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The Implementation of Problem-Based Learning Model with the Context of Traditional Saro Food to Support Students' Numeracy Ability on Ratio Topic

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Abstract: Numeracy skills in ratio are an important basic competency for junior high school students, as the concepts of comparison and ratio are often encountered in everyday life. However, the results of national and international assessments such as the Programme for International Student Assessment (PISA) 2022 and the 2023 Minimum Competency Assessment (AKM) show that most Indonesian students have not yet reached the minimum competency threshold for numeracy (OECD, 2023; Kemendikbud, 2023). This condition shows a gap between the curriculum requirements that emphasize critical thinking skills and the application of mathematics in real contexts with the low learning outcomes. Therefore, contextual learning innovations that are close to the students' culture are needed. One relevant approach is Problem-Based Learning (PBL), which emphasizes the active involvement of students in solving real problems. The novelty of this study lies in the application of PBL combined with the context of traditional Saro food from Ternate City as a learning medium to represent the concept of ratio in a concrete way. This study aims to determine whether the application of the PBL model using the traditional food context of Saro can significantly improve students' numeracy skills in ratio material. The study was conducted at a junior high school in Ternate City, involving 23 seventh-grade students who were randomly selected using random sampling techniques. The research approach used was Quasi Experimental Design with a One Group Pretest-Posttest Design, and data analysis was performed using a Paired Sample T-test. The results showed a significant increase in numeracy skills after the implementation of the Saro context-based PBL model with a significance value of $0.000 < 0.05$. These findings confirm that the integration of problem-based learning with local wisdom is effective in improving mathematics learning outcomes and the relevance of learning to students' real lives (Rahman et al., 2024; Purnadewi & Widana, 2023).

Keywords: Problem-based learning (PBL), Saro traditional food, Numeracy, Ratio

Introduction

Mathematics education plays a central role in students' intellectual development because it provides logical, analytical, and critical thinking skills needed to solve real-life problems. However, national and international assessments reveal that Indonesian students' mathematical literacy and numeracy skills are still below expectations. According to the Programme for International Student Assessment (PISA 2022) (OECD, 2023),

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Indonesian students ranked low among participating countries, with nearly 70% performing below level 2. Similarly, the Indonesian Minimum Competency Assessment report in 2023 showed that less than half of students reached the minimum competency threshold in numeracy, indicating a serious gap between expected and actual learning outcomes (Kemendikbud, 2023).

This learning gap reflects that the learning process in many classrooms still emphasizes procedural understanding rather than the ability to apply mathematical concepts in real contexts (Sofyan, Puspitasari, & Maryani, 2021). In fact, the 21st-century curriculum requires students not only to master mathematical formulas but also to be able to formulate, employ, and interpret mathematics in authentic situations (OECD, 2023). This competency—often referred to as mathematical literacy or numeracy—is essential for preparing students to participate effectively in society and make informed decisions (Purnadewi & Widana, 2023).

Several studies have shown that innovative, student-centered, and context-based learning models can improve students' numeracy and reasoning abilities. One such model is Problem-Based Learning (PBL), which encourages students to develop knowledge through active engagement in problem-solving processes. According to Rahman et al. (2024), the PBL model provides opportunities for students to construct understanding through real-world problems, thereby fostering independence and critical thinking. Similarly, Sofyan et al. (2021) found that PBL can improve mathematical literacy through reasoning and communication-oriented activities. Meanwhile, Purnadewi & Widana (2023) demonstrated that a PBL model that integrates local wisdom can enhance numeracy and contextual understanding of mathematics.

Despite these advantages, most previous studies have examined PBL in general contexts, with limited attention to the integration of local culture into mathematics learning. In fact, incorporating local culture (kearifan lokal) in learning can make the process more meaningful and contextual for students. Juhaevah (2022) emphasized that developing mathematics learning materials based on local wisdom allows students to relate abstract mathematical ideas to their daily lives, thereby increasing motivation and conceptual understanding. Likewise, Jabar et al. (2022) suggested that mathematical problems modeled after local situations can improve students' communication and reasoning skills. Integrating local culture into the learning process also aligns with the national education goal of character-based learning, which values both knowledge and cultural appreciation (Rahman et al., 2024).

In this regard, the present study introduces an innovative learning approach that combines Problem-Based Learning (PBL) with the context of Saro, a traditional food from Ternate City. The Saro context serves as a culturally familiar and concrete representation of ratio and proportion, allowing students to connect mathematical reasoning with real-life experiences. Through this integration, learning becomes more engaging, meaningful, and reflective of students' cultural identities. This approach aligns with the vision of contextual and culturally responsive education, which aims to develop numeracy skills while preserving local traditions and values (Purnadewi & Widana, 2023; Juhaevah, 2022).

This study aims to determine whether the application of the Problem-Based Learning (PBL) model using a traditional food context can significantly improve students' numeracy skills in ratio material. It also seeks to provide empirical evidence of how integrating local cultural contexts into mathematics learning can enhance students' conceptual understanding, foster engagement, and promote cultural appreciation.

Therefore, this study is significant because it bridges the gap between mathematics education and cultural relevance by empirically examining the effect of PBL integrated with local wisdom on students' numeracy skills. It contributes to the growing discourse on culturally responsive pedagogy by demonstrating how traditional cultural practices, such as Saro food preparation, can serve as effective and meaningful contexts for teaching mathematical concepts like ratio and proportion (Rahman et al., 2024; Juhaevah, 2022; Purnadewi & Widana, 2023).

Method

This study used a quantitative approach with a Quasi Experimental Design and a One Group Pretest-Posttest Design. This design was chosen because the study focused on determining the difference in student learning outcomes before and after being given treatment using the Problem-Based Learning (PBL) model based on the local cultural context without a control group. The research was conducted in the even semester of the 2022/2023 academic year at a junior high school in Ternate City, North Maluku Province. This location was

chosen because Ternate City has a wealth of local wisdom, one of which is the traditional food Saro, which is relevant as a context in culture-based mathematics learning.

The research population was all seventh-grade students at the school. The research sample consisted of 23 students, selected using random sampling techniques. Random selection was carried out to provide equal opportunities for all members of the population to become samples, thereby reducing potential bias and increasing the representativeness of the research results. Although the sample size was small, it was considered sufficient for parametric analysis because the data obtained was normally distributed and each participant underwent two measurements (pre-test and post-test) under the same conditions (OECD, 2023).

The research instruments included a PBL-based Lesson Plan, Worksheets with the context of traditional Saro food, and a numeracy test consisting of three main aspects: formulate, employ, and interpret (based on PISA 2022 framework). Before use, all learning devices were validated by two lecturers specializing in Mathematics Education and one mathematics teacher at the school. After validation, the learning devices were implemented and the data were analyzed using descriptive and inferential statistics.

Descriptive statistics were used to describe the pretest and posttest results, while inferential statistics were used to test the research hypothesis using a Paired Sample T-test. All statistical analyses, including the normality test and the Paired Sample T-test, were performed using SPSS version 22 software. The normality test was conducted to ensure that the data met the assumption of normal distribution, while the paired t-test was used to determine the significance of the difference in students' numeracy skills before and after treatment (Rahman et al., 2024).

The use of a paired t-test was based on the characteristics of the paired data (pretest and posttest were conducted on the same subjects) and normal distribution. This test is effective for determining the difference in the means of two interrelated conditions in a single group and remains valid even if the sample size is relatively small ($n > 20$), as long as the assumption of normality is met. Thus, the Paired Sample T-test was considered the most appropriate for testing the effectiveness of the PBL model in improving students' numeracy skills (Purnadewi & Widana, 2023).

Results and Discussion

Conducting Validation Among Experts

Table 1. Summary of validator suggestions

Learning Tools Developed	
Before revision	After revision
Worksheets:	
The writing is not in accordance with EYD (Standard Indonesian Spelling).	Correct the writing in accordance with EYD.
There are too many dots on the worksheets to be filled in by students.	Limit the dots on the worksheets to be filled in by students to 3 dots, and if they appear at the end of a sentence, use 4 dots.
Lesson Plan:	
The time for each step of the activity in the lesson plan is not specified.	Specify the time for each step of the activity in the lesson plan.
There is no assessment instrument.	Add an assessment instrument.
Pretest:	
The pretest questions do not yet include prerequisite material, namely comparison material at the elementary school level.	Add questions on prerequisite material, namely comparison at the elementary school level, to the pretest.
In question number 2, the word "green beans" should be replaced with "green bean porridge" because	In question number 2, the word "green beans" has been replaced with "green bean porridge".

The researchers developed learning tools (student worksheets, lesson plans, pre-tests, post-tests). The researchers developed the student worksheets by adding the element of Srikaya telur, which is a traditional food of Saro. Prior to the implementation of the teaching experiment, the learning tools were validated. The validation data was obtained from the validation sheets filled out by two mathematics education lecturers from University in Ternate City and one mathematics teacher from a public junior high school in Ternate City. Based on the validation results, suggestions were obtained from the three validators. The suggestions from the three validators can be seen in Table 1.

Based on Table 1, the percentage score for the worksheets was 98%, for the lesson plan 92%, and for the pretest and posttest 100% each. This indicates that all instruments were classified as valid, consistent with recent standards for instructional tool validation in mathematics education (Rahman et al., 2024). The detailed results can be seen in Table 2 below.

Table 2. Validation test of learning tools

Learning tools	Percentage of average Criteria score	
Worksheets	98%	Valid
Lesson Plan	92%	Valid
Pretest	100%	Valid
Posttest	100%	Valid

Thus, the interpretation results for the learning tools are valid, so that the learning tools can be used for the next stage, namely the learning implementation stage, with several improvements based on the suggestions of the three validators.

Numeracy Skills with the Application of the PBL Model

The description of students' abilities in solving numeracy problems on ratio material is based on pretest and posttest, which are indicators of the percentage (%) of conceptual ability that is a comparative factor before and after the application of the PBL model. The presentation of the data from the analysis of the comparison of student abilities can be seen Table 3.

Table 3. Data from the comparison analysis of pretest and posttest results

Mastery Level	Qualification	Pretest Frequency	Percentage (%)	Posttest Frequency	Percentage (%)
81-100	Very satisfactory	2	8.7%	9	39.13%
71-80	Satisfactory	4	17.39%	6	26.09%
61-70	Good	2	8.7%	4	17.39%
51-60	Fair	2	8,7 %	0	0.00%
41-50	Poor	8	34.8 %	2	8.70%
31-40	Very Poor	2	8.7%	2	8.70%
<30	Not good	3	13.0%	0	0.00%

Table 3 shows a significant increase in students' numeracy skills in solving mathematical problems on ratio material after the implementation of the Problem Based Learning (PBL) model. Before the implementation of the PBL model, the distribution of student abilities was still low, indicating that most students were unable to relate the concept of ratio to contextual situations or develop appropriate problem-solving strategies. However, after the implementation of the PBL model, there was a clear change in the qualifications of students' abilities.

The proportion of students in the high ability category increased significantly, while the low category was almost non-existent. This shows that the PBL approach has a positive effect on students' critical thinking skills and numeracy abilities. This improvement can be interpreted as a result of the main characteristics of the PBL model, which places students at the center of learning. Through the process of solving real problems, students are actively involved in discovering concepts, testing hypotheses, and developing solution strategies. These activities enable students to not only understand the concept of ratios procedurally, but also to master it conceptually.

In addition, the disappearance of the “fair” and “poor” categories in the post-test results indicates that almost all students experienced a significant improvement in performance. The fact that a few students still fall into the low category shows that although PBL is effective, some students may need additional guidance or more study time to adjust to the problem-based approach. Overall, these results reinforce the finding that the PBL model is effective in improving students' numeracy skills, particularly in the context of mathematical problem solving in ratio material.

Students' Numeracy Skills in Ratio Material with the Application of the PBL Learning Model

Details of the normality test results and research hypotheses before and after the application of the PBL model are as follows:

Normality Test

The normality test is used to determine whether the data is normally distributed or not. In this study, the normality test was conducted using SPSS version 22 software, using the Shapiro-Wilk test with a significance level of 5%. The results of these calculations are presented in Table 4 as follows.

Table 4. Pretest and posttest normality test data		
Test	Significance	Criteria
<i>Pretest</i>	.632	Normal distribution
<i>Posttest</i>	.086	Normal distribution

Based on table 4, the results of calculations using the Shapiro-Wilk test, the significance of the pretest score data is 0.632 and the posttest is 0.086. Because the significance value of the pretest and posttest score data is greater than 0.05, it can be stated that the pretest and posttest data are normally distributed.

Research Hypothesis Test

Based on the results of the calculations using the Shapiro-Wilk test in Table 4, the significance of the pretest score data is 0.632 and the posttest is 0.086. Because the significance value of the pretest and posttest score data is greater than 0.05, it can be stated that the pretest and posttest data are normally distributed.

Decision making based on significance

- If significance < 0,05 H_0 is rejected and H_1 is accepted
- If significance > 0,05 H_0 is accepted and H_1 is rejected.

Explanation:

H_0 : There is no difference in students' numeracy skills in ratio material.

H_1 : There is a difference in students' numeracy skills in ratio material

Table 5. Hypothesis test results on pretest and posttest numeracy skills				
		t	df	Sig. (2-tailed)
Pair 1	Pretest – Posttest	-5.481	22	.000

Based on table 5, the application of the Problem-Based Learning (PBL) model with the context of traditional Saro food significantly improves students' numeracy skills in ratio material. The statistical analysis, with a significance value of $0.000 < 0.05$, indicates that there is a significant difference between the pretest and posttest results, confirming that PBL is effective in enhancing students' ability to understand and apply mathematical concepts in meaningful contexts. This result not only validates the initial hypothesis but also strengthens the growing body of recent evidence supporting PBL as an innovative approach in mathematics education (Rahman et al., 2024; Sofyan et al., 2021).

One of the primary reasons for this improvement is that the PBL approach encourages students to engage actively in problem-solving activities that are grounded in real-world situations. In this research, the Saro food context provided a culturally familiar and tangible setting in which students could explore the mathematical concept of ratios. By calculating ingredient proportions, comparing quantities, and solving contextual problems related to the preparation of Saro, students were able to connect mathematical reasoning with daily life experiences. This connection helps to bridge the gap between abstract mathematical ideas and concrete, everyday practices, making learning more relevant and meaningful for students. As highlighted in Rahman et al. (2024) and Purnadewi and Widana (2023), students' reasoning and numeracy develop optimally when they are given opportunities to explore, discuss, and apply mathematical ideas within authentic contexts supported by inquiry-based learning.

From a theoretical perspective, this finding aligns with the constructivist view of learning, which posits that students construct their own understanding through active participation in problem-solving and inquiry-based activities. The role of the teacher in this model shifts from being a transmitter of knowledge to a facilitator who guides students to discover concepts through exploration and reflection. This pedagogical shift is crucial for developing numeracy, as it requires students to move beyond memorization of formulas and procedures toward a deeper conceptual understanding of mathematical relationships. The PBL framework fosters this process by engaging students in complex tasks that demand reasoning, collaboration, and communication, all of which are essential components of 21st century learning competencies (Systematic Review, 2025).

Furthermore, the integration of local cultural elements, such as Saro, into the learning process contributes an additional dimension to students' educational experience. Culture-based contexts make learning more accessible and relatable because they draw on students' prior knowledge and cultural identity. In this study, using Saro, a traditional food that students are familiar with, created a sense of ownership and pride in learning. It also enhanced students' motivation and engagement, as they could see the relevance of mathematics in their cultural environment. This finding is consistent with Juhaevah (2022) and Jabar et al. (2022), who emphasized that embedding local wisdom in learning materials improves students' conceptual understanding and fosters cultural appreciation. Similarly, Purnadewi and Widana (2023) reported that local wisdom-based learning enhances both motivation and cognitive engagement by connecting mathematical concepts to cultural practices familiar to learners.

The use of contextual learning with local wisdom also aligns with Indonesia's current educational policy direction, which emphasizes character-based and culturally responsive education. By incorporating traditional elements into the learning process, teachers not only strengthen students' mathematical competencies but also contribute to the preservation of local culture. This integration supports the broader educational goal of nurturing students who are not only skilled in academic areas but also culturally grounded and appreciative of their heritage (Rahman et al., 2024; Juhaevah, 2022). In this sense, the PBL model using the Saro context serves a dual function: it enhances numeracy while fostering cultural awareness and identity.

The results of this study also correspond with recent international research emphasizing the importance of contextual and inquiry-based learning. According to the PISA 2022 Framework (OECD, 2023), mathematical literacy and numeracy are defined as the ability to formulate, employ, and interpret mathematics in a variety of contexts. Students who engage in problem-solving that mirrors real-life situations are more likely to develop flexible thinking and adaptive reasoning. The outcomes of this study, which show significant improvement in students' posttest scores, suggest that contextualized PBL learning aligns well with PISA competencies and can contribute to addressing Indonesia's long-standing challenge of low mathematical performance in international assessments (OECD, 2023; Sofyan et al., 2021).

Another noteworthy aspect is the improvement in the distribution of achievement levels among students. Before the PBL intervention, most students' numeracy skills fell into the "poor" or "very poor" categories, indicating difficulty in understanding ratio concepts. After the intervention, a significant proportion of students moved into the "satisfactory" and "very satisfactory" categories, and the lower performance categories were almost eliminated. This shift indicates not only an overall improvement in scores but also a narrowing of the achievement gap among students. The collaborative nature of PBL likely contributed to this change. Group discussions, peer support, and collective problem-solving allowed lower-performing students to learn from their peers, thereby improving their understanding and confidence. This aligns with Rahman et al. (2024), who stated that culturally rooted PBL promotes inclusivity by accommodating diverse learning styles and abilities through social interaction and cooperative inquiry.

However, despite these positive outcomes, a small number of students remained in the lower performance category after the post-test. This suggests that while PBL is generally effective, its implementation must consider individual differences in learning pace and cognitive development. Some students may require additional scaffolding, more structured guidance, or extended time to fully adapt to inquiry-based learning methods. As emphasized by Purnadewi and Widana (2023), successful PBL implementation depends heavily on how well teachers facilitate and support students during the learning process. Therefore, teacher training and lesson design are critical in maximizing the benefits of PBL in mathematics education.

From a methodological standpoint, the use of the One Group Pretest Posttest Design in this study allows for direct measurement of learning gains within the same group of students. The results provide strong evidence that the observed improvement is due to the intervention rather than external factors. Nonetheless, future studies could strengthen the generalizability of these findings by including control groups, larger sample sizes, and longer implementation periods. Longitudinal studies could also examine whether the improvement in numeracy skills achieved through PBL with cultural contexts persists over time and transfers to other areas of mathematics learning (Systematic Review, 2025).

Pedagogically, the findings of this study have several implications for mathematics education. First, they emphasize the need for teachers to adopt learning models that are student centered and contextually relevant. The use of local cultural elements such as traditional foods, crafts, or environmental issues can make abstract mathematical concepts more concrete and understandable. Second, the findings highlight the importance of integrating open-ended problem-solving activities into regular classroom practice. Through guided inquiry, students can develop metacognitive skills such as planning, monitoring, and evaluating problem-solving processes that are crucial for lifelong learning. Third, curriculum developers and policymakers should consider incorporating culturally contextualized PBL materials into the national curriculum, especially for topics with strong real-life applications such as ratios, proportions, measurement, and statistics (Juhaevah, 2022; Rahman et al., 2024).

This research also contributes to the broader discourse on how local wisdom can serve as a foundation for educational innovation. In an increasingly globalized era where education often adopts standardized models, integrating local culture into pedagogy can serve as a counterbalance that preserves national identity while promoting global competencies. The Saro context used in this study illustrates how mathematics learning can be both modern and rooted in tradition, connecting global educational ideals with local realities (Purnadewi and Widana, 2023).

Finally, the overall results of this study affirm that the combination of Problem-Based Learning and cultural context not only enhances academic achievement but also promotes affective and social benefits. Students learn to appreciate teamwork, respect cultural diversity, and value the role of mathematics in their community's daily life. These outcomes are consistent with the holistic goals of education, encompassing cognitive, affective, and psychomotor domains (Rahman et al., 2024). Thus, the findings of this research hold promise or educators seeking to design innovative, culturally responsive, and effective mathematics learning environments.

In conclusion, the discussion reveals that the PBL model with the Saro context provides a meaningful and effective framework for improving numeracy skills among junior high school students. It encourages active learning, strengthens conceptual understanding, integrates local wisdom, and cultivates essential 21st century skills. Although there are areas that require refinement, particularly in providing additional support for lower achieving students, the overall evidence strongly suggests that culturally contextualized PBL can be a powerful pedagogical tool for enhancing mathematical literacy and bridging the gap between school mathematics and real-life applications.

Conclusion

Based on the results of the research and discussion, it can be concluded that there is a difference in students' numeracy skills before and after the implementation of the Problem-Based Learning (PBL) model with the context of traditional Saro food in ratio material in junior high schools in Ternate City. This difference indicates a change in students' ability to understand the concept of ratios and apply it in solving mathematical problems after participating in problem-based learning related to the local cultural context.

This finding is in line with the results of research conducted by Hidayati (2022), which shows that the application of the Problem-Based Learning model can improve students' numeracy skills through contextual

problem-solving activities. This study expands on that application by integrating local cultural elements as part of the learning process. Thus, the results of this study emphasize the importance of using cultural context in mathematics learning as a means of developing numeracy skills while instilling regional cultural values in the educational process.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS Journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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