UJME 7 (2) 2018: 129-136
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

Analysis of mathematical literacy ability on PjBL model assisted by observation independent task

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ARTICLE INFO

Article history:
Received 15 November 2018
Received in revised form 15 November 2018
Accepted 12 August 2018

Keywords:
Mathematical literacy;
Project Based Learning;
Observation independent task.

Abstract

Mathematical literacy ability is an important ability that possessed by students for understanding and solving problems in daily life. In fact, the student's mathematical literacy ability is still low. Due to that fact, the purpose of this research are (1) to know the learning mastery of mathematical literacy ability on PjBL model assisted by observation independent task; (2) to know the increasing of mathematical literacy ability on PjBL model assisted by observation independent task; and (3) to know the student's mathematical literacy ability on PjBL model assisted by observation task. This research uses *mixed methods* with the *concurrent embedded* model. The population of this research is students of 8th grade in SMP Negeri 29 Semarang academic year 2017/2018. In addition, the sampling technique in quantitative is *random technique* and the research subject determination is by using certain consideration. Eventually, the results of the research are (1) the mathematical literacy ability on PjBL model assisted by observation independent task achieves learning mastery; (2) there is an increase in mathematical literacy ability on PjBL model assisted by observation independent task; (3) upper group students have excellent mathematical literacy ability, middle group students have good mathematical literacy ability, and lower group students have less mathematical literacy ability.

1. Introduction

One of the knowledge that supports the improvement of human resource quality is mathematics since mathematics is the *mother of science*. Mathematics is the pattern of thinking, the pattern of organizing, and the giving of logical reasons (Suherman, 2003). In the future, in order to be the master of technology, it requires a strong mathematical mastery early (BSNP, 2006).

Mathematics learning is the process which students actively construct mathematical knowledge (Fitri, 2014). Mathematics learning will be better if students are able to build mathematical concepts based on previous experiences (Suherman, 2003). For that reason, the student's activeness in mathematical learning becomes important in order to create the pattern of thinking on reasoning of the relationship between one concept and others.

The ability of students in mathematics demand is not only to have the ability for counting but also to have logical and critical reasoning ability in problem solving. The problem solving ability is not merely in problem of routine questions, but also in problem with the context of daily life. It confirms that literacy ability is important because the mathematical literacy ability helps them to understand the role and usefulness of mathematics in daily life and also prepare them in association in the modern society (OECD, 2017).

However, the importance of this mathematical literacy ability has not been matched by the learning quality in Indonesia. Based on the PISA 2015, mathematical literacy ability that included the mathematical process is *formulating, employing,* and *interpreting* in various contexts (OECD, 2017a). Additionally, it also includes doing mathematical reasoning and using concepts, procedures, and facts to describe, explain, or predict phenomena or events. Particularly,

To cite this article:
Nitasari, A., Suyitno, H., & Isnarto (2018). Analysis of mathematical literacy ability on PjBL model assisted by observation independent task. *Unnes Journal of Mathematics Education*, *7*(2), 129-136. doi: 10.15294/ujme.v7i2.26462

mathematical literacy is a knowledge to understand and apply the basic mathematics in daily life. There are seven fundamental mathematical abilities in mathematical literacy as follows (1) *communication;* (2) *mathematizing;* (3) *representation;* (4) *reasoning and argument;* (5) *devising strategies for solving problems;* (6) *using symbolic, formal and technical language and operations;* and (7) *using mathematical tools* (OECD, 2017a).

The level of mathematical literacy ability can be observed from the results of the PISA survey. PISA is an OECD international program for evaluating reading, science, and mathematics ability (Stacey, 2011). The purpose of the program is to determine the ability of 15-year-old child in using the abilities and skills that they have learned in the school before to their daily lives. The results of the PISA study on mathematical literacy ability in 2015 show that Indonesia is only ranked in 69 out of 76 countries that take the PISA test.

Based on that result, the greatest increase is in science competencies, that from 382 points in 2012 to 403 points in 2015. Whether in mathematics competence has increased from 375 points in 2012 to 386 points in 2015. Reading competence has increased from 396 in 2012 to 397 points in 2015 (Kemendikbud, 2016).

Additionally, TIMSS is an international study to identify and measure mathematical and science achievement among students in TIMSS participating countries. TIMSS reports that in 2015, Indonesia ranked in 49 out of 53 countries that participate in TIMSS. Based on the international survey, the average score of Indonesia is 397. It shows that Indonesia is still below the international average score which is 500. The average score of the correct answer in mathematics is 26 from international score which is 50. (TIMSS, 2015).

The mathematical domain of TIMSS is divided into two domains: content domains (numbers, geometry, and data exposure) and cognitive domains (knowing, applying, and reasoning). Indonesia's score on geometry content is 28 of international score which is 50, the score on the known domain is 32 from the international average score which is 50, the score on the applied domain is 24 of the international average score which is 48, and the score on the reasoning domain is 20 of the international average score which is 50 (Kemendikbud, 2016).

The results of PISA and TIMSS show that Indonesian students' mathematical literacy ability is still low. According to Karsim *et al* (2017), this happens because of the problem of school mathematics learning both on the process and assignment. Whereas the ability of mathematical literacy is in line with the standard content of mathematics subjects in the Indonesian curriculum (Wardono, 2014). Based on these conditions, it is necessary to have a student-centred mathematics learning innovation in which the teacher as a facilitator and gives the opportunities for students to increase learning activities so the students can find their own mathematical concepts.

The PjBL model (*Project Based Learning*) enables students to engage in scientific learning activities in the form of questioning, observation, investigation or experimentation, reasoning, and making relationships with others in an effort to obtain information or data. The PjBL model assigns tasks based on challenging questions or issues which involves students in planning, solving a problem, making a decision or investigating activities, and students have autonomy rights over a period of time, then the final is in form of real products or presentations (Thomas, 2000).

According to Trianto (2014), PjBL is an innovative learning model or approach, which emphasizes contextual learning through complex activities. Also, PjBL is the application of active learning. The PjBL model tries to relate between daily problems or real problems that students often encounter or with specific school projects.

The implementation of PjBL model learning is expected to be able to optimize the student activities if assisted by observation independent task. One of the methods that can make the students active is by using independent tasks (Sagala, 2019). The task can make sure, deepen, enrich or broaden the knowledge that has been learned. Moreover, the observation method can stimulate students' ability (Kasdriyanto, 2014). Observation is an activity of a process or object with the purpose is to feel and understand the knowledge of the phenomenon based on prior knowledge and ideas with the intention to obtain the required information.

In brief, the observation independent task is a task which is given to the student at the appointed time by utilizing the real object that can provide the stimuli as measured through the project assessment that includes the assessment of the preparation, implementation, and reporting. Through the observation of independent tasks, they can directly explore their knowledge through the experience that they get.

This is in line with the PjBL model learning that begins by giving the project with the problem related to real world. Then, together with the group that has been formed, the students learn to solve and complete the observation independent project that has been given to obtain the concept of material which will be presented when the discussion out. During the discussion, students involved to explore information by asking, doing activity and finding, collecting data and then making conclusions.

Based on *Ausubel* theory, the learning process by memorization does not help students in obtaining knowledge (Sugiyono & Hariyanto, 2011). Thus, learning will be meaningful when students associate initial concepts to solve real problems and not rely on memorization. The PjBL model assisted by observation independent task shaped the students' knowledge by itself from the students' experience during group discussion rather than memorization though.

Based on that description, there are several research problem which can be drawn, as follows (1) does the learning mastery of mathematical literacy ability on PjBL model assisted by observation independent task achieve learning mastery?; (2) is mathematical literacy ability on PjBL model assisted by observation independent task increasing?; and (3) how is the student's mathematical literacy ability on PjBL model assisted by observation task?

2. Methods

This research used *mixed methods* with the *concurrent embedded* model since the quantitative method was a primary method and the qualitative method was a secondary method that played a role to complement and support the discussion of the research results.

In quantitative, the researcher used *One-Group Pretest-Postest Design*. Quantitative sampling technique was determined randomly by *random sampling.* The sample of this research was experiment class which was VIII H with 34 students which got PjBL model assisted by observation independent task treatment. The selection of qualitative research subjects in this study was using certain consideration that the most knowledgeable about what was expected information and the students can give as much information as possible in this research. Research subjects were grouped based on the results of *post-test* of mathematical literacy ability then subjected to subject selection by selecting two subjects in the upper group, two subjects in the middle group, and two subjects in the lower group.

The quantitative data collection method in this research was test method by using test instrument. The test method was used to obtain data on the ability of mathematical literacy before and after treatment. Meanwhile, the method of qualitative data collection in this research was interview method by using the instrument of interview guidance. Interview method was used to collect data of students' mathematical literacy ability in doing PISA similar problem after obtaining learning with PjBL model assisted by self-monitoring task.

Furthermore, quantitative research used two analyzes; the analysis of learning mastery and mathematical literacy improvement. Before doing the quantitative analysis, the reasercher did the prerequisite test that was normality test. For the qualitative research, the reasearcher used triangulation technique. The triangulation technique itself was used to compare the results of the mathematics literacy test with interview results. The instrument must first be analyzed for its validity, reliability, differentiation, and difficulty.

3. Results & Discussions

The learning activities in this study were conducted five times. At each meeting, students did group discussions to solve the problems which were given on the project sheet and then one of them was selected as the group representative to present the results of the discussion in front of class.

The data of students' mathematical literacy ability after being treated with PjBL model assisted by observation independent task are presented in Table 1.

Table 1. Mathematical Literacy Ability Score

No	Descriptive SStatictics	*Pre-test*	*Post-test*
1	Average	53,54	78,23
2	Highest score	67	96
3	Lowest Score	35	56

Based on the table above, there are 34 students who took the *pre-test.* The average of students' mathematical literacy ability is 53.54 with the highest score is 67 and the lowest score is 35, the results were not satisfactory. On the *post-test*

score, the average has increased to 78.23 with the highest score is 96 and the lowest score is 56.

Before doing learning mastery test and mathematical literacy ability test, the normality test was conducted as the prerequisite test. Normality test was performed on *pretest* and *post-test* data. Further, they were conducted by using *SPSS Statistics 17 software* through *Kolmogorv-Smirnov* test with 5% significant level. The Sig value for *pre-test* of experiment class $= 0{,}237 > 0{,}05 = \alpha$ so H_0 is rejected and H_1 is accepted. It means that the score of *pre-test* data in experiment class is normally distributed. Then the Sig value for *post-test* of experiment class $= 0{,}531 > 0{,}05 = \alpha$ so that H_0 is rejected and H_1 is accepted. It means that the score of *post-test* data in experiment class is normally distributed.

The learning mastery test in this research is classical mastery test. It uses the right side proportion test with the significant level $\alpha = 5\%$. It is obtained $z_{value} = 2{,}13$ while the value $z_{table} = 1{,}64$. Because of the value of $z_{value} > z_{\text{table}}$ then H_0 is rejected and H_1 is accepted. It means that students who were in subject on PjBL model assisted by observations independent task have achieved classical learning mastery.

Then, the test of mathematical literacy improvement using the right interval paired with the significant level $\alpha = 5\%$. It is obtained $t_{value} = 13{,}18$ while the value $t_{table} = 1{,}70$. Because of the value of $t_{value} > t_{\text{table}}$ then H_0 is rejected and H_1 is accepted. In other words, there is a mathematical literacy improvement in PjBL model assisted by observation independent task.

The normalized *gain* score shows the categorization of mathematical literacy improvement in each individual. Its calculation is presented in the following table.

Table 2. The categorization of Normalized *Gain* in Mathematical Literacy Abilities

Criteria	Number	Percentage
Low	4	11.76%
Medium	22	64.71%
Height	8	23.53%

Based on Table 2, it can be seen that as many as $11,76\%$ of students are low increasing, $64{,}71\%$ students are middle increasing, and $23{,}53\%$ are high increasing.

The results of this study are in line with the research that conducted by Sari *et al*. (2017), which reports that students with project learning assisted by science literacy module have better science literacy ability than students who receive expository assisted by experiments and teaching materials commonly used in school. As Afriana (2016) says that there is an increase in science literacy ability for male and female gender students for knowledge and skills aspects on the PjBL model.

3.1. The Result of Mathematical Literacy Ability

The research subjects were selected based on the *post-test* score in each group. The research subject can be seen in Table 3.

Table 3. Research Subject

No	*Code*	*Group*
1	E-19	Upper
2	E-1	Upper
3	E-2	Middle
4	E-32	Middle
5	E-12	Lower
6	E-17	Lower

The component of mathematical literacy ability are (1) *communication;* (2) *mathematizing;* (3) *representation;* (4) *reasoning and argument;* (5) *devising strategies for solving problem;* (6) *using symbolic, formal and technical language and operations;* and (7) *using mathematical tools.* The *post-test* number three results of subject E-19, E-2, and E-12 can be seen in Figure 1, 2, and 3.

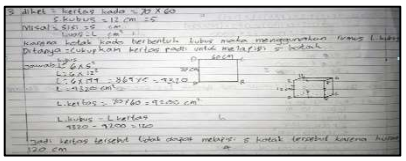

Figure 1. The result of Subject E-19

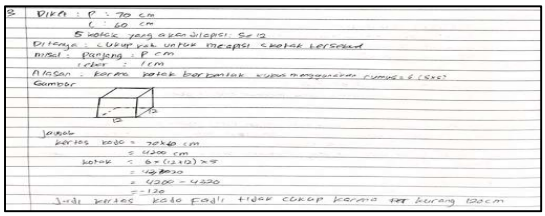

Figure 2. The result of Subject E- 2

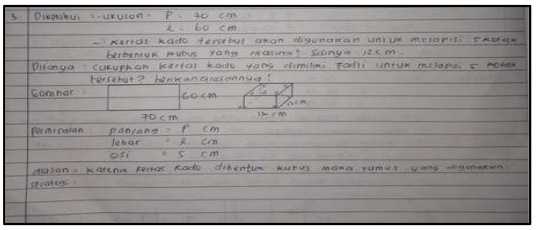

Figure 3. The result of Subject E- 12

Based on the figures, the E-12 subject was not able to determine the strategy needed to solve the problem because she did not understand the formula used. As the result, E-12 was unable to give a final reason and conclusion. Meanwhile, Subject E-19 and E-2 subject were able to solve problems well. They had completed seven components.

The students' mathematical literacy ability of upper group succeeded to reach the excellent achievement in all components of mathematical literacy. They were able to communicate the information and problem of the question by writing the known and asked clearly and smoothly. Also, they were able to transform the problems into mathematical form *(mathematizing horizontal)* and used a mathematical formula to solve the problems *(mathematizing vertical).* In addition, they were able to represent the problem in a different way, use a mathematical tool such as a ruler to draw a sketch of cuboid or cube, develop a used strategy to solve problems, give reason or argument in using strategy that used to solve problems, and use mathematical symbols in solving problem.

Likewise, the mathematical literacy ability of middle group showed a good achievement in all components. They were able to communicate information and problems by writing the known and asked clearly, do *mathematizing horizontal* and *mathematizing vertical*, represent problems that were presented in different ways by giving final conclusions and visualizing cuboid or cube through sketch, use mathematical tools such as ruler, and use mathematical symbols in solving problems. In formulating the strategy, they were able to develop the used strategies to solve the problem well, although there were still miscalculations and some of them were not well understood in solving the problem. Furthermore, they were also able to give a reason or argument in using the used strategies to solve the problem even if they were incomplete or less precise.

On the contrary, the lower group is still poor in their mathematical literacy ability. They were able to write down what they had known and asked well, change the problem into mathematical form (*mathematizing horizontal*) and use a mathematical tool such as a ruler to draw a sketch of cuboid or cube. They had been able to summarize the problem according to the question. Yet they had not been able to devise a strategy that would be used to solve the problem. There was still an error in executing the written mathematical formula *(mathematizing vertical).* In addition, they were not able to give the reason or argument in using the used strategy to solve the problem.

In the PjBL model assisted by observation independent task in the student experiment class, the students seemed active and creative to develop information during learning through discussions and presentations related to daily problem. This is in accordance with the opinion of Bédard in Chiang and Lee (2016) that PjBL method is able to develop students' creativity and thinking ability and also encourage them to cooperate in a team.

3.2. Research Discussion

Students who have got learning treatment on PjBL assisted by observation independent task were able to achieve mastery learning both in individually and in classical. This learning mastery occurred due to the several factors. Firstly, the syntax in PjBL model that included *question; plan; schedule;monitor; faciltate the process, mentor the process, utilize rubrics; and evaluate* made them became more active and creative in learning activity both in finding a concept and in a discussion. By using that syntax, they also can solve the given problem better. This finding is relevant with Nurfitriyanti (2016) who argues that there is a positive effect in the application of PjBL learning model. It is also disclosed in Surya (2018)'s research that PjBL model can increase the students' achievement and creativity that can be seen in the improvement of learning outcomes.

Secondly, PjBL learning model gives the opportunity to students for build the knowledge by themselves based on their experiences through a discussion when the project was not performed through rote the memorization. This is in line with *Ausubel* theory that learning process will be meaning full if the teacher presents the subject matter lightly, connect the relevant concept with the already exists in the structure of students cognition (Harefa, 2013). Thus, PjBL model can help students to solve the problem, especially on the real problem.

Thirdly, another factor that influences the mastery of mathematical literacy ability is the method assisted by observation independent task due to it helps the process of developing students' knowledge outside the classroom lesson based on the state and the real object obtained through the process of observation. They worked directly on real objects and did not just see the sketches. The project that assisted by observation independent task is a learning strategy that the aims to stimulate students by experience and to improve students' ability. This is relevant with the research conducted by Susilawati *et al.,* (2015) which reports that a learning by using independent task gives positive effect to students' skill.

The improvement of student's mathematical literacy ability can be seen from the difference *pre-test* and post-test of students' mathematical literacy ability. The *gain* criteria in the experiment class indicate that there is an increase in students' mathematical literacy ability on PjBL model assisted by observation of independent tasks that is in the medium criterion.

This increase occurs because of the learning process in experiment class during student learning was formed the knowledge as the result of students' thinking and activities through project activities assisted by independent tasks, observations, and discussion. On PjBL model assisted by observation of independent tasks, students are able to learn actively and independently through group discussions in solving mathematics problems related to daily problems. Through that learning process provoked the students' curiosity to find something. Through observation, students can be aroused by their thinking power of daily problems.

The upper group students had excellent mathematical literacy ability. The *communication* ability that they have because they were accustomed to do learning exercises and not ashamed to ask each other if there was information they got was less clear. The *mathematizing* ability raised since the upper group students were accustomed to getting the contextual problem from mathematics teachers so that the upper group students were indirectly accustomed to converting real problems into mathematical form. Again, the upper group students strategized by looking at the information obtained and viewing the drawing sketches that they had drawn before.

The process of upper group students was clear still it needed the accuracy in the calculation process. In the lesson, the upper group students were more active to do or respond when determining the used strategies in solving problems. If there were problems that other students could not complete, the upper group students could complete it. They also could give a clear argument when the researcher asked about the reasons behind the used strategy due to the fact that they had understood the needed steps to solve the problem. During the discussion, if there was a student who asked for solving problem, they could give the reason and argument. In addition, they could use mathematics symbols very well as previously, they were already accustomed to using mathematical symbols in solving problems.

Meanwhile, the middle group students had good mathematical literacy ability. Students in the middle group could relate information and question to the given problem since they were accustomed to do problem exercises during learning activities. During the discussion, the middle group students also helped their friends to find the given information and problems. When doing quiz or homework, students in the middle group had been able to communicate the problem by writing the known and asked. The middle group students' *mathematizing* ability was proven through their activeness in at the learning activity and they were not embarrassed to ask when getting difficulty. They also had been accustomed to getting contextual problem from their mathematics teacher. Consequently, they indirectly had been accustomed to change real problem into a mathematical form or vice versa. They also could express because in this learning model they were accustomed to draw a sketch first before solving the problem and conclude the given problems by using their own language because they could solve and understand the given problem.

Furthermore, the middle group students were formulating strategies based on the information which were obtained and written down. In formulating the strategy, there were some of middle group students who still made miscalculations because they were less thorough or hasty. Surprisingly, there were also middle group students who did not understand, but still wrote strategies as the best they can. They did not understand because sometimes they were embarrassed to ask. However, in general, they were able to determine the strategy and needed some exercises intensely. Actually, they understood what they did so that they could write down every reason even though there were some of them who not quite understand but still gave the

reasons even less precisely. They less understood in giving reasons because when the teacher explained, they wrote a note what teacher explained.

Then, the lower group students had poor mathematical literacy ability. They could give information and problems in the question although it took more time to think first as they were hesitant and lack in concentration. They could understand the problems and write in the form of mathematical (*mathematizing horizontal)* with stuttering and substandard. Yet, they had not been able to do *mathematical vertical mathematizing* since there were many formulas which were not written because they did not understand. Another thing that causes lower group students had not been able to do *vertical mathematizing* was because in finding information or problems in the given question they often felt hesitate, as the result, they had difficulties in doing *mathematizing*.

For more, the lower group students were still not able to use the strategy to solve the given problems. Whereas they had made a strategy but the strategy was still wrong. As matter of fact, the lower group students often unfocused and did not concentrate. Actually, the lower group students had a good spirit. It was proven by during the discussion, they asked their friends. They might know the strategy yet it did not work. Sometimes, they did not know the strategy to solve problems so they asked their friends. In addition, they had not been able to provide good and correct reasons because they were still confused in solving the given problems. They might be confused to reason or argue for having a poor ability to strategize and solve the given problems. However, if the lower group students did the right stage then they were able to argue about the settlement step according to the knowledge they possessed.

4. Conclusion

Based on the description of the analysis, the conclusions that can be drawn, as follows (1) students' mathematics literacy ability on PjBL model assisted by observation independent tasks on the cuboid and cube material is achieve learning mastery; (2) the PjBL model assisted with observation of independent tasks can increase the learning outcomes and mathematical literacy ability; (3) the upper group students have excellent literacy ability in solving although they are less accurate in doing the calculation even though the formula used is correct; (4) the middle group students have good literacy ability in solving problem. In addition, they are less able to coordinate the time in solving the problem, so there are still unsolved problems as the time has out; and (5) the lower group students have poor literacy ability in solving problem due to lack of concentration and lack of focus.

Thereupon, the suggestions that the researcher recommends are (1) PjBL model should be used by teachers to improve the ability of mathematical literacy since this learning model trains seven components of mathematical literacy and not only emphasizes on student results; (2) teachers should use observation of independent tasks that will indirectly require students not only in the class, but also at home; (3) the upper group students are expected to practice resolving more varied exercises to train their accuracy in formulating strategies or in completion calculations; (4) the middle group students should be given exercises which will develop their ability to strategize the problem, consequently they can strategize well and coordinate the time to solve problem; and (5) the understanding of lower group students is still low. For that reason, they need a peer tutor.

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