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The Effectiveness of the Problem Based Learning Model on the Social Arithmetic Learning Outcomes of Students at SMP Negeri 1 Sigi

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A B S T R A C T

This study aims to determine the effectiveness of implementing the Problem Based Learning (PBL) model on student learning outcomes in the Social Arithmetic subject at Sigi State Junior High School 1. This study uses a quantitative approach with a quasi-experimental method and a nonequivalent control group design. The research sample consisted of two classes: an experimental class that used the PBL model and a control class that used direct instruction. The research instruments consisted of essay tests (pretest and posttest) that had been validated by experts. Data analysis was conducted using descriptive and inferential statistics, including normality tests, homogeneity tests, independent t-tests, and N-Gain calculations. The results showed that the average posttest score of the experimental class (81.25) was higher than that of the control class (32.16). The hypothesis test results indicated a significance value of 0.001 < 0.05, meaning there was a significant difference between the two groups. Furthermore, the N-Gain value for the experimental class was 0.78 (high category), while that for the control class was 0.20 (low category). This indicates that the Problem Based Learning (PBL) model is more effective in improving student learning outcomes than direct instruction. Thus, the PBL model has been proven effective in enhancing students' understanding and learning outcomes in Social Arithmetic.

1. Introduction

Mathematics is a subject that plays a crucial role in developing logical, critical, systematic, and creative thinking skills. Etymologically, the word "mathematics" derives from the Greek word *mathema*, which means "knowledge" or "something learned through the process of thinking" (James, 2020). In addition to serving as the foundation for various fields of science, mathematics also functions as a

symbolic language to explain quantitative and spatial relationships and to help solve various problems in everyday life (Nasution, 2021; Kline, 2022; Ruseffendi, 2022).

In the learning process, mathematics aims not only to enhance cognitive abilities but also to develop higher-order thinking skills, such as problem-solving, reasoning, and critical thinking. Therefore, the learning process must be student-centered so that students actively construct knowledge, while teachers act as facilitators who create meaningful learning experiences. The mathematics curriculum at the junior high school level focuses on social arithmetic, which covers concepts such as buying and selling, profit, loss, discounts, interest, taxes, gross, net, and tare. This material is closely tied to everyday life and should therefore be easy for students to understand. However, in reality, many students still struggle because instruction tends to be teacher centered, abstract, and fails to connect the material to real-life situations. This situation highlights the need to implement a learning model capable of connecting mathematical concepts to contextual problems.

One model that can be applied is Problem Based Learning (PBL). According to Arends (2020), PBL is a learning model that uses real-world problems as a context for students to investigate, discuss, and discover solutions through critical thinking. This model encourages students to be more active in identifying problems, gathering information, analyzing, and drawing conclusions from their learning, which is expected to improve learning outcomes. Preliminary observations at Sigi State Junior High School 1 indicate that the mathematics learning process is still dominated by the lecture method; limited learning support facilities are one of the factors contributing to this dominance, resulting in students tending to be passive when it comes to asking questions, engaging in discussions, or expressing their opinions. Consequently, students' conceptual understanding and learning outcomes remain low. This situation is consistent with the research by Surati et al. (2023), which shows that teaching that does not sufficiently engage students leads to low mathematics learning outcomes.

Based on the results of a study conducted at Sigi State Junior High School 1, the initial abilities of students in both classes were relatively equivalent before the intervention. The pretest results showed that the experimental class had an average score of 15.78 with a standard deviation of 5.06, while the control class had an average of 14.74 with a standard deviation of 5.68. After the learning process was implemented, the average posttest score for the experimental class increased to 81.25 with a standard deviation of 4.58, while the control class achieved an average of 32.16 with a standard deviation of 4.71. These results indicate that the average score of the experimental class was higher than that of the control class after the implementation of the Problem Based Learning (PBL) model. These findings suggest that the implementation of the Problem Based Learning model has the potential to yield better learning outcomes than direct instruction on social arithmetic material; therefore, its effectiveness on the learning outcomes of students at SMP Negeri 1 Sigi warrants further study.

Although learning support facilities at Sigi State Junior High School 1 are still limited, the implementation of PBL remains possible through the use of worksheets,

simple teaching aids, and available digital media. With creative learning management, limited resources do not become a major obstacle in the implementation of Problem Based learning. Based on this description, the application of the Problem Based Learning model is considered relevant as an alternative to improve student learning outcomes in social arithmetic. In addition to being expected to increase student engagement and critical thinking skills, this study is also important because it has never been conducted at SMP Negeri 1 Sigi.

Learning effectiveness refers to the degree to which the learning process succeeds in achieving its established goals. Effectiveness is measured not only by improvements in student learning outcomes but also by the achievement of learning objectives, students' active engagement, and the development of critical thinking skills, attitudes, and competencies (Nasution, 2021; Arends, 2022). In this study, learning effectiveness was measured based on improvements in student learning outcomes as reflected in pretest and posttest scores. Furthermore, Hamalik (2020) states that learning outcomes are changes within an individual that encompass changes in abilities, skills, attitudes, and values as a result of intentional learning experiences. Problem Based learning models are certainly applicable across various disciplines and have a high likelihood of success when implemented in the learning process (Imran, 2022).

The effectiveness of learning is influenced by various factors, including teacher competence, instructional models, media, the learning environment, and student characteristics. One indicator of effectiveness is the achievement of learning objectives in the cognitive, affective, and psychomotor domains, supported by students' active participation during the learning process (Bloom, 2014; Johnson & Rising, 2023). Learning assessment serves as the basis for evaluating the success of the learning process and as a basis for improving instruction (Ruseffendi, 2022; Sardiman, 2020). Instructional models are one of the factors that influence the teaching and learning process (Tonda, 2024).

Problem Based Learning (PBL) is a learning model that uses real-world problems as a learning context to develop students' critical thinking, problem-solving, communication, and collaboration skills (Arends, 2022). In this model, students are at the center of learning, while teachers act as facilitators who guide the inquiry process until a solution to the problem is reached. The PBL syntax consists of five stages: (1) problem orientation, (2) organizing students for learning, (3) guiding the investigation, (4) developing and presenting results, and (5) analyzing and evaluating the problem-solving process (Arends, 2022). These stages align with Polya's problem-solving steps understanding the problem, planning a solution, implementing the plan, and reviewing thereby making PBL effective in enhancing mathematical problem-solving skills. The implementation of the Problem Based Learning (PBL) model, which emphasizes active student engagement, is expected to facilitate students' understanding of the material, both in groups and individually (Ardiana, 2025).

Social arithmetic is a branch of mathematics that deals with calculations in everyday life, such as buying and selling, profit, loss, discounts, interest, gross, net,

and tare. This subject aims to equip students with the ability to apply mathematical concepts to simple economic activities, thereby supporting their numeracy skills and rational decision-making (Ruseffendi, 2022; Tan, 2022). The social arithmetic material studied in junior high school includes the concepts of purchase price, selling price, profit, loss, percentage, discount, interest, as well as gross, net, and tare. Because it is directly related to real life, this material is best taught through contextual learning such as PBM (James, 2020; Nasution, 2021).

The Direct Instruction model is a teacher-centered model in which the teacher presents material systematically through explanations, demonstrations, guided practice, feedback, and independent practice (Arends, 2020). This model is effective for efficiently teaching procedural knowledge and basic concepts. Although it offers advantages in terms of time efficiency and mastery of the material, the Direct Instruction model tends to limit students' active engagement, thereby failing to adequately support the development of critical thinking and problem-solving skills (Joyce & Weil, 2021; Slavin, 2022; Trianto, 2023). However, teachers need to balance this with strategies that foster active participation and reflective thinking to make the learning process more meaningful (Sanjaya, 2019). Therefore, learning activities tend to be planned, measurable, and directly controlled by the teacher (Skinner, 2020).

Learning outcomes are changes in students' abilities following the learning process, encompassing cognitive, affective, and psychomotor aspects (Sudjana, 2019; Bloom, 2014). Learning outcomes serve as indicators of learning success and are determined through the evaluation process conducted by teachers. Learning outcomes are influenced by internal factors, such as students' motivation, interest, ability, and physical condition, as well as external factors, such as the family environment, school, and the instructional model used (Slameto, 2020). In this study, learning outcomes were measured through pretest and posttest scores on social arithmetic material to determine the effectiveness of implementing the PBM model. Meanwhile, Purwanto (2020) explains that learning outcomes are relatively permanent behavioral changes in an individual resulting from the learning process.

The social arithmetic material for 7th-grade junior high school students covers percentages, purchase prices, selling prices, profits, losses, discounts, gross, net, and tare. This material emphasizes students' ability to solve problems related to daily economic activities, thereby supporting the development of numeracy and financial literacy. Through social arithmetic instruction, students are expected to be able to apply mathematical concepts in real-world situations, such as calculating profit, determining the amount of a discount, and solving various buying and selling transaction problems accurately and logically.

Several studies indicate that the Problem Based Learning (PBL) model is effective in improving mathematics learning outcomes, particularly in the area of social arithmetic. A study by Istikomah (2020) showed that the implementation of PBL increased student learning achievement from 33.33% to 83.33%. Furthermore, Usman et al. (2021) found that students who learned using PBL had better problem-solving skills compared to those who followed conventional instruction. In line with

this, Masambe et al. (2022) concluded that the implementation of PBL can improve students' cognitive-domain learning outcomes in social arithmetic. Based on these previous research findings, it can be concluded that the PBM model has a positive impact on mathematics learning outcomes. Therefore, this model is considered relevant for application to social arithmetic material because it fosters student engagement, critical thinking skills, and problem-solving abilities, thereby potentially improving the learning outcomes of seventh-grade students.

Based on the research question stated above, this study aims to determine the differences in social arithmetic learning outcomes between students who participated in Problem Based Learning (PBL) and those who received direct instruction in the 7th grade at Sigi 1 Public Junior High School. In addition, this study aims to determine the effectiveness of the PBL model in improving students' social arithmetic learning outcomes at Sigi 1 Public Junior High School. It is hoped that this study will provide insight into the effectiveness of the PBL model in enhancing students' social arithmetic learning outcomes at Sigi 1 Public Junior High School.

2. Methodology

Research Types and Designs

This study employed a quantitative approach using a quasi-experimental method and a nonequivalent control group design. The study involved two classes: an experimental class that received Problem Based Learning (PBL) instruction and a control class that received direct instruction. Both classes took pretests and posttests to measure differences in learning outcomes after the intervention (Sugiyono, 2019).

Research Location and Time

This study was conducted at Sigi State Junior High School 1 during the even semester of the 2025/2026 academic year, from May 11 to May 22, 2026. The study was carried out in two classes: Class VII-B, the experimental class, which was taught using the Problem Based learning (PBL) model; and Class VII C, the control class, which used the direct instruction model. Each class consisted of 33 students.

Population and Sample

The study population consisted of all 193 seventh-grade students at Sigi State Junior High School 1. This population comprised six classes VII-A, VII-B, VII-C, VII-D, VII-E, and VII-F which shared relatively similar characteristics because they were at the same grade level and received instruction in accordance with the current curriculum. The research sample was determined using simple random sampling, a sampling technique that gives each class in the population an equal chance of being selected as a research sample (Sugiyono, 2019). Sampling was conducted randomly through a lottery, resulting in the selection of Class VII-B as the experimental class,

which was taught using the Problem Based learning (PBL) model, and Class VII-C as the control class, which used the direct instruction model. Class VII-B consisted of 32 students, and Class VII-C consisted of 29 students, bringing the total research sample to 61 students. The use of simple random sampling in this study was based on the consideration that each class had an equal chance of being selected as a sample. Thus, the sample obtained was expected to represent the characteristics of the population so that the research results could illustrate the effectiveness of implementing the Problem Based Learning (PBL) model on student learning outcomes in Social Arithmetic in seventh grade at SMP Negeri 1 Sigi.

Types and Sources of Data

The research data consisted of primary data namely, students' pretest and posttest scores as well as secondary data obtained from books, journals, and supporting research documents. The primary data sources were the students in both research classes.

Operational Definitions of Variables & Data Collection Techniques

The independent variable (X) in this study is the Problem Based Learning (PBL) model, while the dependent variable (Y) is students' mathematics learning outcomes on the topic of Social Arithmetic (Sugiyono, 2019). The learning outcomes in question refer to students' cognitive abilities after participating in the learning process, measured based on scores obtained on the pre-test and post-test. To collect data on these two variables, data were gathered through essay tests administered to students before the intervention (pre-test) and after the intervention (post-test). The pretest aimed to determine students' initial abilities before participating in the learning process, while the posttest aimed to determine students' learning outcomes after receiving instruction in accordance with the applied learning model. Before being used in the study, the test instruments were developed based on learning indicators and validated by experts to ensure content validity (Lestari, 2024).

Research Instruments

The research instruments consisted of a teaching module, worksheets, and pretest and posttest questions that had undergone content validity validation by experts. The level of validity was analyzed using validation percentages according to the criteria proposed by Akbar (2016).

Data Analysis Techniques

Data analysis was conducted using descriptive and inferential statistics. Prerequisite tests included a normality test using the Kolmogorov–Smirnov test and a homogeneity test using Levene's test. If the data met the assumptions of normality and homogeneity, hypotheses were tested using an independent two-sample t-test at a significance level of 0.05 (Sugiyono, 2019). In addition, improvements in learning outcomes were analyzed using Normalized Gain (N-Gain) to determine

the extent of improvement in students' learning outcomes after receiving the treatment. The N-Gain values were then interpreted into high, moderate, and low categories (Lestari, 2024).

Research Implementation Phase

The study was conducted in four stages: (1) administering a pretest to both classes, (2) implementing PBL in the experimental class and direct instruction in the control class, (3) administering a posttest, and (4) processing and analyzing the data to determine the effectiveness of the instructional model on student learning outcomes.

3. Result and Discussion

This study was conducted at Sigi State Junior High School 1 during the even semester of the 2025/2026 school year, from May 11 to May 22, 2026. The study was conducted in two classes: Class VII-B, the experimental class, which was taught using the Problem Based learning (PBL) model, and Class VII-C, the control class, which used the direct instruction model. Each class consisted of 33 students. The study focused on the topic of Social Arithmetic. The population distribution in this study is shown in Table 1.

Table 1. The Population Distribution

No	Class	Many Students
1.	VII A	33
2.	VII B	32
3.	VII C	29
4.	VII D	33
5.	VII E	33
6.	VII F	33

The research sample was selected using simple random sampling, as each class in the population had an equal chance of being selected as either the experimental or control class. Sampling was conducted by drawing class numbers at random, ensuring that the selection was free from researcher bias. As a result of the random draw, two classes were selected as the sample: Class VII-A as the experimental class and Class VII-B as the control class.

Descriptive Analysis

A descriptive analysis was conducted to provide a quantitative overview of the initial and final levels of mathematical ability among students in both research groups. This analysis aims to describe students' learning outcomes before and after the intervention was administered, thereby revealing the progress in students' abilities within each group. The data analyzed included the results of the pretest and posttest obtained from the two research groups, namely the experimental and control classes. The pretest was administered before the intervention was

implemented for both groups, which consisted of two classes. The purpose of the pretest was to measure students' initial abilities and to ensure that both groups were at an equivalent level before the learning process began. The pretest results for all classes are presented in Table 2 below.

Pretest Results

Table 2. Pretest Results for the Control Class and the Experimental Class

Class	N	Min	Max	Range	Average	Standard Deviation
Experiment	32	5,00	27,50	22,50	15,78	5,06
Control	29	5,00	27,50	22,50	14,74	5,68

Based on Table 2, the average pretest score for the experimental class was 15.78 with a standard deviation of 5.06, while the control class had an average of 14.74 with a standard deviation of 5.68. The difference in means between the two classes was relatively small, at 1.04, indicating that the students' initial abilities in both groups were relatively comparable before the intervention. The lowest score in both the experimental and control classes was 5.00, while the highest score in both classes was 27.50. The posttest was administered after the entire treatment series had been completed. The purpose was to measure students' mathematics learning outcomes as a result of the treatment provided. A summary of the posttest data is presented in Table 3 below.

Table 3. Posttest Results for the Control Class and the Experimental Class

Class	N	Min	Max	Range	Average	Standard Deviation
Eksperimen	32	72,50	95,00	22,50	81,25	4,58
Kontrol	29	25,00	42,50	17,50	32,16	4,71

Based on Table 3, the average posttest score for the experimental class was 81.25 with a standard deviation of 4.58, while the control class had an average of 32.16 with a standard deviation of 4.71. The difference in means between the two classes was 49.09 points, indicating that the experimental class's average score was higher than that of the control class after the treatment was administered. Although the experimental class showed superior results descriptively, inferential statistical tests are needed to determine whether this difference is statistically significant. Although the experimental class showed superior results descriptively, inferential statistical tests are needed to determine whether this difference is statistically significant.

Inferential Analysis

Inferential analysis was conducted to test the research hypotheses. Prior to hypothesis testing, prerequisite tests namely, normality and homogeneity tests were performed using SPSS.

Normality Test

The normality test was conducted using the Kolmogorov-Smirnov test with a significance level of 0.05. The data are considered to be normally distributed if the Sig. value is greater than 0.05.

Table 4. Normality Test Results

Data	Group	Statistics	df	Sig.	Information
Pretest	Control	0,139	29	0,161	Normal
Pretest	Experiment	0,126	32	0,200	Normal
Posttest	Control	0,126	29	0,200	Normal
Posttest	Experiment	0,142	32	0,097	Normal

Based on Table 4, all significance values are greater than 0.05, indicating that the data from the experimental and control groups are normally distributed.

Homogeneity Test

The homogeneity test was conducted using Levene's test with a significance level of 0.05. The data are considered homogeneous if the Sig. value is greater than 0.05.

Table 5. Homogeneity Test Results

Based	Levene Statistic	Sig.	Information
Mean	0,293	0,590	Homogen

Based on Table 5, the results of the homogeneity test using Levene's Test show a significance value of 0.590, which is greater than the significance level of 0.05 (0.590 > 0.05). Thus, the variances of the data in the experimental and control groups are considered homogeneous, thereby fulfilling one of the requirements for conducting a hypothesis test using the Independent Samples t-Test.

Hypothesis Testing (Independent Samples t-test)

A hypothesis test was conducted to determine whether there was a difference in learning outcomes between students who were taught using the model (PBM) and those who were taught using the direct instruction model.

Table 6. Independent Samples t-Test Data

Group		Sig. (2-tailed)	Average Difference	Information
Equal assumed	variances	0,001	49,09483	H_0 Rejected

Based on Table 6, the results of the independent samples t-test show a significance value (Sig. (2-tailed)) of 0.001, which is less than the significance level of 0.05 (0.001 < 0.05). Thus, H_0 is rejected and H_1 is accepted, indicating that there is a significant difference in learning outcomes between the experimental and control classes. These results indicate that the implementation of the Problem Based

learning (PBL) model has a significant effect on students' mathematics learning outcomes in the Social Arithmetic unit.

N-Gain Calculation

The effectiveness of the improvement in learning outcomes was analyzed using Normalized Gain (N-Gain). The N-Gain values obtained were then interpreted based on Hake's (1999) criteria: an N-Gain value of ≥ 0.70 falls into the high category, a value of $0.30 \leq g < 0.70$ falls into the moderate category, and a value of $g < 0.30$ falls into the low category. The higher the N-Gain value, the greater the improvement in student learning outcomes.

Table 7. N-Gain Calculation Results for the Experimental and Control Classes

Group	N-Gain	Category
Experiment	0,78	High
Control	0,20	Low

According to Table 7, the experimental class achieved an N-Gain score of 0.78 (high category), while the control class achieved 0.20 (low category). These results indicate that Problem Based learning is more effective in improving student learning outcomes than direct instruction.

Discussion

The results of the study show that the initial ability of students in the experimental and control classes was relatively equivalent, as indicated by pretest averages of 15.78 and 14.74, respectively. This indicates that both groups had comparable initial ability before the intervention. After instruction, the posttest average for the experimental class (81.25) was higher than that of the control class (32.16). The results of the Independent Samples t-test showed a significance value of $0.001 < 0.05$, indicating a significant difference between the two groups. Furthermore, the N-Gain value for the experimental class was 0.78 (high category), while that for the control class was 0.20 (low category), suggesting that the Problem Based Learning (PBL) model is more effective in improving student learning outcomes. This finding is consistent with the research by Istikomah (2020), which stated that PBL can improve mathematics learning outcomes in Social Arithmetic. Similar results were also reported by Usman et al. (2021), who found that PBL has a significant effect on mathematical problem-solving skills, as well as by Masambe et al. (2022), who concluded that PBL is effective in improving students' cognitive learning outcomes in Social Arithmetic.

Theoretically, PBL improves learning outcomes because it places students at the center of the learning process through activities such as identifying problems, discussing them, and finding solutions independently. This process helps students develop a deeper conceptual understanding, improve their critical thinking skills, and connect mathematical concepts to real-world situations (Arends, 2020). Thus, the results of this study reinforce the finding that the implementation of Problem

Based Learning is effective in improving students' mathematics learning outcomes in the subject of Social Arithmetic.

Problem Based Learning (PBL) is closely linked to improvements in student learning outcomes, both theoretically and empirically. Conceptually, PBL influences learning outcomes because the learning process places students in contextual problem situations, such as buying and selling, discounts, and profit and loss in everyday life. Through this approach, students do not merely passively receive material but are also required to actively discuss, analyze problems, and find solutions both independently and in groups. These activities directly foster the development of critical thinking and problem-solving skills. Thus, the implementation of PBL makes mathematics learning particularly in the area of social arithmetic no longer abstract but more closely tied to real life, making it easier for students to understand.

Empirically, this relationship is also clearly evident from the results of the study. In the initial stage, the abilities of students in the experimental and control classes were relatively equivalent, as indicated by pretest scores of 15.78 in the experimental class and 14.74 in the control class, showing no significant difference before the intervention was administered. However, after the learning process was implemented, there was a considerable difference in the posttest scores: 81.25 in the experimental class and 32.16 in the control class. The results of the Independent Samples t-test showed a significance value of 0.001, which is less than 0.05; therefore, it can be concluded that there is a significant difference between the two groups. Additionally, the N-Gain analysis results also showed that the experimental class achieved a score of 0.78, classified as high, while the control class scored only 0.20, classified as low. These findings indicate that the implementation of PBL has a positive and significant effect on improving social arithmetic learning outcomes. In other words, the more effective the implementation of PBL in learning, the higher the students' learning outcomes; thus, this model has proven to be more effective than direct instruction in improving mathematics learning outcomes.

4. Conclusion

Based on the research findings and discussion, it can be concluded that there is a difference in Social Arithmetic learning outcomes between students who used the Problem Based learning (PBL) model and those who used the direct instruction model. This is evidenced by the results of the independent samples t-test, which showed a significance value of $0.001 < 0.05$, indicating a significant difference between the two groups. Furthermore, the N-Gain analysis results indicate that the implementation of the Problem Based Learning (PBL) model is highly effective in improving the Social Arithmetic learning outcomes of seventh-grade students at SMP Negeri 1 Sigi, with the experimental class achieving an N-Gain score of 0.78 (high category), while the control class scored 0.20 (low category). Thus, the Problem Based Learning (PBL) model is effective for teaching Social Arithmetic because it improves student learning outcomes more effectively than the direct instruction model.

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