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An analysis of students' literacy ability in mathematics teaching with realistic mathematics education based on lesson study for learning community

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Abstract. The aims of this research is to explore students' literacy abilities descriptively and teacher's response in Math instruction of lesson study for learning community based realistic mathematics education. Literation ability is the ability of the individual to form, use, and interpret mathematics in various contexts. Realistic mathematics education aims to present the real world context to students. The research subjects were 29 seventh grade students of MTs Ma'arif Ambulu. The descriptive approach of qualitative method becomes a choice to understand literation ability and teachers' response. Data collection was done by observation, PISA test questions, student and teacher interviews, and documentation. Data analysis was using the theory of induction and reduction. The results of the research showed that the students were positively responding to this approach. The ratios of mathematical literacy ability based on the total students respectively were 44.83% on level 4 and 31.03% on level 5, and 24.14% on level 3. The teacher's response showed that this approach could change the atmosphere to be more active between the teacher and the students as well as the students with their fellow. The teacher could optimize his role; recognize his weakness through reflection with the team so that he had the opportunity to prepare the next strategy to improve quality.

1. Introduction

The growth of global economy has experienced acceleration. The technological sophistication marks the industrial revolution reaching round 4.0 which emphasizes the pattern of a digital economy, artificial intelligence, big data, and others or which has been known as the phenomenon of disruptive innovation. This acceleration requires human resources to have high competency to be able to compete. World Economic Forum (WEF) reports that some abilities are needed in facing the competition of Industrial 4.0 era. The abilities include analytical and innovative thinking, emotional intelligence, and mathematics reasoning [1]. In the other hand, OECD-PISA reports that Indonesia students' mathematical literacy in 2015 reached the score of 386 ranked 63 from 70 countries, in 2012 ranked 64 from 65 countries with the score of 375, and in 2009 ranked 61 from 65 countries with the score of 371 [2][3][4]. It means that the acquisition of PISA mathematics scores in the last three periods has increased. However, the scores are still far from the average score of literacy ability established by PISA.

Literacy is not only the ability to read and write but also knowledge and skill that can make someone has the ability to think critically, able to solve the problem in some various contexts, able to communicate effectively and able to develop potential as well as actively participate in social life [5]. Mathematical literacy is an individual's capacity to formulate, employ and interpret mathematics in a



variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens [6]. There is a strong relationship between literacy skills or understanding and mathematics word in problem solving-skill [7]. Problem understanding covers formulating, implementing, and interpreting mathematics in some various contexts in which include reasoning mathematically and using concept, procedure fact, and mathematic tools to explain as well as to predict a phenomenon. Mathematical literacy is analyzed from three aspects that related to each other namely process, content, and context aspects and PISA has established six levels to know the students' mathematical literacy ability.

Some various approaches have been done to reach mathematical literacy. Ability is not a destiny yet it is shaped and developed through instruction, practice, and activity mastery, so it is a must for the teacher to shape, develop, process, and improve child's ability [8]. Realistic mathematics education is an approach oriented to the reality of daily life as the entry point of learning. The steps of this approach cover: First, understanding the contextual problem where the teacher gives a contextual problem. Second, explaining the contextual problem, in this step, the teacher asks the students to explain or describe the contextual problem given by using their own words. Third, solving the contextual problem, the students individually or in group solving the contextual problem by using their own way. Fourth, comparing and discussing the students' answer, the teacher provides time and chance to the students to compare and discuss their answers in the group to be then compared (checking and revising) and discussed to the whole class. Fifth, concluding, from the result of the discussion, the teacher guides the students to draw a conclusion of a concept or procedure [9].

Lesson study for learning community is a method which emphasizes professional development that is maximized by structuring daily administration task; help each other in searching and consultation is prioritized by creating collaborative learning and by reforming daily learning; the teacher view about learning is shifted to focus on the signals of child's needs; and the perspective about studying shifts to confess and accept error, confusion, and struggle [10]. Some things that should be given attention are how the students study each other with no ignorance, the students' gesture or student body movement [11]. Therefore, it could be depicted that lesson study emphasizes the study aspect about the teacher, and material mastery by the students rather than students' learning activity. This method is then developed as lesson study for learning community which emphasizes study about how students learn and collaborate, rather than the study about how the teacher teaching and mastering the material.

The above phenomenon motivates to analyze deeply about the students' literacy ability by giving realistic mathematics education approach based on lesson study for learning community. This approach is implemented on the material of social arithmetic by involving some teachers. The teacher of mathematics subject of grade VII becomes the model teacher while the other teachers as the observer. This activity is conducted as an effort to improve the students' ability in formulating, implementing, and interpreting mathematics in some various contexts and solving the problem in real life.

Previously, research by Hobri's *et al.* [12] aimed at developing mathematical learning instruments by using Contextual Teaching and Learning (CTL) and determining their influence on the students' high-level thinking skill. The research by Wardoyo *et al.* [13] aimed at determining differences in mathematical literacy skills in Change and Relationship content. Research by Andini, *et al.* [14] aimed at describing the suitability of students' activities with the characteristics of Problem-Based Learning (PBL) that oriented to the lesson study for learning community. Whereas, this research is more about describing the learning process and mathematical literacy skill with LSLC-based RME, reinforcing realistic mathematics education by adding lesson study for learning community as a basis for increasing teacher professionalism and achieving student mathematical literacy and implementing social movement in school communities for the students' mathematical literacy and better professionalism of teacher.

2. Methodology

This research was qualitative research with a descriptive approach which aimed at exploring the students' literacy skills, the learning process of mathematics with realistic mathematics education approach based on lesson study for learning community, and the responses of teachers and students to the approach. Technically, the data collection was done through observation, interview, and test. The observation was carried out on the learning planning activities, open class with social arithmetic material by using realistic mathematics education approach based on lesson study for learning community and reflection of learning. Teacher and student interviews were conducted after reflection of learning which was intended to explore the responses of teachers and students related to the realistic mathematics education approach based on lesson study for learning community. Whereas, the study of the document was carried out on the answer sheet for the test of mathematical literacy ability [15].

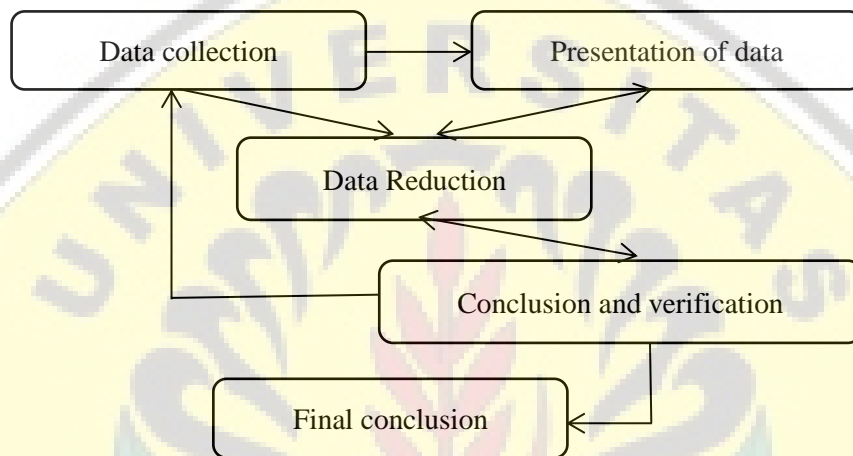


Figure 1: Qualitative method analysis, Miles

3. Results and Discussion

Lesson planning was the preliminary activity of Lesson Study for Learning Community. In the first phase, plan, a pre-learning activity, the researchers developed learning equipment and its instruments collaboratively with peers [16]. This activity was intended to formulate learning strategies that were in accordance with the material and in accordance with the students so that learning became more meaningful. This activity was attended by four people who were an academic department, math teacher, social science teacher, and prospective teacher-student. While the agenda for this activity was the discussion of learning instruments, which were the lesson plans and student worksheets. The discussion of the lesson plan was carried out by exploring the core competencies, basic competencies, and indicators of achievement, objectives, social arithmetic material, methods, media, learning resources, steps, and assessment of learning. Whereas, the discussion of student worksheets explored their suitability with the learning steps and the exercise. This discussion resulted in the lesson plans and student worksheets that were in accordance with the steps of realistic mathematics education approach. This instrument was predicted to make students more active so that they can achieve learning goals, and on this basis, the teacher team decided to use it in an open class with social arithmetic material.

Open class was the core activity of lesson study for learning community. Four teachers involved in planning to join this open class with different roles. The mathematics teacher played as the model teacher by facilitating the learning process in social arithmetic classes, while the academic department, social science teacher, and prospective teacher-student as the observers for the entire learning process. Technically, the model teacher started the learning by greeting and inviting the students to pray together, checking for the students' attendance, then taking preliminary steps. The core activity began with providing worksheets to students, facilitating, facilitating groups to do the learning based on the steps in worksheets, individual and group assistance, and facilitating class discussions and concluding

learning outcomes. The observer observed the learning process which included the steps of learning and students' activities.

Worksheets were structured learning instructions. Students tended to respond positively to the different learning instructions so that they become more motivated and involved in the instruction [17]. Students received worksheets which were shared by the teacher, the students formed groups according to the teacher's directions. Individually, students began to fill in the identity worksheet by writing down their name, class, absence number, group name and the names of the group members, then they continued the activities by reading the instructions as a guide to complete the worksheet. Students read and understood the text presented on a worksheet as a form of contextual problems. Students filled and completed the table with data information which they obtained from contextual problems, the data contained the name of the item, the purchase price, and the sale price. Then students compared the price of sales and the price so that they found differences between the two data. Students wrote their ways to obtain the differences in mathematical sentences and concluded the conditions that occur from contextual problems based on mathematical calculations.

Students compared the processes and results of their work with the work process and the work of other group members and discussed it. Student activities in group discussions were presented in the following figure (taken from one group as a sample).

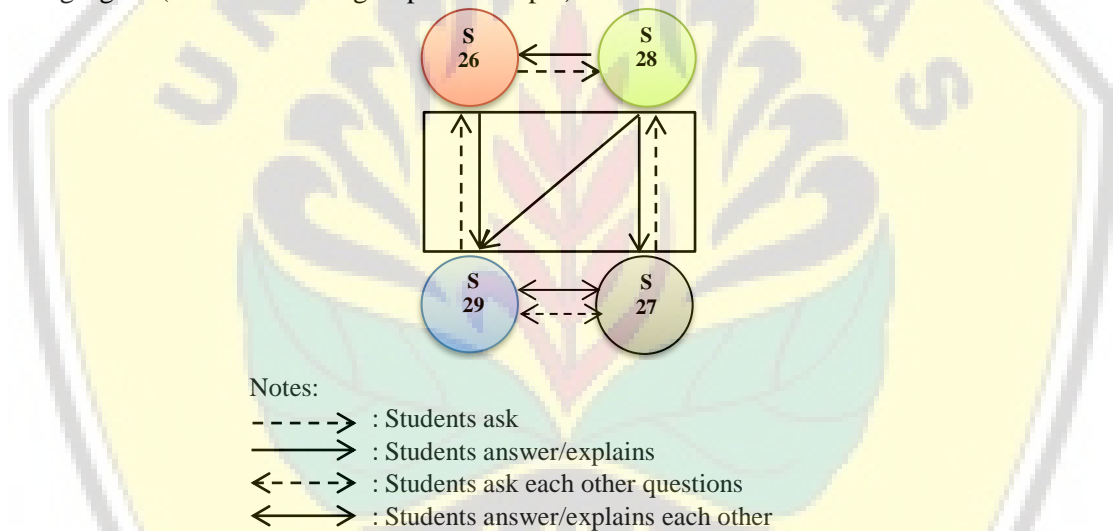


Figure 2: The students' activities in group discussion

Figure 3 informs that S26 asked S28 and obtained an explanation from him. S29 asked S26 and then S26 gave an explanation, S27 asked and got an explanation from S28. Not only for those who asked to S28, but S28 also explained to the others three students and after he had obtained an explanation, but it can also be seen that S29 and S27 asked each other questions and explained in solving problems on the worksheet. Based on the activities of students in the group, it was found that S28 had higher literacy skills than the other three students.

The group discussion went well. Each student gave input or questions about the material being studied. This condition showed that students had been able to collaborate and build caring communities [12]. In this process, occasionally the teacher played an assistance function to groups and individual students to strengthen understanding and provide motivation. Through this, students could conclude temporarily about ways to solve contextual problems.

The teacher facilitated class forums. In this forum, students presented the process and results of their group work. Other groups compared the process and work results of their group and then discuss it. Occasionally, the teacher interrupted the discussion process between these groups to help by doing clarification, to make clear the intentions of the questioner and the presenter so that the discussion forum was directed. At the end of the forum, all groups of students drew conclusions together and they were

guided by the teacher as a forum facilitator. This shows that the teacher must provide opportunities for students to build their own knowledge [18].

Reflection of learning was also attended by three teachers and one teacher candidate. Reflection sessions helped teachers to learn new teaching strategies from practice and improved student learning outcomes [19]. This activity began with sharing the experience of the teacher model during the open class.

“...in the first few minutes, I felt awkward, it felt like I was being watched every time I behaved, it didn't feel good, but after a while, I ignored it already...”

“...Good sir, the throat wasn't dry...”

“...children seemed happy...”

All observers reported the results of their observation, O1 said that; First, the model teacher forgot to convey the learning objectives to students. Second, from the 2 groups observed there were 2 students who were afraid, which were S2 in group 1 and S7 in group 2, but after starting to work on the worksheet students already looked more relaxed following the process. In general, students in groups 1 and 2 were quite active. O2 suggested that groups 3 and 4 were active. There were S14 who often cheated on S11 while working on the student worksheets. O3 also recognized that the students in groups 5 and 6 looked active both in completing the student worksheets and group discussions. For the teacher model, O3 provided input that when concluding in class discussions was too fast, that there were concerns for students not able to digest in detail.

The teacher interview produced information that the model teacher was a VII grade math teacher who had taught for nine years. Mathematics learning was done through lecturing method followed by giving examples of questions and then doing exercise. According to him, so far the students were happy with that method. Learning with the realistic mathematics approach based on the lesson study for learning community was the first time it had been done. The teacher's interest in this approach was illustrated in his sentence expressions.

“...I am really happy, usually, I think about everything by myself only, now there are many teacher friends who help...”

“In my opinion, the realistic approach based on lesson study for learning community is very effective, I was helped to prepare instruments, get input for improvements, and children are also more active...”

The learning was better because of the review by other teachers from diverse perspectives. Mathematics teachers were increasingly convinced that the instrument was more applicable, and felt well prepared to facilitate the learning process because mastery of all technical aspects was better. The Lesson study provides a chance for teachers to reflect upon their long-held beliefs and started to form new kinds of beliefs is related to this teaching practices [20]. After the open class, the teacher obtained observational reports from other teachers so that they knew the weaknesses that can be used as the basis for finding the next strategy. Through this activity, other teachers could understand the mathematics learning strategy and could associate with some materials in social science, and made it possible to combine it during learning in their class. The academic department considered that togetherness strengthened each other among teachers so that learning became more in line with the objectives of the academic program and led to the vision and mission of the school. The prospective mathematics teacher felt that he had gained additional learning strategy knowledge which could be a provision for facilitating learning correctly after graduation. Based on this, it can be said that realistic mathematics education approach based on lesson study for learning community received a good response from the teachers. In line with Ilma, the Realistic Mathematics Education approach can improve teacher professionalism [21]. The teachers also had space to share with each other based on the background of scientific discipline and experience so that it would automatically have a positive effect on their professionalism.

The questionnaire was given to all students with the intention of obtaining information about the response to the lesson-based realistic mathematics education approach to the study for learning community. Based on the questionnaire, the results obtained as in the table.

Table 1: Student Response to the Realistic Mathematics Education Approach Based on Lesson Study for Learning Community

No.	Statement	Student Response			
		Yes		No	
		Amount	Percent (%)	Amount	Percent (%)
1	The way of learning that just took place was very interesting and makes me happy to learn	23	79,31	6	20,69
2	Learning material was easy to understand	24	82,76	5	17,24
3	Worksheets really helped me find out the information, find ways to resolve, and solve problems	20	68,97	9	31,03
4	Learning with worksheets and groups made it easier for me to solve questions	25	86,21	4	13,79
5	I became more happy with group learning than studying on my own	25	86,21	4	13,79
6	Group discussions made me more courageous to ask friends and teachers	20	68,97	9	31,03
7	Together with the group, I became more courageous in presenting the results of the discussion and dared to answer if anyone asked	25	86,21	4	13,79
8	By learning like this, it made me appreciate other people's opinions	20	68,97	9	31,03
9	I want other topics to be taught in this way	19	65,52	10	34,48
10	Solving problems with mathematics can be used to deduce conditions and the basis for making decisions (such profit/loss)	29	100	0	0

Based on table 1, statements 3, 4, 8 and 10 lead to the effectiveness of learning and responded positively by 81.03% of students. This learning was learning in groups with worksheets. The same result with Hobri's experiment, through this learning students, became more appreciative of the opinions of others [22]. This result also strengthening Tokada's findings, this table shows that students more easily understand problems, found their own ways of solving, solved problems mathematically, and concluded phenomena that occur as the basis of arguments in the context of everyday life [23]. Statements 6, 7 and 9 lead to attitudes that arise in students as a result of learning and this was responded positively by 73.56% of students. This shows that this approach increased the courage to ask questions and argue with students in discussion forums. While statements 1, 2 and 5 lead to emotional students related to the learning model which was responded positively by 82.75% of students. These results indicate that the learning approach is very interesting for students and by learning in groups students felt happy so that the learning material becomes easier to understand.

Students interviews were conducted by taking three respondents from high-ability students (S28), moderate (S19), and low (S5) based on the achievement of learning outcomes in the previous semester. This interview was intended to determine the responses of students to realistic mathematics education approach based on lesson study for learning community. The students' responses were seen from two aspects, which were; the first aspect of the student's direct response to this approach and the second aspect of the student's ability from the stages of learning activities with this approach. From the first

aspect, the three respondents expressed directly that this approach was more interesting than the previous approach that was the conventional approach. They were also very happy if other materials use this approach. The second aspect informed that all respondents stated that it was easier to understand the contextual problems given. For the completion independently and discuss with friends in the group, the three respondents stated;

S1; *“Of course, Sir, it is already in the story above, just put it in the columns”*

S2; *“Yes, but I have to read it first and ask it to my friends afterward”*

S3; *“My friends had the same thing, so I just follow them, Sir.... yes, I keep asking how they got it, then they told me straightaway”*

The process of discussion was actively done by the students both formally in groups and informally among individuals in the group. In line with Yuanita, The process and interview document showed that the quality of learning increased, this was proved by the increase of students’ activities, students’ participation within group discussions, and students’ ability to solve mathematical problems covering real context both independently and within groups [24].

The test of literacy ability was given to twenty-nine students by adopting PISA-math questions. These questions consisted of three questions with the following details; the first question was "EXCHANGE RATE" with two questions, question 1 was about to measure the literacy ability of math level 1 and question 2 was used to measure the literacy ability of math level 2. The second question was "SKATEBOARD" with one question for measuring the literacy ability of math level 3. The third question was "SELLING NEWSPAPERS" with two questions, question 1 was intended to measure the literacy ability of math level 4 and question 2 was used to measure the literacy ability of math level 5. These questions were included in the quantity contained in which it was the most important mathematical aspect of daily life. Whereas the contexts of these questions were personal as it was related to shopping, health, and game.

The students’ answer sheets informed that 7 students were capable to solve the questions of math literacy up to level 3. Level 3 questions were "SKATEBOARD", if the students wanted to solve these problems, basically the students were given the stimuli to be able to identify the information and connect the information so that they could complete the alternative choices which involved mathematical reasons covering concepts, procedures, and problem-solving for the phenomenon of skateboard purchases. The following figure 2 is a representative of the answers on questions level 3.

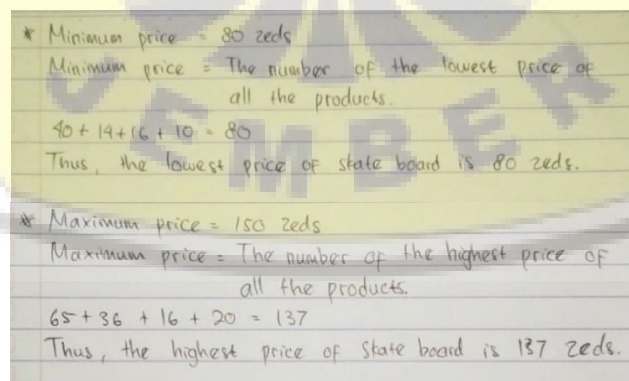


Figure 3: The answer to “SKATEBOARD” question

Figure 2 was the answer from S19 and represented 6 other students who answered the literacy questions of mathematics level 3 correctly. It can be seen that S19 could identify the information from the problem then reasoned it so that he found the concept. S19 was also able to carry out mathematical procedures clearly by doing it in a structured way so that he could solve the problem correctly. S19

applied a simple strategy, interpreted and used the representation based on the sources of information and presented the reasons directly.

As many as 13 students were only capable to solve the questions to level 4. The literacy questions of mathematics level 4 had "SELLING NEWSPAPERS" as its theme for question 1. The following figure shows the students' answers which solved the literacy problem of mathematics level 4.

Known = Sold Zealand Star = News paper 350 pcs
 The cost of 240 pcs @ 0.20 Zeds
 $(350 - 240) = 110$ pcs @ 0.40 Zeds

Question: Total income of a week : ...?

Answer:
 Total income of the week
 $= (240 \times 0.20) + (110 \times 0.40)$
 $= 48 + 44$
 $= 92$ Zeds
 The number of zeds = 92 zeds

Figure 4: the answers of "SELLING NEWSPAPERS" on Question 1

Figure 3 showed the answers done by S5 and presented 13 students who answered the literacy questions of mathematics level 4. These problem provided real-context problems in the product marketing field which was in the form of the newspaper. From the figure above, it can be seen that S5 was able to identify the information, use different representations, and solve them effectively by using his skills and procedures. In accordance with this, S5 is capable of level 4 math literacy.

As many as 9 students completed the literacy questions of mathematics level 5 correctly. The following figure informed about the students' abilities through the stages of solving the literacy questions of mathematics level 5.

* Known:
 - Christine income 74 Zeds
 - Salary every week 60 Zeds
 - Additional every 1 newspaper 0.5 Zeds

* Question:
 How many newspaper sold ...?

* Answer:
 Total of newspaper sold:

$$= \frac{\text{Christine income a week} - \text{Salary every week}}{\text{Additional every 1 newspaper}}$$

$$= \frac{74 - 60}{0.5} = \frac{14}{0.5} = 28$$

So, the total of newspaper sold is 28 newspaper.

Figure 5: The Question so "SELLING NEWSPAPERS" on question 2

Figure 4 pointed out the problem solving done by S28 who put his effort to develop and love the problems with the model in a complex situation. S28 belong to one of 9 students who solved the question level 5. S28 identified the information, assumed it then compared and evaluated the appropriate resolution strategy. S28 could solve the context problems through mathematical thinking and reasoning skill which represented the context problem. S28 reflected the solution, formulated and interpreted it with reasons as well.

There is a relationship between the approach of realistic mathematics education and student literacy ability [25] [26]. In relation to the completion of literacy questions from mathematics level 1 to mathematics level 5 done by all of the students through the tests of mathematical literacy ability can be illustrated as follows;

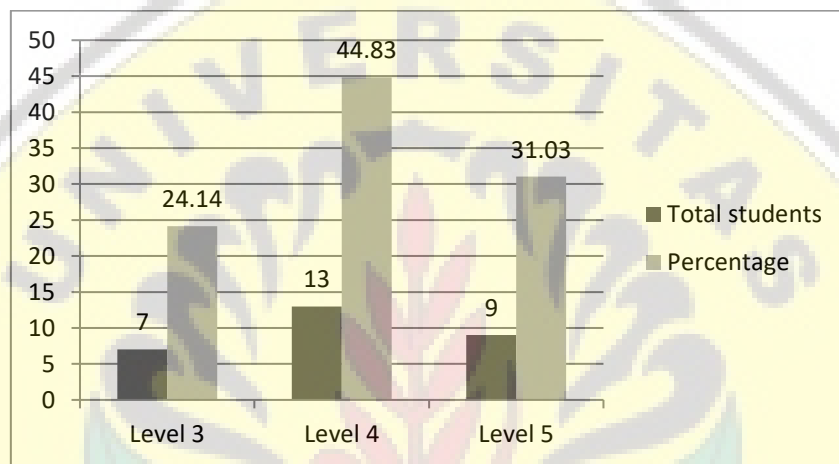


Figure 6: The ratio of mathematical literacy skill

From figure 6, it can be described that 7 students were only able to solve the mathematical literacy problems up to level 3. For the problem of level 4, as many as 13 students solved it correctly. While the mathematical literacy problems of level 5, as many as 9 students solved the contextual problems correctly and fulfilled most of the indicators of PISA mathematical literacy skills. If the achievement of the students' mathematical literacy skill was presented, therefore from the total of 29 students, it obtained that 24.14% students were at the level 3 and 44.83% students were at the level 4, while 31.03% students were at the level 5. This means that the lesson study for learning community based realistic mathematics education approach can improve student literacy ability.

4. Conclusions

Arithmetic material is given through the lesson study for learning community based realistic mathematics education approach. On the other hand, the test problems given are the PISA mathematical literacy that has relatively close context with social arithmetic. This means that the lesson study for learning community based realistic mathematics education approach strongly supports the students' ability to solve the mathematical literacy problems or the contextual problems in real life. The ratio of the mathematical literacy skill based on the number of students, respectively at the level 4 as much as 44.83% and level 5 as much as 31.03% and level 3 as much as 24.14%. The observation result of the learning design process, class opening, learning review, and interview revealed that the teacher showed that this approach was able to change the situation became more active between the teacher and the students. The teachers were able to optimize their roles, find their weakness through the reflection with the team so that they got a chance to prepare a further strategy to improve the quality. It means, there was a positive response from the teachers toward the lesson study for learning community based realistic mathematics education approach. The students' active participation can be seen during the learning process accompanied by the result of the interview of the students showed that the students had a positive

response toward this approach. Nevertheless, this result was still not general or still within limitations in which there are still many materials and schools that have never been used in this approach.

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