksheet. There were several examples of debit that was connected to *Mahkota Binokasih* Statue Roundabout in the forms of figures and videos. The images of the *Mahkota Binokasih* Statue Roundabout can be seen in Figure 1.

Figure 1. *Mahkota Binokasih* Statue Roundabout (Zaidan, 2019)

The examples of problem solving problems based on Figure 1 is:

The Sumedang Regency Government will replace water in the Tugu *Mahkota Binokasih* Statue Roundabout pool. Concerning agencies use the Water Tank to fill the Pool full, the time taken to fill the pool is 1.5 hours with a Water Tank pipe discharge of 100 liters / minute. What is the volume of the *Mahkota Binokasih* Statue Roundabout pool, and if 1 liter of water costs Rp. 1000, how much money does the government have to pay to fill the *Mahkota Binokasih* Statue Roundabout *Pool*. Analyze how to solve the problem and check the results of the answers, and make alternative answers.

Students were challenged to solve problems which they often meet since the given problems to them had connection to their local culture. According to Brunner, as quoted by

Lestari (2014), on inactive and iconic stage, students could see, feel concrete object, and show concept in the form of visual or pictorial images. In this case, students ever seen the picture or directly saw *Mahkota Binokasih* Statue Roundabout.

According to Piaget's cognitive development, as quoted by Juwantara (2019), students adapt and interpret with surrounding objects and events. Therefore, when students are given problems by using *Mahkota Binokasih* Statue Roundabout, students will not think abstractly anymore since they ever manipulated and experienced it.

Thus, it could be concluded that PBL model with ethnomathematics nuances was more effective in learning problem solving skill. Since PBL with ethnomathematics requires students to always solve irregular problems in which the students in the problems were described by a frequently seen and felt object, such as local culture.

Description of Problem Solving Skill Pattern

The qualitative research was done to describe problem solving skill patter reviewed based on cognitive styles. The test used MFFT (A-Silmi, 2010) from 23 research subjects. The detailed information could be seen on Figure 2 Cognitive Style Test Result Graphic

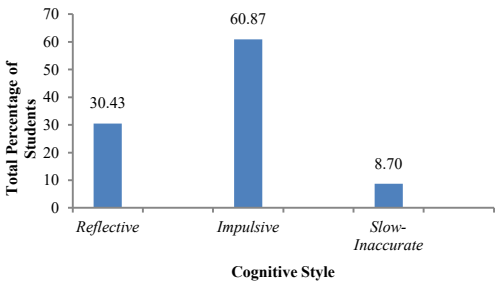

Figure 2. Cognitive Style Test Result

According to the data, it could be concluded that the proportion of subject data with Reflective and Impulsive cognitive style typed characteristics were dominant than Slow-Inaccurate cognitive typed students.The source and technique triangulation of problem solving skill test showed that.

Table 4. Problem Solving Skill of Students Reviewed based on Reflective, Impulsive, and Slow - Inaccurate Cognitive Style Types

Cognitive Style Types	Number of Subject	Question Number	Problem Solving						
			Understanding Problem		Planning Problem Solution	Solving Problem		Rechecking	
			Indicators						
			1	2	3	4	5	6	7
Reflective Subjects	7 Subjects	1	√	√	√	√	√	√	x
		2	√	√	√	√	√	-	x
		5	√	√	√	√	√	-	x
		6	√	√	√	√	√	√	x
Impulsive Subjects	14 Subjects	1	√	√	√	√	√	√	x
		2	√	√	√	-	-	-	x
		5	√	√	√	-	-	-	x
		6	√	√	√	√	√	√	x
Slow-Inaccurate Subjects	2 Subjects	1	√	√	√	√	√	√	x
		2	√	√	-	-	-	x	x
		5	√	√	-	-	-	x	x
		6	√	√	√	-	-	x	x

Remark: (√ : capable), (-: less capable), (x : in capable).

The described problem solving skill pattern is based on difficulty level. Therefore, the described problems were selected into number one, two, five, and six about velocity and debit. The explanation of Table 4 is shown below:

(1) From 7 Reflective cognitive typed students, they had problem solving patterns as follow: (a) they could understand properly problem number one, two, five, and six; (b) they could create problem solving plan accurately on number one, two, five, and six; (c) they could solve problems properly on number one, two, five, and six; and (d) only some of them rechecked, specifically on number two and five.

(2) From 14 Impulsive typed students, they had problem solving patterns as follow: (a) they could understand properly problem number one, two, five, and six; (b) they could create problem solving plan accurately on number one, two, five, and six; (c) they could solve problems properly on number one, two, five, and six; and (d) only some of them rechecked, specifically on number two and five.

(3) From 2 Slow-Inaccurate typed students, they had problem solving patterns as follow: (A) they could all understand problems well on number one, two, five, and six; (b) they were not capable to create problem solving plan properly, especially on number two, five, and six; (c) they could solve the problems well on number one, two, five, and six; and (d) they could not do rechecking well on number one, two, five, and six.

Generally, each research subject had various problems solving skill characteristic on number one, two, five, and six. The descriptions of problem solving skill pattern characteristics reviewed from Reflective, Impulsive, and Slow-Inaccurate cognitive styles are:

First, on understanding stage, all Reflective, Impulsive, and Slow-Inaccurate students could understand problems properly although they were still not careful. All subjects could show, organize, and select complete information data by writing what was known and asked. However, there were several research subjects had not been able to write properly about scale, scale symbol, unit of magnitude, and what was asked. The examples of the subjects' works are shown on Figure 3.

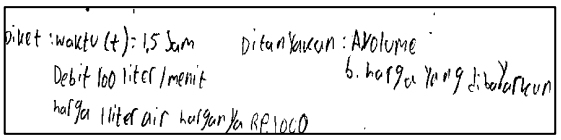

Figure 3. The Result of Reflective Cognitive Typed Students Written Test in Understanding Problem Number 2

Based on the Figure 3, it shows that the result of the Reflective cognitive typed students proved that they could understand by writing the known problems completely, started from time, debit, unit of 1 liter water), and write what was asked completely, such as volume and bill to pay. The Impulsive cognitive style typed students could be seen in Figure 4.

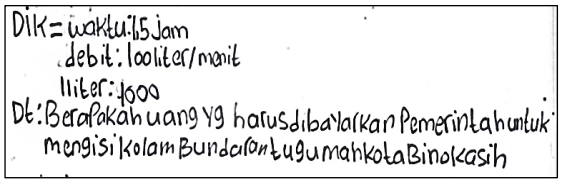

Figure 4. The result of Impulsive Cognitive Typed Students Written Test in Understanding Problem Number 2

From the Figure 4, it is obtained that Impulsive cognitive style typed students proved they could write what was known and asked but it was not complete in term of what was asked since they only wrote the volume. The Slow-Inaccurate cognitive style typed students could be seen in Figure 5.

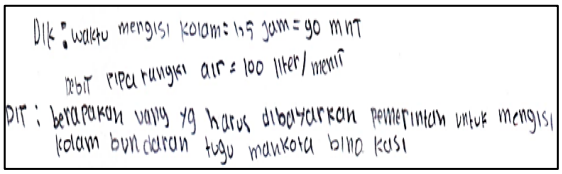

Figure 5. The Result of Slow-Inaccurate Cognitive Typed Students Written Test in Understanding Problem Number 2

Based on the Figure 5, it is known that the Slow-Inaccurate cognitive typed students could

understand problems by writing what was known and asked although it was not complete in term of writing the unit of 1 liter water as the known, and lack of writing the unit of volume as the asked.

Second, on planning problem stage of number one, two, five, and six, it was seen that those three student types could create problem solution plan accurately although there were several carelessness. Almost all students selected accurate problem solving method and approach. However, there was several carelessness from several subjects, such as writing the formula without any remarks and vice versa. The examples of the subjects' works are shown on Figure 6.

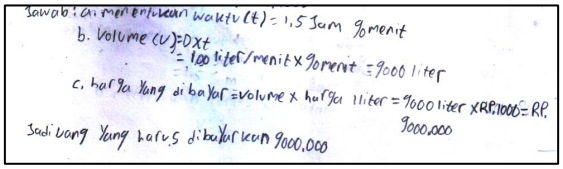

Figure 6. The Result of Reflective Cognitive Typed Students Written Test in Planning Problem Solution for Number 2.

Based on the Figure 6, it shows that Reflective cognitive style typed students could write the plan orderly and accurately started from time change volume determination by using the formula, and bill determination to pay. The Impulsive cognitive style typed students could be seen in Figure 7.

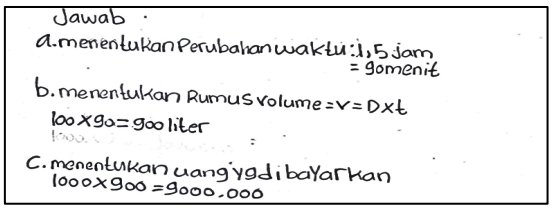

Figure 7. The Result of Impulsive Cognitive Typed Students Written Test in Planning Problem Solution Number 2

Based on the Figure 7, it shows that Impulsive cognitive style typed students could write the plan orderly and accurately started from time change volume determination by using the formula, and bill determination to pay. The Slow-Inaccurate cognitive style typed students could be seen in Figure 8.

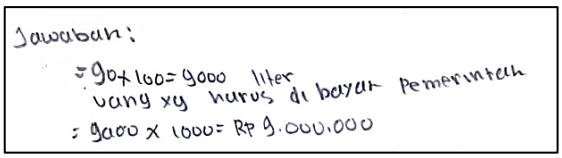

Figure 8. The Result of Slow-Inaccurate Cognitive Typed Students Written Test in Planning Problem Solution for Number 2

Based on the Figure 8, it was found that Slow-Inaccurate cognitive typed subjects could not plan problem solution in which they did not write the time changes and volume remarks. They only wrote the bill to pay.

Third, on solving problems number one, two, five, and six, Reflective and Impulsive cognitive typed students could solve problem but it did not happen to Slow-Inaccurate students. The examples of the subjects' works are show on Figure 9.

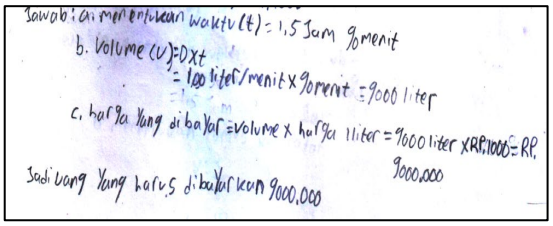

Figure 9. The Result of Reflective Cognitive Typed Students Written Test in Solving Problem Number 2

Based on the Figure 9, it shows that the written test result proved that the students could solve the planned problems orderly in term of time changes, volume formula writing, and bills to pay. Then, they could input the unit values and conduct calculation by completing the unit of magnitude. The Impulsive cognitive style typed students could be seen in Figure 10.

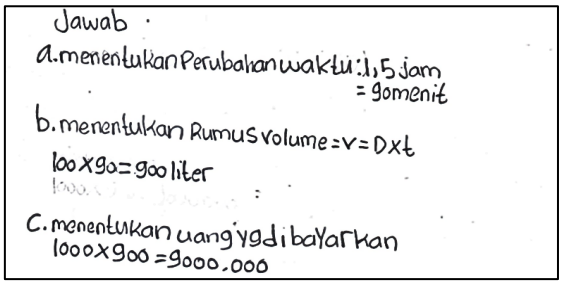

Figure 10. The Result of Impulsive Cognitive Typed Students in Solving Problem Number 2

From the Figure 10, it could be seen that Impulsive cognitive typed students could solve problems orderly in terms of time changes, volume formula writing, and bills to pay by inputting the values. They were then proceeding to calculation which was entailed by accurate unit of magnitude. The Slow-Inaccurate cognitive style typed students could be seen in Figure 11.

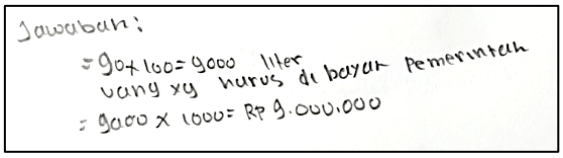

Figure 11. The Result of Slow-Inaccurate Cognitive Typed Students in Solving Problem Number 2

From Figure 11, it was obtained that the students were not capable in solving problems in which the subjects did not write the time changes. However, they had accurately done to calculate volume and bills to pay.

The Slow-Inaccurate cognitive style subjects could solve problems but they had incorrect formula writing. However, generally, there were tendencies of carelessness in planning the solution. It was still dominant which realized into incomplete mathematics formula writing and giving no remarks.

Fourth, there were rechecking stages on number one, two, five, and six. From those two indicators, there was only an indicator (1) creating and interpreting mathematics model from a problem into conclusion. Meanwhile, dealing with indicator (2) solving irregular problems was indicated by students' in capabilities in creating alternative answers. The examples of the subjects' works are shown on Figure 12.

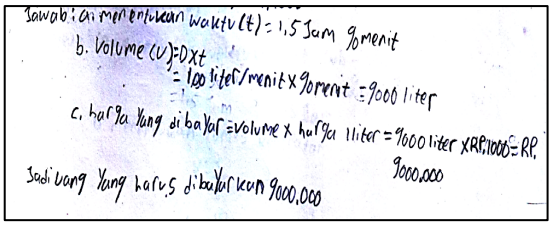

Figure 12. The Result of Reflective Cognitive Typed Students Written Test in Rechecking Problem Number 2

Based on figure 12, it shows that Reflective cognitive style typed subjects were not capable in doing rechecking since they only could make conclusion without other alternative answers. The Impulsive cognitive style typed students could be seen in Figure 13.

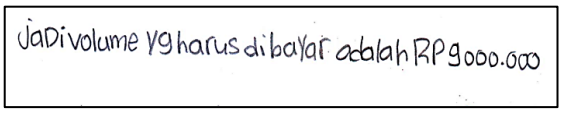

Figure 13. The Result of Impulsive Cognitive Typed Students Written Test in Rechecking Problem Number 2

Based on Figure 13, it shows that Impulsive cognitive style typed subjects were not capable in doing rechecking since they only could make conclusion without other alternative answers. Slow-Inaccurate students were not able to do rechecking since they could not make conclusion and write alternative answers.

CONCLUSION

The stage of understanding, Reflective, Impulsive and Slow-Inaccurate cognitive style subjects were able to understand the problem by writing down what was known and what was asked correctly. While, the stage of planning the problem solving, Reflective and Impulsive cognitive style typed students could plan problem solving and Slow-Inaccurate studetns were not able to plan problem solving. The stage of solving the problem according to plan,

Reflective and Impulsive cognitive style students were able to solve the problem and Slow-Innaccurate cognitive style whom was unable to solve problems. The last stage, that is re-checking stage for subjects Reflective and Impulsive cognitive style students, they were less able to make conclusions, whereas for Slow-Inaccurate cognitive style subjects were not able to make conclusions and three styles were not able to make alternative answers. The implementation of PBL model with ethomathematics nuances could make problem solving skills better, for example slow-inaccurate subjects were able to understand problems by writing down what was known and asked, even though they were still unable to plan problems, solve problems and were unable to check problems. However, dealing with easy level question, the subject was able to solve the problem. This happened because the subject did the exercise repeatedly in solving problems by granting problems in stages from easy, moderate, and high difficulty levels.

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