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The Effect of Numerical Literacy Activities in Problem Based Learning Environment toward Mathematical Reasoning Ability of Elementary School Students

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Abstract: 21st-century competence demands that students can reason according to current conditions that are relevant and accurate. Still, learning in the classroom uses a learning model that often does not support students' reasoning. This study aims for differences in students' mathematical reasoning abilities after being taught using an integrated problem-based learning model of numeracy literacy activities with students' mathematical reasoning abilities using a problem-based learning model. This type of research is quasi-experimental design. The population is all grade IV elementary school students, Takalar. The sampling technique is cluster random sampling. The instrument uses a reasoning test. The results showed a difference in mathematical reasoning ability between students taught with an integrated problem-based learning model of numeracy literacy activities and students trained with problem-based learning. Teachers can improve students' reasoning power by using a problem-based learning model integrated with numeracy literacy activities

Keywords: Problem-based learning, numeracy literacy, reasoning, mathematics

Abstrak: *Kompetensi abad 21 menuntut siswa dapat bernalar sesuai dengan kondisi saat ini yang relevan dan akurat. Namun pembelajaran di kelas menggunakan model pembelajaran yang seringkali kurang mendukung penalaran siswa. Penelitian ini bertujuan untuk mengetahui perbedaan kemampuan penalaran matematis siswa setelah diajar menggunakan model pembelajaran terintegrasi aktivitas literasi berhitung dengan kemampuan penalaran matematis siswa menggunakan model pembelajaran berbasis masalah. Jenis penelitian ini adalah quasi-experimental design. Populasinya adalah seluruh siswa kelas IV SD Negeri, Takalar. Teknik pengambilan sampel adalah cluster random sampling. Instrumen yang digunakan adalah tes penalaran. Hasil penelitian menunjukkan adanya perbedaan kemampuan penalaran matematis antara siswa yang diajar dengan model pembelajaran berbasis masalah terpadu kegiatan literasi berhitung dan siswa yang dilatih dengan pembelajaran berbasis masalah. Guru dapat meningkatkan daya nalar siswa dengan menggunakan model pembelajaran berbasis masalah yang terintegrasi dengan kegiatan literasi berhitung.*

Kata kunci: *Problem-based learning, literasi numerik, penalaran, matematika*

▪ INTRODUCTION

Mathematics learning objectives and process standards are aligned so that participants and students can use reasoning on patterns and traits. In addition, students can perform mathematical manipulation to make generalisations and build evidence or explain ideas and statements in mathematics. The reason is one of the abilities that must be achieved in learning mathematics. Determining reasoning ability as the goal and vision of learning mathematics proves that reasoning ability is essential for students. It is reinforced by a study that states that reasoning abilities are needed by students in learning mathematics because the thinking patterns developed in mathematics need and

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involved critical, systematic, logical, and creative thinking (Hanifah et al., 2019, Fadillah, 2019).

Mathematical reasoning is also necessary to develop students' scientific attitudes (Mukuka et al., 2021, Jeannotte & Kieran, 2017). Mathematics results from human thinking related to ideas, processes and reasoning. The ability to use logic is essential in understanding mathematics. In learning mathematics, students should be able to connect their knowledge with the knowledge they are still learning (Eriksson & Sumpter, 2021). For this reason, students' mathematical reasoning abilities must continue to be developed, which impacts achieving maximum learning outcomes.

The fact that occurs in learning, especially in learning mathematics, is the low reasoning ability of students, one of which is caused by the use of conventional learning methods or lecture methods in classroom learning activities. The results of the author's initial observations in the fourth grade of elementary school cluster 1, Pattallassang sub-district, Takalar Regency, it is known that the mathematics learning process carried out by teachers in several schools is more concerned with the memorisation process, not understanding. It creates learning in a less conducive atmosphere, and students become passive. The results of interviews with elementary school teachers in cluster 1 Pattallassang District, Takalar Regency, revealed that student learning outcomes, especially in mathematics, were still in the low category. The material in mathematics is more complex for students to understand than in other subjects. In addition, students still find it very difficult to solve problems related to problem-solving and reasoning abilities are still low. It can be seen from the average score of semester one exams for mathematics subjects in the 2021/2022 school year, where the average student score is below 70. The average value, compared to learning completeness according to the curriculum, is 75. Its value is still lower or below the expected minimum completeness criteria.

Low student learning outcomes, especially in reasoning abilities, allegedly occur due to several factors, both teachers and students. From the teacher's perspective, the lack of application of learning models or methods that can hone students' reasoning skills. In addition, the low learning outcomes of students, especially in mathematics, are also the impact of learning that tends to be teacher-centred and less meaningful for students. Teacher-centred education manages to cram procedural knowledge into children and emphasises memorising that knowledge. Of course, this situation needs attention so that learning models can be applied in learning mathematics to optimise students' reasoning abilities.

Problem Based Learning (PBL) model is one alternative that can be applied in learning mathematics in the context of developing students' problem-solving abilities (AK Amin et al., 2021, Rott et al., 2021). The PBL syntax is orienting students to problems, organising students, guiding the investigation process, presenting student work and analysing and evaluating the problem-solving process (Kelly et al., 2016, Basadur et al., 2014, Meister et al., 2018). From the syntax, it is illustrated that the teacher in learning with the PBL model only acts as a facilitator and motivator, where learning begins with problems and students are allowed to develop their abilities in solving these problems. This activity can familiarise students to participate actively in classroom learning while simultaneously developing students' ability to solve problems (Hendriana et al., 2018, Seibert, 2021).

Mathematics demands in schools in the 21st century emphasise critical thinking skills, connecting knowledge with the real world, mastering information technology, and communicating and collaborating (Salas Rueda, 2018). The demand for abilities that must be achieved will be realised if students have good numeracy skills (Durrani & Tariq, 2012, Mercader et al., 2018, Singh et al., 2021). Numerical ability is a critical ability for students to have because this ability is closely related to solving mathematical problems in everyday life. In simple terms, numeracy skills are defined as the ability to understand, use, and analyse mathematics in various contexts to solve problems in everyday life, as well as explain the use of mathematics (Apriliawan & Parmiti, 2021).

The minimum competency assessment is an effort made by the government to improve the quality of education in Indonesia. The results of the PISA (Program for International Student Assessment) and TIMSS (Trends International Mathematics and Science Study) assessments are very concerning. This mathematical literacy ability is not in line with the mathematical literacy ability in Indonesia, which is far behind other countries. This mathematical literacy ability is one of the challenges to face in the future, namely in the 21st century. Mathematical literacy can develop communication. This ability includes mathematical reasoning and the ability to use mathematical concepts, procedures, facts and mathematical functions to describe, explain and predict a phenomenon.

An important aspect of mathematical literacy is using, doing, and recognising mathematics in various situations. When solving problems that allow students to understand mathematical applications, the choice of methods and mathematical representations often depends on the situation in which the problem is presented (GLN, 2017). Thus, mathematical literacy activities will result in understanding mathematical terminology and numerical and spatial information, developing basic mathematical skills in analysing critical situations, and creatively solving everyday problems. Numerical literacy activities need to be adequately designed because they have a good influence on a person's development and ability to think so that this habit will become a good skill in solving life problems (Kamza et al., 2021). Numerical literacy ability is very influential on student learning achievement. If the numeracy ability of each student is high, the learning achievement that will be obtained is also high, and vice versa. Therefore, how enhancement is the students' reasoning power before and after treatment? Is there a difference between the two models on the reasoning ability of fourth-grade elementary school students?

▪ METHOD

Participants

The research population was all fourth graders of Elementary School Cluster 1, Pattallassang District, which consisted of 4 schools. Schools belonging to cluster 1 in Pattallassang District are located in the centre of Takalar city. The quality and characteristics of students in cluster 1 schools in Pattallassang District are almost identical. Random sampling technique. The results of the random selection of fourth-grade students of SD Negeri 234 Inpres Takalar Kota consists of 2 classes, namely IVA and IVB.

Research Design and Procedure

This research refers to quantitative research methods. The type of research used in this study is a quasi-experimental research type of nonequivalent control group design. Design draft nonequivalent control group, before was given treatment, both the experimental group and the control group were assigned a test, namely the pre-test, to know the condition of the group before treatment. Then after being given treatment, the experimental group and the control group were assigned a test, namely the post-test, to determine the condition of the group after treatment. The operational definition of research is that mathematical reasoning is the ability of students to carry out an activity, process or logical thinking activity to draw a conclusion or make a new statement based on several reports whose truth has been proven previously in solving mathematical problems

Instruments

Instrument the research used a reasoning test in the form of a written test in the form of a description question. The making and assessment of description test questions are guided by indicators of students' mathematical reasoning abilities. The results of the descriptive test will be scored according to the scoring criteria. The mathematical reasoning test given to students is in the form of a description test as a measuring tool for mathematical reasoning abilities. The test obtains quantitative data from students' abilities to solve mathematical reasoning problems. The instrument validity consists of content validity and constructs validity. The validation process begins with observation of the instrument by experts, then the experts correct all the items on the instrument according to or not with the instrument grid, and then the instrument is revised based on expert input. After examining the revised results and evaluating them systematically, the experts provide an assessment of whether the instrument is feasible to use or not. There are two validators, namely internal validators, namely supervisor one and external validators, namely research expert lecturers.

Data Analysis

The data analysis technique used descriptive analysis and inferential analysis. Descriptive analysis is used to provide an overview of the data on the results of the implementation of learning using the integrated PBL model of numeracy literacy activities with the PBL model approach, as well as data on the results of students' reasoning ability tests in experimental class 1 and experimental class 2. An inferential analysis is intended to test research hypotheses. Before the hypothesis, the data normality and homogeneity were first tested using the Shapiro-Wilk test with a significance level of 5%. The data is normally distributed if the p-value is 0.05. The homogeneity test is used to determine whether the data is homogeneous/same or not. The homogeneity test used Levene's test statistic. The data is homogeneous if the p-value is 0.05. Hypothesis testing using independent sample t-test. Data analysis application using SPSS.

▪ RESULT AND DISSCUSSION

Recapitulation of the results of the fourth-grade students' mathematical reasoning ability test at Cluster 1 Elementary School, Patalassang District, Takalar Regency for pre-test and post-test data for the experimental class. These mean, standard deviation,

maximum value and minimum values for the pre-test are 67.33, 9.07, 55 and 90, while for the post-test are 71.67, 12.55, 45 and 95. Based on these values, there is an increase in the value from pre-test to post-test even though the range of student scores in the post-test was greater. It means that students' abilities are more varied during the post-test when compared to the pre-test.

The percentage of achievement criteria for pre-test and post-test results of mathematical reasoning abilities of experimental class students of fourth-grade students shows the percentage of pre-test and post-test results of the fourth-grade students of SD Cluster 1 after the treatment was carried out using the integrated PBL learning model for numeracy literacy activities. There were five people, or 17%, who entered the very high category, 17 people or 57%, who entered the high category, and eight people or 27%, who fell into the moderate category. These results indicate that the student's mathematical reasoning abilities showed improved results after being given treatment. The number of students with a post-test score higher than the pre-test score was in the very high and high categories, while low and very low did not have enough supporting data.

The results of the mathematical reasoning ability test of Class IV Elementary School Cluster 1 Elementary Schools, Patalassang District, Takalar Regency, for pre-test and post-test data for the control class. These results are the mean, standard deviation, maximum value and minimum value for the pre-test, i.e. 63.83, 9.25, 35 and 80, while for the post-test, i.e. 64, 9.59, 40 and 85. Based on this value, there was an increase in the score from pre-test to post-test even though the range of student scores in the post-test was greater. It means that students' abilities are more varied during the post-test when compared to the pre-test. The descriptive difference between the post-test was that the experimental group was higher than the control group. It also happened in the post-test. However, these results are still limited to the characteristics of the sample. The characteristics of the sample only reflect itself not yet up to the parameters (Kim, 2015, Mallik, 2020).

The percentage of achievement criteria for the pre-test and post-test results of the control class students' mathematical reasoning abilities in Class IV Elementary School Cluster 1 pre-test and post-test for the control class shows students' mathematical reasoning ability test results in Class IV Elementary School Cluster 1 after the PBL learning model treatment. After being given a retest or post-test, the results showed a slight increase for the control class. As a result, there are one person or 3% who are in the very high category, as many as 16 people or 53% are in the high category, 12 people or 40% are in the moderate category, and one person or 3% shows that the post-test and pre-test are almost the same, whereas in the high category, the same, while in the high category, the post-test is higher, and in the moderate category, the pre-test is higher.

The data normality distribution test showed a sig value of 0.090, which was greater than 0.05, meaning that the experimental class pre-test data was normal. The data normality distribution test showed a sig value of .393 greater than 0.05, meaning that the experimental class pre-test data distribution was normal. Furthermore, the post-test data distribution normality test shows a sig value of 0.150, which is greater than 0.05; the experimental class pre-test data is normal. The data normality distribution test showed a sig value of 0.150, which was greater than 0.05, meaning that the experimental class pre-test data was normal. The normality test shows the value of sig.

0.053 for statistics Kolmogorov-Smirnov and 0.300 for the Shapiro-Wilk statistic. The two values indicate that the value obtained is greater than the significant level =0.05 (sig. > 0.05), so it can be concluded that the value of the control class's mathematical reasoning ability (Post-Test) is normally distributed. The homogeneity test of the mathematical reasoning ability data in the control and experimental classes. A score of 0.078 is greater than 0.05 so it can be concluded that the data on mathematical reasoning ability in the control and experimental classes came from a homogeneous population. The homogeneity test requirement is a requirement to compare two groups (Flores et al., 2018, Hsu et al., 2020). That is, the data from the experimental group and the control group can be compared

Hypothesis testing shows differences in mathematical reasoning abilities between students taught using the integrated PBL learning model for numeracy in literacy activities, and PBL learning models show a significance of 0.010, which is smaller than 0.05. The mean value of integrated PBL in numeracy literacy activities is higher. Therefore, the mathematical reasoning ability of students taught using the integrated PBL learning model of numeracy literacy activities is higher than the PBL learning model. Furthermore, there are differences in students' mathematical reasoning abilities before and after using the integrated PBL learning model for numeracy literacy activities with the paired sample t-test. Based on the test on the paired sample t-test table (increase test) above, a significance of 0.000 was obtained. This signature value is smaller than 0.05, so it can be concluded that there are differences in students' mathematical reasoning abilities before and after being taught using the integrated PBL learning model of numeracy literacy activities.

There are differences in students' mathematical reasoning abilities before and after using the PBL learning model with the paired sample t-test shows a significance of 0.000, which is smaller than 0.05, so it can be concluded that there are differences in students' mathematical reasoning abilities before and after being taught using the PBL learning model.

Analysis of independent samples t-test to see a comparison of the implementation of the integrated PBL model of numeracy literacy activities with the application of the PBL model, the value of is obtained significance of 0.010. This signature value is smaller than 0.05, while the control class average is 64 and for the experimental class 71.67, so it can be concluded that there are differences in mathematical reasoning abilities between students who are taught using the integrated PBL learning model of numeracy literacy and the PBL learning model. The integrated PBL learning model for numeracy literacy activities is a learning process where students will be faced with a problem, then organised to learn to solve the problems they face where the problem is associated with events often encountered in everyday life (Seibert, 2021, Ghani et al., 2021, Hendarwati et al., 2021). Using the integrated PBL learning model for numeracy literacy activities is more effective than applying it. The integrated PBL learning model makes it easier for students to solve problems, improve their understanding, and make it easier for them to conclude. It can be created because the PBL learning model trains students to analyse information in various forms that are poured into solving problems related to everyday life (Munawaroh, 2020, Amin et al., 2020, Suhirman et al., 2020).

Applying number concepts and arithmetic operations skills in everyday life is also needed to solve the problem. In addition, reasoning ability is also required in solving

problems, where the mathematical reasoning ability in question is the ability to solve problems, analyse new situations or problems, make logical assumptions in solving existing problems and provide good reasons for making conclusions. Learning with problem-based learning models makes the classroom atmosphere fun and interesting because, in the mathematics learning process, the lecture method is no longer used but group discussions and assignments (Ramadhani et al., 2019, Kardoyo et al., 2020, Beckton et al., 2016). The PBL model makes students accustomed to solving complex questions independently (Weber, 2005). The enthusiasm of students in working on problem-solving questions increased from before.

The emergence can see the increase in students' mathematical reasoning abilities of indicators of mathematical reasoning in students in learning, namely, students can present mathematical opinions. Then, it can express opinions or arguments accompanied by logical reasons, propose assumptions from statements, check the validity of an idea, conclude, compile evidence, give the reason for the truth of a solution, and determine the pattern or nature of mathematical phenomena to make generalisations.

Problem-based learning models help students to use their reasoning in solving problems, assist students in mastering the concepts of the material being taught and provide opportunities for students to show their potential abilities, including creative abilities and problem-solving abilities. It is in line with research conducted by Mostopha & Hidayah, 2020 which explains that PBL positively affects aspects of critical thinking and cognitive reasoning after being given problem-based learning (Darhim et al., 2020).

Problem-based learning begins with student orientation, where students face problems that will make them think and use their skills to solve them. Then students are guided or directed in solving these problems. Problem-based learning is a process which involves mental operations such as reasoning and encourages students not only to think concretely but also to think about abstract and complex ideas using their skills (Shandy Narmaditya et al., 2018). It is related to mathematical literacy. The mathematical literacy of the experimental group was significantly higher after being taught through the instructional process (Sumirattana et al., 2017). The PBL model positively influences students' mathematical reasoning abilities. Students will use their abilities to solve a given problem. Students face a complex problem with learning materials that they often encounter daily. In learning mathematics, various skills are needed to solve practical problems in various contexts in everyday life. One of the skills that students must have in studying mathematics is numeracy literacy skills.

Numerical literacy is the knowledge and skill to use a variety of numbers and symbols related to basic mathematics to solve practical problems in various contexts of everyday life and analyse information presented in various forms (graphs, tables, charts, etc.) use the interpretation of the results of the analysis to predict and draw conclusions and decisions (Hill & Brase, 2012). In simple terms, numeracy can be defined as the ability to apply number concepts and arithmetic operations skills in everyday life. Numerical literacy also includes the ability to translate quantitative information that is around us (Sunderaraman et al., 2020). Model proses problem solving bukan hanya pada tataran eksperimen namun menjadi system intelligent sessua kebutuhan pendidikan lebih luas (Koike et al., 2020, Pejić & Molcer, 2021, Sun et al., 2022) or living lav (Choi et al., 2021), and game-based learning environments (Liu & Israel, 2022).

Based on this, PBL learning integrated with numeracy literacy activities is a learning process that can improve students' reasoning power. Students are often faced with problems or problems related to events that are frequently encountered in everyday life. These activities require a high level of reasoning power according to the demands of the 21st century. Therefore, it is recommended that school teachers choose an integrated PBL learning model for numeracy literacy activities.

▪ CONCLUSION

There was a significant increase in students' mathematical reasoning abilities before and after implementing the integrated PBL learning model for numeracy literacy activities. Likewise, there was a significant increase in students' mathematical reasoning abilities before and after implementing the PBL learning model. However, the increase in score was higher than the integrated PBL learning model for numeracy literacy activities. There is a difference in mathematical reasoning ability between students taught using the PBL learning model integrated with numeracy literacy activities and those taught using the PBL learning model. This study only relates the learning model to students' reasoning power while other variables are not considered. In addition, this study does not test the N-Gain for each indicator of the reasoning variable. Therefore, other researchers can explore these two things further.

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