# The Effect of PBL Model and Learning Styles on Mathematical Problem-Solving and Self-Esteem Abilities

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**Abstract**

This study aimed at determining whether the PBL model and learning styles could influence the students' mathematical problem-solving and self-esteem abilities. This study was a quasi-experimental study, in which in include of two classes namely X MIPA 1 class (Mathematics and Natural Sciences); moreover, there were 24 students who used the PBL learning model as an experimental class and X MIPA 2 (Mathematics and Natural Sciences) that consisted of 22 students used a scientific learning model as a control class at SMAN 17 Pandeglang on the academic year of 2019/2020. In addition to the learning model, the students were also categorized based on visual, auditory, and kinesthetic learning styles. The data were collected by means of learning style questionnaires, problem-solving ability test, and self-esteem questionnaires. The data analysis was performed statistically both descriptive and inferential. The validity of mathematical problems was based on the expert assessment and validity test while the reliability was tested using product moment correlation. Pre-test and post-test data had been tested and both of them were homogeneous and normally distributed. The homogeneity test used Lavene test and the normality test used Chi Square. The influence test was performed using statistics, the average difference test, the two-way ANOVA test, and the Post Hoc follow-up test with Scheffe. All data were processed using SPSS. This study indicated the success by obtaining a significant value of $0.00 < \alpha$. Hence, it can be concluded that there is an effect of the implementation of PBL models and learning styles on mathematical problem-solving and self-esteem abilities.

**Keywords:** PBL, Scientific, Learning Styles, Mathematical Problem-Solving Ability, Self-Esteem

## INTRODUCTION

Problem-solving is a general objective in mathematics learning, even as the heart of mathematics means that the ability to solve problems is a basic ability in learning mathematics (Angkotasan et al, 2013). The abilities of problem understanding, creating a mathematics model, problem-solving, and interpreting the solutions are needed to be developed in order to improve problem-solving ability. The ability to solve mathematical problems is increasingly valued and sought after by employers and higher education institutions (Walport et al, 2010). The students can be mastered the mathematical problem-solving ability well if the students master the affective abilities i.e. self-esteem (Pamungkas et al, 2018). Currently, mathematics learning still tends to implement teacher-centered learning. The teachers' activities in learning are greater than the students' activities. This causes the students to be inactive and not independent to learn the subject matter; hence, when learning takes place, communication occurs only in one direction since the teacher is the only information center. The importance of problem-solving is related to the ability as a success in school or real-life (Bahar et al, 2015).

Learning still emphasizes the aspect of memorizing and disregards on the aspects of understanding, reasoning, communication, and problem-solving aspect. Problem-solving can be interpreted as an ability to use knowledge and mathematics skills possessed to answer a question or complicated situation (Nissa et al, 2019). One of mathematics learning purposes is to solve the problems which cover up the ability to understand the problems, devising the completion, implementing the completion, and interpreting the obtained solutions. This is necessary to be done so that the students can reach a good goal that is formal and even material (Razak, 2018).

Referring to the results of TIMSS and PISA studies concerning on mathematics learning, the Indonesian students are still feeble to solve problems that demand a problem-solving ability. As stated by ( *Strategic Review*, 2011) based on the PISA which represented by the 15 years old-students, half of Indonesian students only reach the scores below level 1 in mathematics (on the scale of level 6); meanwhile, there are no students who reach the levels 5 or 6, where these levels measure the creativity, problem-solving, and complex reasoning. Additionally, poor problem-solving ability in SMAN 17 Pandeglang could be proven using the daily test results of students who did not complete the problems based on problem-solving ability. The students had not been able to describe the formulation of the problem contained in the problems and the completion plan that would be carried out to answer the problems.

Low mathematics learning affects the difficulty of students in understanding mathematics. In the classroom learning process, the students are less encouraged to develop problem-solving abilities; moreover, the students cannot combine previous concepts to achieve the desired goals (Faturahman, 2015). The classroom learning processes are directed to the students' abilities in memorizing the information, the students are induced to memorize, and collecting various information they remember is to connect the information with the daily life. This influences the completion of mathematics problems; the students are difficult to complete the problems. Ideas sharing and giving clarification of understanding can be done by means of problem-solving ability. To create quality human resources (*SDM)*, human resources must be developed based on 21$^{st}$-century skills i.e. the ways of thinking, ways of working, working devices, and life skills. Those ways of thinking include of creativity, critical thinking, problem-solving, and decision making. Then, the ways of working include of communication and collaboration. Furthermore, the working devices include of information and communication technology (ICT) and information literacy.

Along with the development of age and social environment, the problems faced up by someone will be more complex (Happy, 2014). The use of proper learning models in the classroom is in accordance to the demands of current development. One of the learning models that implicates the students to solve a problem by means of scientific method stages is using the PBL model so that the students can learn about knowledge related to the problem and the students have a problem-solving skill as well (Khamid, 2016). To solve a problem, it is needed a special ability of which ability is called as thinking habit. There are sixteen thinking habits of students when they are giving responses on a problem intelligently, in which one of the habits is by utilizing their sense to collect and process the data. The senses of visual, auditory, and kinesthetic are often used during the learning processes (Liberna, 2018).

The PBL learning model which gives an orientation to the students as a problem at the beginning of learning will ease the students who have auditory learning style to speak fluently, yet it does not necessarily provide convenience for students who have visual and kinesthetic learning styles that tend not to speak fluently. Likewise, the students who are good at visuals do not necessarily provide convenience for auditory or kinesthetic students, and vice versa. This study used the PBL learning model referred to the stages proposed by (Fachrurrozi, 2014), namely the students' orientation on problems, the students' organizing to

learn, guiding individual and group investigations, developing and providing attainments, as well as analyzing and evaluating the problem-solving.

Maximum results of learning can be reached if in the learning process the students are provided with an opportunity to develop the ability possessed by the students (Rahman, 2016). Thus, the selection of a learning model should be based on the learning model that can explore the students' abilities. The teachers who have a role as the learning implementer should be able to decide on effective and efficient learning models so that the learning objectives can be reached maximally.

Learning that is expected to be able to develop the problem-solving ability and students' self-esteem is a learning which involves the whole students on the learning processes, of which learning is the PBL learning model (Fachrurrozi, 2014). This is in accordance with the speculation that each learning stage should be active in constructing the knowledge so that it can train the students' abilities to reveal the ideas or notions both in written, verbal and even visual (Happy, 2014).

One of the ways that can be implemented by the teacher to improve the problem-solving ability and the students' self-esteem is by creating a compatible learning situation that fits the students' learning styles (auditory, visual, and kinesthetic); hence, it is expected that the learning objectives can be reached effectively (Sariningsih, 2017). Basically, each student has different learning styles to reinforce their success in learning  (Burroughs et al., 2019).

The learning activities can be separated from the students' learning styles. It will give a contribution to the learning quality that will be gained by the students so that the learning activities become more meaningful (Haryati, 2017). For this reason, the teachers need to know the quality of students' learning styles. By discovering the types of visual, auditory, and kinesthetic learning styles, it is expected to ease the teachers to monitor the students' learning progress while developing the students' optimal mathematical problem-solving abilities. The learning style is a container based on its ability to absorb and process the information and then convey it. There are three types of learning styles namely visual where the students tend to learn through what they see, in the auditory learning style, the students tend to learn through what they hear, while kinesthetic learning style tends to learn through motion and touch.

Departing from the above explanation, it can be occupied an underlying cause that it is very important to be able to design and implement learning that can facilitate the problem-solving ability, as well as for the students' self-esteem. One of the alternative ways is by implementing the problem-based learning (PBL) to the experimental class and the scientific learning to the control class. In addition to the learning model, it is also reviewed the students' learning styles in the class based on the visual, auditory, and kinesthetic categories. This study aims to describe the effect of PBL learning model and the learning styles to the problem-solving ability and self-esteem. The results of this study can give an illustration on the mathematical problems that are challenging and the ways of students' thinking in understanding the situation to design the mathematical strategies and procedures.

**METHOD**

This study was a quasi-experimental. The form quasi-experimental design for the mathematical problem-solving ability in this study was the non-equivalent pretest-posttest control group design. In this design, the samples taken were not selected randomly (random) and purely both for the experimental and even control groups, yet it was selected based on certain considerations (Purposive sampling).

The whole students of X MIPA (Mathematics and Natural Science) class of semester 2 at SMA Negeri 17 Pandeglang on the academic year of 2019/2020 were chosen as the population of this study, in which it consisted of 319 who got abroad into 12 classes. The *purposive sampling* was used as the sample collection technique of this study, of which technique was by taking off two classes from the population randomly (drawn) using a

requirement that the population should be normal and homogenous. In gaining the data of this study, it was done by using two kinds of instrument i.e. test and non-test. The instrument of test consisted of a set of test items to measure the problem-solving ability. While the non-test instruments were in the form of Self-esteem questionnaire and Student Worksheet (*LKS*).

To discover the students' learning styles, the instrument used was by completing the test of multiple-choice items, of which items are provided by three options i.e. a, b, and c. If the *a* score was prominent, it meant that the most dominant of students' learning style was the learning style of visual. This indicated that the student tended to learn by observing something. The students adore to see pictures, diagrams, watch a performance, demonstration of an activity, or even watch a video.

For the students who had a visual learning style, the learning material should be made in the form of concept maps, starting with a large theme in the middle of the page. To ease and accelerate the students to understand the subject matter or other things learned, the teachers must try to change the subject matter into the form of posters that were easily seen, with interesting pictures, graphics, and colors as beautiful as possible.

If the *b* score was stood out, it meant that the most dominant students' learning style was the auditory learning style. This meant that the students tended to learn by hearing something. The students were fond of to listen to speeches, the teachers' lectures while explaining something, listen to the radio or cassettes, debate or discuss. To ease the students to understand something, the teachers should provide the material by reading the lesson in a dramatic way reading such as a poet reading poetry.

If the *c* score was prominent, it meant that the most dominant students' learning style was the kinesthetic learning style. It indicated that the students tended to learn by means of physical activities and involve themselves directly. The students adore to touch, feel, unpack something and do bodywork. To speed up and simplify the learning, the teacher could try the learning by walking. Every time the students read or listened to someone talk, got up to move a little every 20-30 minutes.

Problem-solving ability test instruments were not only used to determine the profile of students' ability to solve mathematical problems they faced up, but it could also be used as a facility to practice the students' ability to think systematically in solving mathematical problems. This was in line with the statement of Sumiati (2007) who asserted that in solving the mathematical problems, the students were required to be able to think systematically. The method used to collect the data about the ability to solve mathematical problems was by means of the test method in the form of essays, in which it consisted of 5 questions or items. The instrument of the results of the ability to solve mathematical problems in the cognitive domain was carried out through the post-test questions. Furthermore, this test was called as mathematical problem-solving test (TPMM). Subsequently, student answers were assessed using the rubric as presented in Table 1.

Table 1. The Scoring Guidance of Mathematical Problem-Solving Ability Test

| Scores | Assessment Rubric |
|---|---|
| 10 | Correct answer, being able to read by means of an understanding on a written mathematical percentage |
| 7.5 | Correct answer, based on the criteria but there was a little bit of wrong answer |
| 5 | Correct answer but did not fit most of the criteria |
| 2.5 | There was the answer but did not fit to the criteria |
| 0 | No answer |

Before using the test of mathematical problem-solving ability, the validity and reliability tests were first performed (Table 2).

Table 2. The Validity Test of Items

| Items | $r_{value}$ | $r_{table} = 0.374$ $\alpha = 0.05$; dk = n-1 | Conclusion |
|-------|-------------|-----------------------------------------------|------------|
| no.1 | 0.727 | >0.374 | Valid |
| no.2 | 0.888 | >0.374 | Valid |
| no.3 | 0.767 | >0.374 | Valid |
| no.4 | 0.793 | >0.374 | Valid |
| no.5 | 0.805 | >0.374 | Valid |

The reliability calculation results of the instruments trial gained *Alpha-Croncbach* = 0.835. It indicated that those items were reliable to be involved on very high category. The complete calculation results were elucidated in Appendix B. Here was the recapitulation of reliability calculation results (Table 3).

Table 3. The Reliability Test on Mathematical Problem-Solving Ability

| Alpha Cronbachs | Criteria | Category |
|-----------------|----------|----------|
| 0.835 | Reliable | Very High |

The analysis results indicated that the items of mathematical problem-solving ability had met the characteristics that appropriate to be used in this study.

The obtained results data of study both from the results of problem-solving ability test and the results data of self-esteem scale of students were analyzed in order to interpret the results of study conducted.

The data analysis used:
1) The data analysis that used inferential statistics was in accordance with predetermined hypotheses of study, in which those were parametric and non-parametric statistical test data analysis. The determination of the type of statistical test depended on the type of data analyzed, whether it was normally distributed or not.

The data analysis stages that carried out:
a) Normality Test

The normality test was carried out to discover whether the data of two sample groups that were investigated came from the population that were normally distributed or not. The *Chi-square* was used as the normality test that the test was assisted by a certain application program; moreover, it included of the p-value level of 5%. The basic consideration if the $H_0$ was rejected was that the P-*value* ≤ 0.05, and $H_0$ was received if it was obtained the P-*value* > 0.05.

If the normality test was met, then the homogeneity variant test was performed, yet if the normality of the data did not meet then the test was continued on the non-parametric statistical test of *Mann-Whitney U.*

b) Homogeneity Test

The homogeneity test of variance between a class used the PBL model and a class used a scientific approach was carried out to determine the variance of the two groups being the same or different. The hypotheses tested were explicated as follow (Lestari, 2017) :

$H_0 : \mu A_1 \leq \mu A_2$
$H_1 : \mu A_1 > \mu A_2$
$\mu A_1$ = experimental class score variance (PBL Model)
$\mu A_2$ = control class score variance (Scientific Model)

The calculation of the homogeneity test of variance for two classes as the samples of study used the statistical test of *Lavene test* assisted by a certain application program by using a basic decision, i.e. the $H_0$ was rejected if the P-value ≤ 0.05 and the $H_0$ was received if the p-value > 0.05.

c) Two-Way Anova

This hypothesis test was to realize the effect of the class which used the PBL model and the class which used the scientific model, in which it was reviewed from the learning styles.

1) The results data of problem-solving ability and students' self-esteem tests

The results of students' problem-solving ability and self-esteem tests were analyzed to discover how the differences in the students' problem-solving and self-esteem enhancements between classes that used the PBL model and scientific model.

If there was no difference in the average *pretest* of students' mathematical problem-solving abilities and self-esteem between the classed that used the PBL model and scientific model. This indicated that the problem-solving abilities and self-esteem of students at the beginning of the study were the same. The difference testing to improve the students' problem-solving abilities and self-esteem was carried out by means of statistical tests of *posttest* average differences between the classes that used the PBL model and scientific model.

Statistical hypotheses used were elucidated as follow:

$$H_0 : \mu A_1 \leq \mu A_2$$
$$H_1 : \mu A_1 > \mu A_2$$

Description:

$\mu A_1$ : There was no effect of the implementation of PBL model to the problem-solving and self-esteem abilities.

$\mu A_2$ : There was effect of the implementation of PBL model to the problem-solving and self-esteem abilities.

By using One-way test criteria, the $H_0$ was rejected if the value was p-value $< 0.05$

2) The results data of problem-solving ability and students' self-esteem tests based on the learning styles

Departing from the results of the learning styles carried out at the beginning of the study, the data of students' problem-solving abilities and self-esteem were grouped according to the visual, auditory, and kinesthetic learning styles. The data of the three learning style groups were then tested for normality and homogeneity to determine the next hypothesis testing step.

**RESULTS AND DISCUSSION**

The quantitative data processing was obtained from 46 students of X MIPA (Mathematics and Natural Science) class at SMAN 17 Pandeglang; moreover, there were 24 students came from the experimental group and 22 students came from the control group. The samples distribution was based on the students' learning style, in which it could be established from the Table 4 below.

Table 4. Sample Distribution and Grouping

| Cognitive Styles | Classes | | Total |
|---|---|---|---|
| | Problem Based Learning | Scientific Learning | |
| Visual | 9 | 11 | 20 |
| Auditory | 8 | 6 | 14 |
| Kinesthetic | 7 | 5 | 12 |
| Total | 24 | 22 | 46 |

Before conducting the hypothesis test, it was better to carry out several tests as the prerequisite of the hypothesis test. These tests were normality test and homogeneity test of variance (Table 5). The data processing was carried out through the data processing program.

Table 5. The Normality Test Results of KPMM Data

| Class | Df | P-Value | Description |
|---|---|---|---|
| PBL Model | 14 | 0.998 | $H_0$ was received |
| Scientific Learning Model | 11 | 0.848 | $H_0$ was received |

Based on the Table 5 above, the p-value for the Experimental Class using the PBL learning model was 0.998; while the Control Class that used the scientific learning model was 0.848; (greater than $\alpha = 0.05$). Thus, it could be stated that the $H_0$ was received and this indicated that the data were normally distributed.

Testing the hypothesis of this study used the two-way ANOVA, it was used to find out the truth of the hypothesis proposed. According to the results of the normality and homogeneity tests, the mathematical problem-solving ability data could be arranged in the two-way ANOVA calculation table. The results of the hypothesis testing of the problem-solving ability was obtained a P-Value for the learning model with a *Sig* value smaller than $\alpha$, then $H_0$ was rejected. While the *Sig* value of the learning model was 0.002; then $0.002 < 0.05$; hence, it indicated that there was a positive effect on the implementation of the Problem Based Learning (PBL) model to the students' mathematical problem-solving abilities. The P-Value values for learning styles with a *Sig* values was greater than $\alpha$, then $H_0$ was rejected. The *Sig* value of the learning model was 0.021; then $0.021 < 0.05$; thus, it could be concluded that there a positive effect on the interaction between the learning models (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) on the ability of mathematical-problem solving. The results of the interaction between the learning models and the learning styles could be ascertained in Figure 1 below.
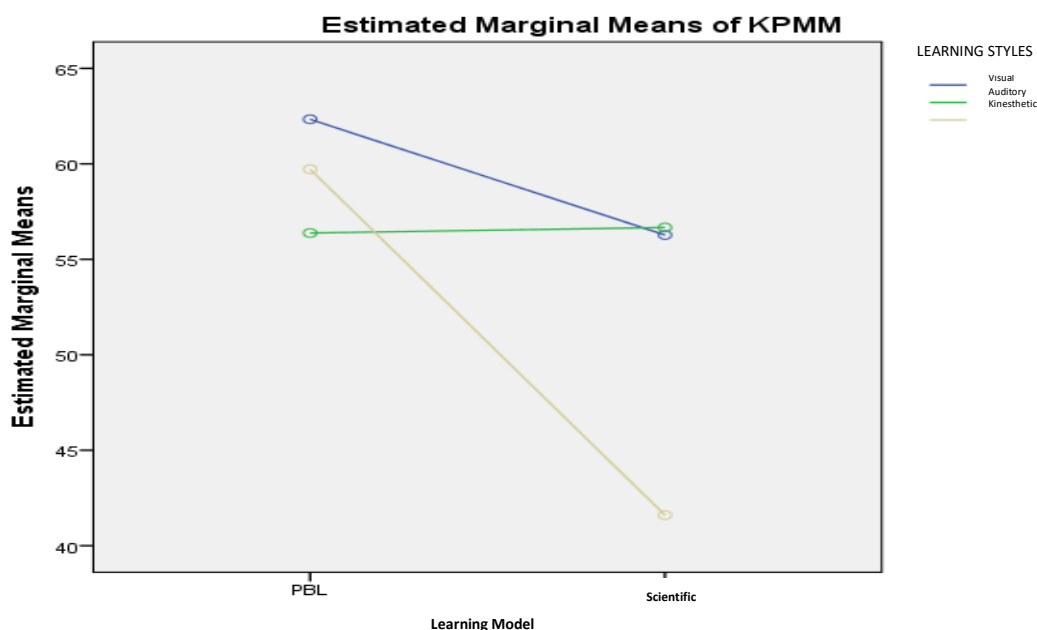


Figure 1. The Interaction Between the Learning Model and Students' Learning Styles on the Mathematical Problem-Solving Ability

The P-Value for learning styles with *Sig* values greater than $\alpha$, then $H_0$ was rejected. The *Sig* value of the learning model was 0.021; then, $0.021 < 0.05$. It could be concluded that the learning styles on the Problem Based Learning (PBL) model had more positive effect than the scientific learning model on the ability to solve mathematical problems.

While the hypothesis test results for the self-esteem questionnaire obtained P-value values for the learning model with a *Sig* value smaller than $\alpha$, then $H_0$ was rejected. With the *Sig* value of the learning model 0.011; then $0.011 < 0.05$; hence, it indicated that there was a positive effect on the implementation of the *Problem Based Learning* (PBL) model to the students' self-esteem. The P-Value for the learning styles with *Sig* values greater than $\alpha$, then $H_0$ was rejected. With the *Sig* value of the learning model 0.000; then $0.000 < 0.05$, so it could be concluded that there was an effect of interaction between the learning models (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) on self-esteem. This was shown on the Figure 2.

Figure 2. The Interaction Between the Learning Model and Students' Learning Styles on the Self-Esteem

The above diagram indicated that there was an effect on the interaction between the learning model of PBL and the students' learning styles regarding to the effect on the mathematical problem-solving ability. Briefly, the factors of learning model and learning styles gave a significant effect on the students' mathematical problem-solving ability. The P-Value for the learning styles which has a *Sig* value that greater than $\alpha$, the $H_0$ was rejected. The *Sig* value for the learning model was 0.000; then $0.000 < 0.05$ so that it could be concluded that the learning styles on the *Problem Based Learning* (PBL) model gave more positive effect rather than on the scientific learning model to the students' self-esteem.

PBL was one of learning model-based problems which emphasized on the existence of a problem faced up by the students in the learning processes (Isrok'atun, 2018). Problems in the classroom served as a starting point in constructing the concepts. In learning mathematics, the students were given a life problem about mathematical concepts. Through these problems, the students could learn from what were in the everyday environment so that it could facilitate the students in understanding and implementing the mathematics into their life. Rianto (2010), proposed that problem-based learning was a learning model that confronted the students in the learning challenges. The students were active to work in team so that they could find out the solution of real-life problems. The *Problem Based Learning* was not only a learning but also a thinking method since in the problem-solving the students could use other methods by looking for the data to draw the conclusion (Sudjana, 2011).

Referring to Slameto (2012) who asserted that factors which influenced the learning were the external and internal factors. The external factors were factors that existed outside the individual, while the internal factors were the factors that existed in individuals who were learning. One of the factors that could affect the ability to solve mathematical problems was the implementation of learning models planned by the teachers in the learning process, while one of the factors within the students that could affect the ability of solving mathematical problems was the students' learning styles.

Problem Based learning is a learning model designed for the students so that they could get important knowledge, in which it would make the students to master while solving problems and have a model for participating in team skills (Kemdikbud, 2015). The learning process used systematic approach to solve problems or face up challenges needed in the daily life. Furthermore, the Problem Based Learning had been considered by several high education institution in all of the world as a learning method, and pedagogical education approach that concerned on assisting the students to develop their independent learning

ability (Chen, 2013). Meanwhile, the Problem Based Learning was defined as an approach toward structuring learning that involved the students to deal with sensual problems in daily life (Cheong, 2008).

Learning style was someone's way to process the information in learning (Ridwan, 2017). The students' learning styles were related to di information absorption. The students' way to absorb the information could be called as learning modality. De Potter (2001) grouped the learning modalities into three types i.e. visual, auditory, and kinesthetic modalities. The students who had visual learning style conducted the learning by observing and using pictures. The students who categorized into this modality tended to adore in seeing the pictures and diagrams, watching a presentation and even videos. The students who had auditory learning style did the learning by discussing and listening. The students who had this modality preferred to listen music, lectures, discussion, debate, and verbal instructions. The students who had kinesthetic learning style did the learning by moving on and working. The students who categorized on this modality tended to "handle", move on, touch, and experience it by themselves.

The combination of these three modalities would accelerate the students to understand the material. The students gathered up the visual, auditory and kinesthetic memory in different parts of the brain. Therefore, this multi-sensory way of learning might be an effective way. The senses that were often used during the learning process were the visual senses, auditory senses, and kinesthetic senses. Referred to this circumstance, the authors chose one of the appropriate approaches, namely the Visual-Auditory-Kinesthetic approaches (Faturahman, 2015).

A learning style was a consistent way carried out by the students to catch up stimulus or information, how to remember, think, and solve the problems. Furthermore, the characteristics of kinesthetic learning styles (movements) were: 1) Speaking slowly, 2) Responding physical signs, 3) Touching someone to gain their attention, 4) Standing close when talking to people, 5) Always oriented to the physical and moved a lot, 6) Having a large muscle development, 7) Learning through manipulation and practice, 8) Memorizing by walking and seeing, 9) Using fingers as a pointer when reading, 10) Many using body cues, 11) Unable to sit still for a long time, 12) Could not remember geography, unless they had been there, 13) Using words that contained an action, 14 ) Liked books that were oriented towards their plot reflecting action with body movements while reading, 15) Having poor writing, 16) Being anxious to do everything, 17) Liked a busy game (Sundayana, 2018).

The learning style was a unique learning method that possessed by each individual in the learning process i.e. selecting, receiving, absorbing, storing, handling, and processing the information (Rahayu, 2016). Considering from a person's learning style profile, not everyone had the same learning style, even if they went to the same school or even sat in the same class. In fact, one's ability to understand and absorb lessons was certainly different in level, some were fast, moderate and some were very slow. Therefore, they often took different ways to be able to understand the same information or lessons. In this regard, with a different learning style, the mathematical reasoning abilities were also different.

According to (Keliat, 2016), learning style was an important factor that could affect the academic achievements of students, yet nowadays the implementation of learning styles that matched to the students was often forgotten. The students needed comfort in learning both in the process of understanding mathematics itself and in everyday life. In learning mathematics, the learning styles played a role both in understanding the concepts and solving the problems (*problem-solving*). In the daily life, the learning styles were useful to solve problems occurred both in the individual scope and even in the community.

The students' learning styles in this study were not only used to group the students into three categories, namely visual, auditory, and kinesthetic. This clarification was based on the test results obtained from the fulfillment of questionnaire of control and experimental classes. Based on the results of study, the P-

Value for the learning styles with the *Sig* value that greater than $\alpha$, the $H_0$ was rejected. The *Sig* value of learning model was 0,021; then 0,021 < 0,05. It could be concluded that there was an effect on the interaction of the learning model (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) to the mathematical problem-solving ability. The P-Value for the learning styles with the *Sig* value that greater than $\alpha$, the $H_0$ was rejected. The *Sig* value of learning model was 0,000; then 0,000 < 0,05. It indicated that there was an effect on the interaction between the learning model (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) toward the self-esteem.

The improvement of students' self-esteem in class, the problem-based-learning (PBL) was quite significant since in the implementation the authors combined the model with the activites suggested by Lawrence (2006) such as expressing the emotions in writing, revealing the students' argumentation about an expression, remembering the events than made the students for being happy, and giving affirmation or reinforcement to students to better respect themselves. In addition to these activities, the students always got success stories of someone whose life was not completely perfect. This encouraged the students to realize that each individual had their own strengths and weaknesses. The students were also more familiar with themselves and could appreciate the situation and what they had achieved today without having to look at others. Consequently, the students' self-esteem could increase. This was in line to the statement of (Setiawan, 2015) who proposed that the students' who had high self-esteem would have good self-acceptance, respect the needs of others, and have the ability to empathize.

In the problem-solving processes, giving assistance to the students did not need to be done immediately so that the actual development of students was maximized. The assistance or intervention was given when it was really needed by the students. In an effort to increase the students' self-esteem for preparing the teaching materials, a reinforcement of students' self-esteem could be inserted. In the classroom, the teacher played a very important role in influencing the students' self-esteem. The teacher's role was not only to maintain the quality of relationships with the students, but also to carry out a series of activities that could improve the students' self-esteem.

**CONCLUSION**

Departing from the results data of study, the analysis and hypotheses examination have been carried out; thus, it can be concluded that the implementation of PBL learning model gives positive effect on the mathematical problem-solving ability. There is an interaction between the learning model (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) to the mathematical problem-solving ability. The learning styles of PBL learning model give more positive effect than the scientific model to the mathematical problem-solving ability. The implementation of PBL learning model gives positive effect on the students' self-esteem. There is an interaction between the learning model (PBL and scientific) and the learning styles (visual, auditory, and kinesthetic) to the students' self-esteem. the learning styles of PBL learning model give more positive effect rather than on the scientific learning to the self-esteem.

**RECOMMENDATION**

For the students, it is expected to be more active, creative, innovative to increase their knowledge and perception. For the teachers, it is suggested to implement the PBL model ad an alternative solution for the learning model and consider the students' learning styles, so that the material delivery is appropriate to the characteristics and the potency owned by the students, in which it can improve the students' problem-solving ability. It is necessary to do an initial identification for the students in school to group the students based on the learning styles; thus, it is expected that the teacher can design a proper learning based on the students' learning styles so that the material delivery is appropriate to the characteristics and the

potoncy owned by the students, in which it can improve the students' mathematical problem-solving ability. Always continue to be creative and innovative in providing a learning by implementing various alternative learning model, in which it aims to improve the competencies and problem-solving abilities that can be reached by the students and do forget to pay attention to the learning styles possessed by these students.

For the school, it is expected that the PBL learning model can be used as one of alternative learning model in school by noticing, using the results of this study for the educational progress in school. It is necessary to conduct a further investigation about the implementation of PBL learning model that is related to the students' learning styles on the different subject matter by accessing not only the cognitive aspects but also the aspects of affective and psychomotor. Support on the implementation of various learning model to improve the students' problem-solving ability is needed.

## ACNOWLEDGEMENT

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