Increasing mathematical literacy ability and learning independence through problem-based learning model with realistic mathematic education approach

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Abstract. The purpose of this study was to see the effect of implementing the PBL model with the RME approach on mathematical literacy skills and learning independence. This research is a combination research using a sequential explanatory design. The quantitative research method was carried out in the first stage by following a quasi-experimental model which was designed in the form of a non-equivalent (pre-test and post-test) control group design then continued by further analyzing the results of the quantitative method using qualitative methods. This study shows that there is an effect of the Problem Based Learning model with the Realistic Mathematic Education approach on mathematical literacy skills and learning independence and describes the relationship between independent learning and mathematical literacy skills.

1. Introduction

Education will run well if there is good collaboration between leaders, teachers and the education system that aims to advance it [1]. Learning that involves the activeness of students with the teacher as facilitator is a perfect collaboration to build students’ mentality in learning, foster curiosity and self-confidence, the learning becomes ultimately changing the educational paradigm [2].

Studying in idealism means psycho-physical-socio-activity towards complete personal development. Learning is a process of acquiring knowledge. According to Kimble and Garmezy, learning is a change in behavior that is relatively fixed and results from repeated practice. At every level of education there must be mathematics lessons. Mathematics is considered as the mother of science because mathematics has links with various other scientific fields of study. In addition, mathematics is also related to various contexts of problems in everyday life. Knowledge to know and apply basic mathematics in everyday life is defined as mathematical literacy.

One of the topics raised in the USA in 1980 was the topic of mathematical literacy. One program that measures international standard literacy skills is the PISA (Program for International Student Assessment) which is held by the OECD (Organization for Economic Cooperation and Development) every 3 years. PISA defines literacy skills as an ability possessed by individuals in identifying, understanding, and interpreting mathematics in various contexts built by using and including mathematics in daily life [4]. PISA is an international survey program run by the OECD (Organization for Economic Cooperation and Development) that will assess the ability of 15 year old students to apply what they learn while at school into their daily lives [5].
PISA defines literacy skills as an ability possessed by individuals in identifying, understanding, and interpreting mathematics in various contexts built by using and including mathematics in daily life [4]. The purpose of PISA is to improve the ability of individuals to understand mathematics, who can make sound criticisms, and can use these skills in their daily lives [6].

With mathematical literacy, individuals can predict, solve everyday problems, interpret data, pose reasons in numerical, geometric and graphical situations, and communicate using mathematics. But in Indonesia's, mathematical literacy in international circles is still low. Indonesia ranks 64th out of 65 participating countries in 2012, in 2015, Indonesia ranks 63rd out of 70 participating countries, while in 2018, Indonesia ranks 73th out of 79 participating countries.

The main factor that affects the achievement of mathematics literacy in PISA 2012 is internal factors, namely in the form of students' identities. Internal factors are driving factors in students who are influenced by biological factors and psychological factors. Independent learning is one of the keys to success in the academic or career field, this factor is called an internal factor. Meanwhile, socio-economic and cultural conditions are external factors [7]. Research conducted by Pakpahan was carried out on students at the high school level showing that the achievement of mathematics literacy of class VII students is the lowest when compared to other levels at the junior and senior high school levels, which is equal to 1, 78%.[8]. The RME learning model is one way to improve mathematical literacy skills [9].

The factors that affect the achievement of mathematical literacy are crucial problems and need to be addressed since students are at the junior secondary level, they are in the phase of building an understanding of mathematics at an early level at the secondary education level. Based on the observations made, it was found that many students complained that they felt difficulties in solving the questions given so that students often made mistakes. Mistakes that are often made include (1) errors in understanding the problem, (2) errors in understanding the mathematical concepts used in the problems, (3) errors in representing contextual problems into mathematical forms, (4) errors in implementing strategies to solve problems, (5) errors in using formulas, (6) errors in performing mathematical operations, (7) errors in representing mathematical forms into contextual forms to answer problems in problems.

Based on the results of the interviews, students often complained if they got long story questions so that it was difficult for them to understand the questions. Internal factors in the form of self-motivation and student learning strategies can affect learning outcomes. Behaviors such as not paying attention to the teacher during learning, not being enthusiastic about learning, not learning independently, and cheating are quite disturbing problems. These mistakes and behaviors indicate that mathematics literacy and learning independence are still low. Learning that is done still often uses conventional models. Increasing mathematical literacy skills needs to be done by using a learning model that encourages students to be active.

Learning models that encourage students to actively exploit their inner potential to think with the guidance of the teacher include problem-based learning (PBL). The teacher guides students to solve these problems from various points of view. Students are expected to be able to collect their own understanding by thinking critically, able to solve problems, gain knowledge, and concepts from learning materials. Learning models that can provide students with the opportunity to develop their own abilities and knowledge, find mathematical rules and higher order thinking, include the PBL model. With the PBL model students will be able to think critically, logically to find solutions to problems [10].

Presentation of mathematics in the form of contextual problems is known as Realistic Mathematic Education (RME). RME was developed by Freudenthal based on his statement that mathematics is a form of human activity. The RME approach directs students to solve contextual problems based on students understanding. Realistic mathematics education (RME), one of the learning concepts in basic mathematics related to context, illustrations based on everyday situations. RME can motivate students to be more active and creative in looking for math problems based on real-life everyday conditions.[11]. Students will get a concept of mathematical ideas in their life with the guidance of the teacher through learning RME [12]. There are five principles in RME learning, namely understanding problems and
turning abstract problems into real (concrete) problems, modeling, reflecting and assigning special tasks, according to context and there are interactions for discussion, arrangement and relationships [13].

The advantages of the PBL learning model include that this model can require students to always learn maximally to solve real problems in groups. This model will spur students to think critically and analytically to exchange ideas with friends in their group to find solutions to problems by utilizing relevant learning resources [14]. Students' ability to think critically and creatively will increase if students experience interesting mathematical problems in their presentation that they can feel like they are experiencing them being involved in real problems. From this, the researcher has an assumption that PBL learning with the RME approach will be able to increase student curiosity, student creativity and students 'critical thinking level so that it will be able to improve students' mathematical literacy skills.

Mathematical literacy is a person's ability to use and apply mathematics to the problems of everyday life. The abilities that are covered in mathematical literacy include the ability to reason, mastering concepts, procedures, understanding facts, being able to predict future events based on current events and others.

Independent learning is believed to play a key role in student success in both academics and careers life [7]. Independence, includes capable behavior take initiative, be able to overcome obstacles/problems, have self-confidence and can-do things yourself without the help of others.

2. Methods
This research is a mixed method research using a sequential explanatory design. Sequential explanatory design is a combination research model that combines quantitative and qualitative methods sequentially. The quantitative research method was carried out in the first stage by following a quasi-experimental model which was designed in the form of a non-equivalent (pre-test and post-test) control group design. Quantitative data collection was carried out using written tests and questionnaires. Then proceed with deeper analysis of the results of the quantitative method using qualitative methods. Qualitative data collection was carried out by analyzing the results of written tests and questionnaires and conducting interviews.

3. Results and Discussion
The results showed that the lowest score of the students' mathematical literacy ability was 62 and the highest score was 96 with the experimental class average was 74.8 and the control class average was 67.6. The final data analysis was conducted to determine the achievement of the post-test results of mathematical literacy skills and learning independence questionnaire. The first hypothesis is that the PBL learning model with the RME approach can improve mathematical literacy skills. The average value of the mathematical literacy ability of the experimental class was 74.80, while the average value of the control class mathematics literacy ability was 69.38. Hypothesis testing was carried out and obtained sig 2 tailed = 0.017 <0.05 so that it can be concluded that there is a significant difference in the mean value between the experimental class and the control class.

The second hypothesis is whether the PBL learning model with the RME approach can increase learning independence. The results showed that the average value of independent learning in the experimental class was 81.06, while the average value of learning independence for the control class was 71.06. The second hypothesis testing results in sig 2 tailed = 0.01 <0.05, so it can be concluded that there is a difference in the average learning independence between the experimental class and the control class, where the learning independence value of the experimental class is better than the control class.

Based on interviews and analysis of the answers to the mathematics literacy test, it was found that the achievement of indicators of mathematical literacy skills and learning independence was obtained. The achievements indicators are shown in Table 1.

| Indicators                          | Experimental Class | Control Class |
|------------------------------------|--------------------|---------------|
| Reasoning and arguments            | 6 indicators       | 1 indicator   |
| Less good                          |                    |               |
| Good                               |                    |               |
| Others                             |                    |               |

Based on interviews and analysis of the answers to the mathematics literacy test, it was found that the achievement of indicators of mathematical literacy skills and learning independence was obtained. The achievements indicators are shown in Table 1.

The achievement of indicators of mathematical literacy skills in the experimental class of the upper group in the "good" category were 6 indicators and 1 indicator was in the poor category. Indicators that are "less good" are reasoning and arguments. This shows that students are accustomed to working on questions as exemplified by the teacher, but these students are not used to giving reasons or arguments
to the steps taken. This shows the lack of mathematical reasoning of students in expressing answers and arguments. Students are not used to being invited to construct their own answers, they are used to textbooks. In accordance with the theory of constructivism which says that learning is a process of forming knowledge that must be carried out by the individual himself. For the lower group, what needs more attention is the mathematizing indicator and reasoning and arguments. Lower group students still have difficulty transforming real problems into mathematical language and expressing their reasons or arguments, they are accustomed to following the steps to solve the problem taught by their teacher.

### Table 1. Achievement of mathematical literacy skills and independence of learning.

| Mathematical literacy skills | Indicator | High | Middle | Low |
|-----------------------------|-----------|------|--------|-----|
| communication               | v         | v    | v      |
| mathematizing               | v         | v    | v      |
| Representation              | v         | v    | x      |
| Reasoning and Argument      | v         | v    | v      |
| Devising                    | v         | v    | x      |
| Mathematical tools          | v         | v    | x      |
| Using mathematical tools    | v         | v    | x      |
| Optional strategies for solving problem | v | v |
| Using symbolic, formal and technical language and operations | v | v |
| Performance                 | v         | v    | x      |
| Self-reflection             | v         | x    | x      |

There are 5 indicators of learning independence in this research, namely self-efficacy, intrinsic value, tests of anxiety, cognitive strategy use and self-regulation. Learning independence indicators that need more attention from the teacher are tests of anxiety and cognitive strategy use. Students still experience anxiety when working on questions in the form of reasoning. The PBL learning model can guide their thinking / reasoning direction to become more organized. The RME approach can help students to understand abstract mathematical characters.

Learning in the experimental class uses the PBL model with the RME approach which allows students to actively link mathematics with contextual problems that exist around students and can increase learning independence. This is because during learning students solve contextual problems and relate them to learning materials, conduct group discussions to solve problems, and can give and listen to friends' responses to assess understanding. This also agrees with Vygotsky's theory of learning. When students construct a concept, students need to pay attention to their social environment so that learning with more meaningful interactions, both interactions between students, student interactions with teachers, even student interactions with conditions and problems around students.
4. Conclusion
Students who get learning with the PBL model with the RME approach have better mathematical literacy skills and learning independence than the conventional model with satisfactory indicators.

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