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Problem based learning with Indonesian realistic mathematics education approach assisted e-schoology to improve student mathematization

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Abstract. This study aims to determine (1) the quality of problem based learning with Indonesian realistic mathematics education approach (*PMRI*) assisted e-schoology (PPS), (2) the initial conditions of students' mathematization, (3) improvement of the mathematization of junior high school students at PPS. This study uses experiments. The population of this study was class VIII students of SMPN 4 Semarang. Samples were taken randomly and obtained three classes, one first class using PPS learning, second class using *PMRI* and third class using expository. Research result; (1) The quality of PPS learning devices and *PMRI* learning devices meets the very good category, (2) the initial mathematization ability of students is still below level 1. (3) Increasing the mathematization of junior high school students in PPS learning is higher than the improvement of students' mathematization with *PMRI* learning and higher than increasing students' mathematization in expository learning.

1. Introduction

Education is a process to develop all aspects of the human personality which includes knowledge, values, attitudes, and skills. Education is a means to prevent risk, as well as tools that can help improve the quality of human life in a sustainable manner. Literacy is the ability to process information by applying the techniques of reading, writing, representation and counting in a variety of diverse media [1]. The PISA Draft Assessment Mathematics Framework defines mathematical literacy as a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures, and facts to describe, explain or estimate event phenomena [2].

Mathematical literacy skills contain mathematical abilities (mathematical process). Mathematics comes from mathematisation or matematisation. The word mathematisation or mathematization is a noun from mathematize verb or matematisasi which means to be mathematical. So the simple meaning of mathematization is a process for mathematical phenomenon. Mematematisasikan can be interpreted as modeling mathematical phenomena (in the sense of looking for mathematics that is relevant to a phenomenon) or constructing a mathematical concept of a phenomenon. Mathematics is modeling a phenomenon mathematically or constructing a concept from a phenomenon. Mathematical education expert, distinguishes mathematics into two kinds, namely horizontal mathematical and vertical mathematical [3]. Horizontal mathematization defined by Gravemeijer as an activity to change contextual problems into mathematical problems, while vertical mathematical is the process of formulating problems into various mathematical solutions using a number of appropriate rules [4]. Another view of mathematics, terming informal mathematics as horizontal mathematical and formal



mathematics as vertical mathematical [5]. Horizontal mathematical activities begin by solving problems in life situations by transferring problems to mathematical problems then proceeding with vertical mathematics, namely scoring and visualization to find order and relationships between concepts, which are needed to identify specific mathematics in a more general context.

The 2012 PISA results showed that the score of Indonesian students' mathematics literacy abilities was 375 and ranked 64th out of 65 countries, reading literacy score of 396 ranking 61 of 65 countries and 382 scientific literacy scores ranked 64th out of 65 countries, while Indonesia's participation in the 2015 PISA received results that Indonesia ranked 62 of 70 countries with an average score of 403[6]. Because mathematics is a basic science, it is important for students to learn, both as a tool for other lessons, as a science, as a guide to mindset, and as a form of attitude. Every activity carried out by humans is realized or not, there is always a connection with mathematics. Therefore, mathematics is one of the basic sciences that must be mastered by humans, especially by students in order to prepare students to face problems in the real world. Students' mathematical literacy skills in Indonesia are still very low the OECD (Organization for Economic Corporation and Development) scores and also from several countries participating in the PISA (Program for International Student Assistance) [7]. Students in Indonesia can answer PISA questions at level 1, 2, 3 and only a few students can solve problems at level 4 [8]. Weak mathematical literacy for level 3 to level 6 categories because; 1) students have not been able to develop their thinking skills optimally in mathematics subjects at school; 2) the process of learning mathematics has not been able to make students have the habit of reading while thinking and working, in order to understand essential and strategic information in solving problems; 3) from solving the problems made by students, it appears that the mechanistic dose is still too large and the reasoning dose is still low; 4) mathematics subjects for students have not become "schools of thinking", but students still tend to "receive" information then forget about it, so that mathematics subjects have not been able to make students smart, smart and deft.

The results of interviews with some grade VII math teachers at SMPN 4 Semarang, stated that students' abilities were still low, namely the ability to solve contextual questions and problems related to geometry, algebra, opportunities and numbers. Based on these conditions, the need for innovation in mathematics learning student-centered, learning that provides opportunities for students to be able to improve learning activities so that students can find their own concepts in mathematics. Problem Based Learning (PBL) is a learning that uses real-world problems as a context for students to learn about problem solving skills. In the PBL model, the problems raised by the teacher are real and interesting world problems, so students are trained to solve problems that require creative thinking [9]. According to Nalole relating to the presentation of mathematics which begins with something concrete, in the Netherlands Realistic Mathematics Education (RME) has long been developed [10]. The RME refers to Freudenthal's opinion that mathematics must be linked to reality and mathematics is human activity. This means that mathematics must be close to children and relevant to everyday situations. RME was adapted to adapt Indonesia's culture and natural environment to become Indonesian Realistic Mathematics Education (PMRI).

The effort that the teacher can do to improve students' mathematics literacy skills is by developing innovative learning tools and applying them in the classroom. Based on the mandate of the 2013 curriculum, teachers are encouraged to apply learning to the Problem Based Learning (PBL) learning model. In PBL learning there will be meaningful learning, students will be able to solve a problem by applying their knowledge or trying to fulfill the knowledge needed to solve the problem at hand. In PBL situations, students integrate knowledge and skills simultaneously and apply them in relevant contexts. In addition, PBL can improve critical thinking skills, foster student initiative in work, internal motivation to learn, and can develop interpersonal relationships in group work. PBL's complexity lies in the process of introducing PBL to students. Potential stressful students at the beginning of the introduction applied PBL but will improve after they are familiar with PBL [11].

PBL is a learning model that presents contextual problems that stimulate students to learn. In classes that apply problem-based learning, students work in teams to solve real-world problems. PBL has student-centered characteristics, is designed based on real problems that are open-ended or

ambiguous, and encourages students to build a rich understanding of contextual mathematical concepts through a series of constructive questions. The advantages of PBL according to are: (1) PBL facilitates the occurrence of meaningful learning by encouraging students to solve a problem dealing with the situation in which the concept is applied; (2) students integrate knowledge and skills simultaneously and apply them in relevant contexts in PBL situations; (3) PBL can improve critical thinking skills, foster student participants' initiative in working, internal motivation to learn, and can develop interpersonal relationships in group work.

Furthermore, it is known that the assessment of PISA mathematics literacy uses questions with real-world contexts. To support the assessment, the problem formulation in PBL should be raised from real / realistic problems. An approach that fits this purpose is a realistic approach or PMRI. This approach considers that mathematics has human values so that mathematics learning must be linked to reality and close to the child's experience and relevant to people's lives. One of the rules of learning using the PMRI approach is to use problem-based learning ; where the implementation of the PMRI approach with PBL settings requires realistic problems. In PBL environments, learning content is transformed into a problem that is not well structured to provide a PMRI approach to learning [12].

One approach to learning mathematics in accordance with the Indonesian curriculum as well as in line with the PISA objective is learning to use the Indonesian Realistic Mathematics Education (PMRI) approach, which is a learning approach that combines views on mathematics, how students learn mathematics, and how to teach mathematics. If viewed from the perspective of PMRI, the three types of processes in the process are characteristic of PMRI. Therefore, it can be said that the application of PMRI for learning mathematics is in line with the curriculum. This learning approach was adapted from learning using Realistic Mathematics Education (RME) applied in the Netherlands. This is consistent with the results of Wardono's research and Wardono, et al mention that PMRI learning adapted from RME can improve students' mathematical literacy skills [13, 14]. In the 1970s the Dutch had developed the RME learning approach, the fundamental principle of RME is that involvement in mathematics for students must begin in a meaningful context. Development of understanding and ability to make mathematical representations begins with students' formal reasoning. Descriptions from the cognitive perspective of learning, students relate to existing knowledge in previous mathematical representations, concepts, and skills. So, a stronger way to know and complete mathematics is built from the perspective of students. This approach gives students a sense of belonging. Although the teacher's role is very important to help students collectively explain the conventional meanings and uses of mathematical terms, symbols, representations, and procedures [15].

RME learning students become able to easily understand the language of mathematics, solve and construct problems, especially to recognize mathematical concepts in certain situations [16]. The RME according to Webb et al is not only because of its relationship to the real world context, but related to the emphasis on RME placing on the problem of students' problems with real-life situations [15]. The principle of RME is that involvement in mathematics for students must begin in a meaningful context and the development of mathematical representations and abilities that begin with students' formal reasoning. According to De Lange the five characteristics of Realistic RME Mathematics are: (1) using contextological exploration or the use of contexts; (2) using models (the use of models or bridging by vertical instruments); (3) appreciate the variety of answers and contributions of students (the use of students own); (4) interactivity (the interactive character of the teaching process or interactivity); (5) integrated with other learning topics (the intertwining of various learning strands) [5].

Schoology is a site that combines social networking features and LMS. Through schoology, you can interact socially as well as learn. Schoology is similar to Edmodo, with its advantages in several features and can be entered into the system with the link www.schoology.com. The features possessed by schoology are courses (courses), namely facilities for creating subject classes, for example mathematics subjects, groups, namely facilities for creating groups, and resources (learning resources). On the course menu can make a quiz of many types, namely multiple choice, right wrong, match up,

and short entries. Making questions in schoology comes with symbols, equations, and latex. So, all types of questions that contain images, symbols, and equations can be written in schoology. In addition, to include members or students who take part in the class that is given enough to give the code to students who are taught.

Based on the description above the research objectives to be achieved are as follows. (1) Knowing the quality of PPS and PMRI learning devices for junior high school students that can contribute to improving mathematical abilities; (2) Knowing the initial mathematical conditions (3) Knowing the improvement of the mathematics of junior high school students in PPS learning is higher than the increase in mathematical students with PMRI learning and higher than the increase in mathematics in expository learning.

2. Materials and Methods

This research is a type of quantitative research. The subject of the research was the eighth grade students of SMPn 4 Semarang in 2016 / 2017. The three classes as the research sample consisted of 2 experimental classes, 1 control class. Determination of research samples based on random sampling. The first class as the experimental class that applies PPS, the second class as the PMRI class, the third class the control class uses the expository model. Data collection techniques to determine the quality of learning devices is done by filling out the device validation sheet by the validator. Data retrieval of mathematical ability with mathematical ability test (MAT) in the form of a written test. MAT is used to collect research data about the mathematical abilities of junior high school students. To find out that the sample comes from a normal and homogeneous population, normality test and homogeneity test are carried out. To find out that the experimental group with PPS, the experimental group with PMRI and the control group with the expository in the initial conditions had the same mathematical ability to do an average similarity test with ANOVA. To find out the quality of PPS and PMRI learning devices, the validator results were analyzed by using descriptive statistics. Furthermore, to find out the improvement of mathematical ability with PPS and PMRI learning, the average differences in the results of the final mathematical ability test were done by ANOVA.

3. Results and Discussion

3.1. PPS and PMRI Learning Devices

The PPS learning device consisting of syllabus, Lesson Plan(LP), Student Worksheet(SW), Teaching Materials, MAT and in this study after being validated by 6 validators was valid with a very good category. This happens after the learning tools and research instruments are prepared by referring to guidelines and guidelines for the preparation of learning tools and good research instruments. The PMRI learning device consisting of syllabus, LP, SW, Teaching Materials, MAT in this study after being validated by 6 validators turned out to be valid with a very good category. This happens after the learning tools and research instruments are prepared by referring to guidelines and guidelines for the preparation of learning tools and good research instruments. This is in accordance with the results of previous studies by Wardono, et al who conducted research on students of the Junior High School Mathematics Curriculum Review with the results of the study showing that the learning tools developed were valid, practical and effective and could improve student mathematics literacy [17]. Learning quality meets good categories and student character increases.

3.2. Initial Mathematization Ability of Junior High School Students

Descriptive statistics show that the mean mathematical ability of students of Semarang 4 State Junior High School is still at level 1 with the control group mean of 307.5, the mean of experimental group 1 (PPS) 317.8 and the mean of experimental group 2 (PMRI) 308 and the mean of all groups 311.1 . While the descriptive statistics show that the mean mathematical ability of students of Semarang 4 State Junior High School is still at level 1 with the control group mean of 300, the mean of experimental group 1 (PPS) 343.1 and the mean of experimental group 2 (PMRI) 303.4 and the mean of all groups 315 , 5. The results of the initial mathematical ability research at SMPN 4 with the mean

of all 311.1 groups was in accordance with the results of the latest PISA survey 2015 by the OECD that Indonesian students' mathematical literacy skills were still low at 386 at level 1 below 419.

3.3. *Improvement of Mathematization Ability of Junior High School Students*

The results showed that the treatment with PPS learning and PMRI learning could improve the mathematical ability of junior high school students with the highest increase in PPS learning followed by an increase in PMRI learning. Indicator of the ability of the mathematical process in horizontal mathematical namely identifying mathematical concepts that are relevant to the real world, presenting problems in different ways, including organizing problems in accordance with relevant mathematical concepts, and formulating appropriate assumptions, looking for relationships between "languages" problems with symbols and formal "language" of mathematics so that real problems can be understood mathematically, looking for order, relationships and patterns related to problems, translating problems into mathematical forms in the form of mathematical models and indicators of the ability of vertical mathematical process consisting of using various mathematical representations different, using symbols, "languages" and formal mathematical processes, adjusting and developing mathematical models, combining and combining various models, mathematical arguments and generalizations [5]. This is in accordance with research on students' mathematics with PBL-Realistic-Card learning better than the mathematical process of students with scientific learning [18].

Indicators of the ability of the mathematical process of junior high school students mentioned above are highly contributed by the advantages of PPS and PMRI, namely in PPS and PMRI learning students are always oriented to the problem, the teacher always tries to guide students both individuals and groups to always learn optimally, students are constantly encouraged to presentation presents all the results of work / study in various forms and ways, students are always directed to analyze and evaluate the problem solving process. PPS and PMRI on PBL learning students are faced with authentic and meaningful problems to students which serve as the basis for students to conduct investigations and investigations, so that students can structure their own knowledge, develop higher skills and inquiry and can make students confident and more independent students. PPS and PMRI in PBL is a student-centered learning model, so that student activity is prioritized rather than prioritizing the activities of the teacher. PBL as a learning model that empowers students to conduct a study, integrates theory and practice, and applies knowledge and skills to develop solutions to defined problems. PBL is an effective learning condition for students to be actively involved in meaningful learning.

The horizontal mathematical process occurs when students use their informal strategies to describe and solve contextual problems while vertical mathematization occurs when the informal strategy of students can solve problems by using mathematical language or by finding algorithms that are suitable for problem solving . Learning mathematics in a context, with methodological changes, requires things that challenge students to become more independent thinkers in order to become better mathematical problem solvers. In theory, the RME / PMRI is a learning approach that encourages every student in the mathematics class to do mathematical contests in using mathematics to solve everyday problems or mathematical problems they face.

The results of other studies that support the results of this study that PMRI learning presents real problems are used as the beginning of learning which is then used by students in mathematical processes and the development of mathematical models [18]. Improvement of Mathematical Problem Solving Ability (KPM) of PMRI students is higher than the increase in KPM of Ordinary Learning (PB) students. The implication of this finding is that realistic mathematics education is suitable to be used to replace ordinary learning in junior high schools in the city of Yogyakarta in order to improve students' ability to solve mathematical problems [19]. Mathematics education for pre-teaching teachers must incorporate professional, vocational, and mathematical avocational contexts into pedagogical and content discussions to ensure K-6 teachers can introduce students to the correct mathematical context outside of math class. One approach to mathematics learning is oriented towards mathematize of everyday experience and applying mathematics in daily life is RME [20].

Learning with the PMRI learning approach to learning quadrilateral flat building material is better than the constructivism learning approach using hypnosis in teaching and conventional learning approaches [20]. Learning with the help of tablets compared to traditional learning outcomes is better for students; Using Realistic Mathematics Education with the use of software for tablets results in better learning outcomes than teaching using thematic-based curriculum in Greece [16]. In mathematics learning we often find students who have difficulty in receiving the material being taught, to anticipate that mathematics learning should begin with the introduction of problems that are appropriate to the situation (contextual problem). One of the appropriate approaches to support teachers as professional teachers is the PMRI approach, so students can construct their own knowledge. .

PMRI is effective in increasing the ability to understand the addition and subtraction of negative integers in mathematics learning in the fourth grade of SDN Sukalerang I in Ciamalaka District, Sumedang Regency. The use of the RME approach is effective in improving teacher skills and creativity. The real success of students when facing challenging questions and instructors themselves motivates them to adapt using RME / PMRI and progressive formalization. Geist, Webb & Van der Kooij prove the usefulness of RME / PMRI can focus more on the mathematics class [21].

In the RME approach students must be guided to find mathematics again by working in a motivating context. As such, it is important for the teacher to choose mathematical problems that trigger the interest of students. It must be intrinsically inviting students to be involved with problems and enthusiasm to solve problems faced [22]. Researchers argue strongly that if students learn material functions in the way discussed in the study, they can develop a strong foundation for other mathematical concepts and also mathematical procedural knowledge that helps them to learn other mathematical concepts deeper and more meaningfully. Another advantage of PPS and PMRI when compared to expository learning is that by PMRI students will be better able to understand contextual problems, students are more skilled at describing contextual problems faced, students are always trained to solve contextual problems, students are always invited to compare and discuss answers to problems and students always learn how to draw conclusions based on mathematical arguments.

The advantages of PPS and PMRI are very contributing to the indicators of mathematical ability that makes the mathematical ability of students with PPS and PMRI learning increases and the increase is higher than the increase that occurs in the expository group. Another advantage of this PPS is students in learning, in finding solutions to problems that are an important part of mathematical ability by using cool media that are currently popular, such as social media, namely the media e-learning schoology. By using pleasant media in accordance with the times, students can learn with unlimited classrooms and time. Students can also learn to communicate interactively with their teacher at any time even though teachers and students in separate places students and teachers can interact with each other online and this is what causes the improvement of the ability of the PPS group matematiation process to be higher than the mathematical ability of the group of students with PMRI learning.

4. Conclusions

1. The quality of PPS learning devices and PMRI learning tools meets the excellent category.
2. The initial ability of students' mathematics in Semarang 4 Junior High School is still low
3. The improvement of students' mathematics in SMPN 4 on PPS learning is higher than the increase in students' mathematics with PMRI learning and higher than the increase in mathematics in expository learning.

PPS learning needs to be implemented so that students are more interested and feel happy learning mathematics, using mathematics to solve everyday real-world problems. This means that it has accustomed students to learning mathematics and mathematical literacy so that it will have an impact on improving the ranking of PISA mathematics literacy in Indonesian junior high school students at the international level. The use of cellphones for positive things, namely as a medium for learning

mathematics using e-learning schoology needs to be continued as well as to eliminate the negative image of using cellphone.

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