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Integrating *Sedekah* Context in Mathematics Learning to Enhance Students' Mathematical Communication Skills and Awareness of SDG 1: No-Poverty

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Abstract

The implementation of Education for Sustainable Development (ESD) requires students to have higher order thinking skills (HOTs), which remain challenging for many Indonesian students. One key component of HOT is mathematical communication skills, which can be improved through the Problem-Based Learning (PBL) model. From an Islamic perspective, *Sedekah* (*Sedekah*) represents an act of giving that aligns with the Sustainable Development Goal (SDG) 1 objective of poverty alleviation. This study aims to determine the differences in enhancing mathematical communication skills and students' awareness of No-Poverty through PBL learning in the context of *Sedekah* in Islamic and Regular Schools. This study employed a quantitative approach and a quasi-experimental research design. The population was all students in one Regular School, Banda Aceh and one Islamic School, Aceh Besar, Aceh, Indonesia. This sample included 56 students in an experimental class and 56 in a control class. The instruments in this study were a mathematical communication skill test and a questionnaire assessing students' awareness of No-Poverty. The hypothesis was tested using MANOVA, the Independent t-test, and the two-way ANOVA. The effect size of PBL learning was determined based on the Cohen-d effect size calculation. The findings reveal a significant difference in the improvement of mathematical communication skills and awareness of poverty alleviation between students in regular and Islamic schools. However, no interaction was found between the PBL model contextualized in *sedekah* and students' educational levels regarding mathematical communication skills and awareness of poverty alleviation. These results suggest that the PBL model effectively enhances students' mathematical communication skills and awareness of poverty alleviation.

Keywords: ESD**,** Mathematical Communication Skills, Problem-Based Learning, SDGs (No-Poverty), *Sedekah*

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INTRODUCTION

High-quality education is essential for addressing issues such as poverty, funding constraints, discrimination, high education costs, and resource unavailability, aligning with the objectives of SDG 1 (Wiegand, 2023). Education will serve as the foundation for government efforts to implement Sustainable Development Goals (SDG) by 2030, as directed by the UN. The 2030 Agenda, initiated by all UN members, addresses global issues and challenges through 17 sustainable development goals (SDGs) and 169 indicators aimed at achieving social, environmental and cultural balance (United Nations Educational, 2014). Improving the quality of education is critical to accelerating the achievement of SDGs, particularly SDG 1: No-Poverty.

Poverty is a global issue that particularly affects developing countries, including Indonesia. BPS-Statistics Indonesia the poverty line has declined to pre-pandemic levels and there continues to be a

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trend of trade balance surpluses. Spatially, the poverty rate as of March 2023 decreased by 8,57% in urban and rural areas but it remains high at 11.79%. Addressing poverty is a humanitarian challenge that requires integrated and comprehensive efforts.

High-quality education is expected to address issues such as poverty, funding constraints, discrimination, high education costs, and resource unavailability, aligning with the objectives of SDG 1 (Wiegand, 2023). A crucial aspect of sustainable development in education is Education for Sustainable Development (ESD), introduced by UNESCO as a framework to prepare students for global challenges by integrating educational, economic, social and environmental aspects (Leicht et al., 2018). To effectively drive change, the younger generation must be involved and empowered, supported by the necessary understanding and knowledge (Cahyaningsih & Isbah, 2021). The vision of ESD is to integrate values, activities, and principles of sustainable development into local, national, and international education (Buckler & Creech, 2014). ESD involves higher order thinking skills (HOTS), creativity, problem-solving, and student competence in taking action (Noviati et al., 2023). However, Indonesian students' HOTS remain low (Rahmayanti et al., 2018). This finding is is supported by Tanudjaya & Doorman's research (2020), which indicate that while most students are able to build mathematical models, they struggle to transfer their knowledge to new contexts when solving problems. The 2020 results from the Program for International Student Assessment (PISA) showed that Indonesia improved its ranking by 5 to 6 places compared to the 2018 PISA results. However, there is still a significant need for improvement in mathematical communication skills, which is one of the abilities assessed by PISA (Indicators & Hagvísar, 2022).

Mathematical communication skills are essential for students to effectively communicating their mathematical ideas in writing and orally. Mathematical communication skills emphasizes that students should use mathematical language to express ideas through tables, graphs, diagrams, and algebra (Baroody, 2000; NCTM, 2000; Rubenstein & Thompson, 2002; Whitin & Whitin, 2003). These skills enable students to express mathematical ideas about their problems, fostering collaborative problem-solving and critical thinking for future challenges (Shodiqin, 2020). Communicating mathematical thoughts enhances students' conceptual understanding, problem-solving abilities, and capacity to identify and correct misconceptions about mathematical concepts (Biber, 2023).

One area of mathematics that heavily relies on mathematical communication skills is exponents, a critical topic for Grade 10 due to its relevance to everyday life, such as bacterial growth, economic growth, population growth and financial investment. However, research indicates that many students struggle with calculating accurately and understanding the fundamental concepts of exponents (Anis et al., 2011). For example, students often incorrectly solve the problem like $20^5: 2^5$, providing 10 as a result. Errors in solving problems involving exponents, roots, and logarithms are often classified as either conceptual or procedural (Aprilianti et al., 2024). In addition, Borji et al (2024) found that the properties of exponents are among the most challenging topics for students.

A learning model that enhances mathematical communication skills is necessary to reduce conceptual errors among students. One learning model that can be applied is the Problem-Based Learning (PBL), which guides students to learn through problem-solving through non-routine problems linked to real-life scenarios and their own experiences (Hmelo-silver, 2019). For example, exponential learning can be contextualized within the *Sedekah* (*Sedekah*) framework, helping students understand the importance of SDG 1 (No-Poverty). *Sedekah*, as an Islamic value, can be integrated into exponent learning, enhancing mathematical communication and promoting awareness of poverty alleviation.

Integrating Islamic values in the mathematics learning process can serve as a bridge to achieve knowledge, understanding, and application of Islamic values. Islamic values integrated into mathematics subjects include faith, sharia, and moral values (Anis, 2022). Additionally, integrating religious values into mathematics education aligns with the goals of Islamic education in Aceh Province (Pemerintah Nanggroe Aceh Darussalam, 2002). Applying the value of *Sedekah* is expected to create broader social impacts.

Previous studies provide insights relevant to this research. Novita et al. (2022) found that SDG-based student worksheets improved students' critical thinking skills. Furthermore, Churil (2019) demonstrated that student worksheets effectively enhanced critical thinking skills and fostered environmental awareness, as perceived by students during trials. Wirevenska et al. (2021) found a significant influence on students' mathematical communication skills. However, research on the integration of awareness of No-Poverty (SDG 1) and mathematical communication skills through the PBL model in Regular and Islamic Schools remains limited. Thus, this research aims to address the following research questions: (1) Is there a difference in the improvement of students' mathematical communication skills through PBL learning in the context of *Sedekah* compared to conventional learning, based on student levels (high, medium, low)?, (2) Is there a difference in the improvement of students' awareness of No-Poverty through PBL learning in the context of *Sedekah* compared to conventional learning?, (3) Is there an interaction between the PBL model in the context of *Sedekah* and student levels of mathematical communication skills?, (4) Is there an interaction between the PBL model in the context of *Sedekah* and student levels on No-Poverty awareness?, (5) Is there a significant difference in the improvement of mathematical communication skills between students in Islamic Schools and Regular Schools using PBL learning in the context of *Sedekah* compared to conventional learning?, (6) Is there a significant difference in increasing No-Poverty awareness among students in Islamic Schools and Regular Schools using PBL learning in the context of *Sedekah* compared to conventional learning?

METHODS

This study employed a quantitative approach with a quasi-experimental type (Creswell, 2014). The research design adopted was a pretest-posttest control group design, requiring an experimental and control group (see Figure 1).

Experimental Class	O_1	X	O_2
Control Class	O_1		O_2

Figure 1. Research design

Where:

O_1 = Pre-test

X = Mathematics learning by applying the PBL learning model with the context of No-Poverty and *Sedekah*

O_2 = Post-test

In the experimental class, the teacher applied PBL learning by guiding students in solving problems related to general forms of exponents, properties of exponents, exponential growth, and exponential decay. However, in the control class, the teacher did not use the PBL learning model. Learning activities aimed at enhancing students' mathematical communication skills and awareness of No-Poverty were structured over five sessions, each lasting 3 × 45 minutes. The mathematics content and Sedekah in Islamic context is presented in Table 1.

Table 1. The mathematics content and *Sedekah* in Islamic context

Session	Content	Learning activities
1	Exponential forms and properties of exponential multiplication	The learning activity begins with the problem of open donations for mosque renovation. If there are 3 people who give alms every day and each day each person invites three other people to give alms to the same mosque, how many people give alms for 7 days. This activity aims to complete the exponential form. The Islamic value inserted in this activity is the Word of Allah in Al-Quran surah Al-Hadid verse 18 regarding the reward of people who give alms. "Indeed, those who give alms, both men and women, and lend to Allah good loans, will be multiplied (reward) for them, and they will receive a noble reward" (QS. Al-Hadid: 18)
1	properties of exponential multiplication	Solving the problem of a businessman who distributes alms to people around him. This activity aims for students to be able to write the properties of exponential multiplication. The Islamic value that is inserted is the word of Allah about the manners of giving alms. "If you show your alms, it is good. But if you hide it and give it to the poor, it is better for you and Allah will remove some of your sins. And Allah is All-Knower of what you do" (QS. Al - Baqarah: 271)

Session	Content	Learning activities
2	properties of exponential division	Resolving the problem of providing food for people to break their fast. If there are 81 types of food obtained from people's gifts and they are divided into 27 groups, then how many types of food will be obtained in one group? This activity aims for students to understand the properties of exponents. The Islamic value that is inserted is the word "The parable of a person who spends his wealth in the way of Allah is like a seed that grows seven stalks, on each stalk there are a hundred seeds. Allah multiplies for whom he wills, and Allah is all-encompassing, all-knowing." (QS. Al – Baqarah: 261)
3	Exponential function	Solve the problem of how many people are influenced to give *Sedekah* after seeing their friends give *Sedekah*, and have a pattern of involving people in giving *Sedekah*. This activity aims to provide students with an understanding of exponential functions. The Islamic value that is inserted is the hadith of the Prophet "Almsgiving will not reduce one's wealth. No one forgives another person, but Allah will increase his glory. And there is no person who humbles himself because of Allah, but Allah will raise his rank." (HR. Muslim)
4	exponential growth	Solving the problem of the growth of alms for 10 days in one of these mosques aims for students to be able to understand exponential growth. The Islamic value that is inserted is that Allah loves His servants who like to do alms and their sins will be forgiven as Allah says in Surah Al-Baqarah: 271 "if you show your alms, it is good. (However), if you hide it and give it to the poor, it is better for you. Allah will erase some of your mistakes. Allah is all-knowing of what you do.
5	Exponential Decay	Solve the problem of the relationship between exponential decay graphs and alms. If the graph is associated with alms, then the alms can also be lost if you mention it, make fun of it, and hurt the heart of the recipient of the alms. So that over time our alms will become zero and the reward for alms will even be lost. The Islamic value that is inserted is the word of Allah "Hi, you who believe, do not lose (the reward) of your alms by mentioning it and hurting (the feelings of the recipient), like a person who spends his wealth out of respect for humans and he does not have faith in Allah and the Last Day. The example of (that person) is like a smooth stone with dust on it, then heavy rain falls on the stone, then the stone is left smooth again. They do not get anything from it. what they do. And Allah does not guide the disbelievers." (Al-Baqarah:264)

The population in this study were Grade 10 students from two senior high schools, one Islamic School and one Regular School in Banda Aceh, Indonesia. Islamic school is a Tahfidz Quran school that combines Islamic and general education and is equipped with dormitory facilities. This school applies the Integrated Islamic School Network (JSIT) Curriculum, combining the National and the Integrated Islamic School curricula (Ismail, 2018). A regular school implements the National Curriculum and is not equipped with dormitory facilities. Both schools are A-grade accredited. The textbook used by these two schools was the High School Mathematics Book for Grade 10 by the Ministry of Education, Culture, Research, and Technology in 2023. From each school, two classes were randomly selected for the experimental class (56 students) and the control class (56 students), making the total sample of 112 students.

The instruments in this study were a mathematical communication skill test and a questionnaire assessing students' awareness of No-Poverty. The No-Poverty awareness questionnaire was administered before and after the learning; the questionnaire was adapted from Dikmenli, Yakar, and Konca (2018) which has been tested for reliability and validity. Meanwhile, the mathematical communication test was administered before and after the learning. The test items (long-answer questions), developed by the authors, were validated to ensure their appropriateness. The test was designed to address four indicators of mathematical communication ability as formulated by NCTM (2000) and Sumarmo (2012). The indicators were 1) Representing everyday events in mathematical language or symbols or constructing a mathematical model of an event; 2) Mathematical terms, symbols, and structures are used to model mathematical situations or problems; 3) Interpreting and evaluating mathematical ideas from problems both orally and in writing, 4) Explaining mathematical ideas, situations, and relationships in writing or orally using real objects, images, or algebraic forms. The test items underwent a readability test with a sample of 15 students. An example of the test item is provided in Figure 2.

Rahman is a mathematics student who loves to share and give *Sedekah* to others daily. When Rahman was giving *Sedekah*, three friends saw him giving *Sedekah*, so they were influenced to give *Sedekah* the next day, if the next day each person invited 3 other people.

a. How many people will be affected on each day of the week following the program?

b. Which of the following function graphs illustrates the increase in the number of people affected to participate in the program if the process occurs continuously in the same way?

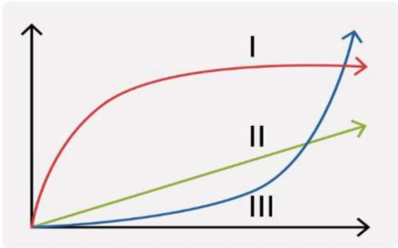

Figure 2. An example of mathematical communication skill test problems

The student knowledge questionnaire on No-Poverty was adopted from Dikmenli, Yakar, and Konca (2018), which also underwent a reliability and validity test process. This questionnaire consisted of 34 items that meet the No-Poverty indicators. A language expert translated, validated and corrected the questionnaire. Furthermore, the questionnaire was tested for its readability in Grade 10 students. The results indicated that students clearly understood the intent of the items in the questionnaire.

Data analysis was conducted using descriptive and inferential techniques. Descriptive analysis included the number of students, posttest and pretest scores, mean scores, variance, and standard deviation for pretest and posttest results, as well as for the questionnaires from the control and experimental groups. The pretest and posttest results were classified based on interval criteria, as presented in Table 2.

Table 2. Classification of students' mathematical communication skills

Score	Category
$x < M - 1SD$	Low
$M - 1S \leq x < M + 1SD$	Moderate
$x \geq M + 1SD$	High

Categorizing students' mathematical communication skills based on ability levels helps researchers effectively group students according to their proficiency. The hypotheses of this study are: (1) there is a difference in the improvement of students' mathematical communication skills through PBL learning in the context of *Sedekah* compared to conventional learning, based on student levels (high, medium, low) (2) there is a in the improvement of students' awareness of No-Poverty through PBL learning in the context of *Sedekah* compared to conventional learning, (3) there is no interaction between the PBL model in the context of *Sedekah* and student levels of mathematical communication skills, (4) there is no interaction between the PBL model in the context of *Sedekah* and student levels on No-Poverty awareness, (5) there is a significant difference in the improvement of mathematical communication skills between students in Islamic Schools and Regular Schools using PBL learning in the context of *Sedekah* compared to conventional learning, and (6) there is a significant difference in increasing No-Poverty awareness among students in Islamic Schools and Regular Schools using PBL learning in the context of *Sedekah* compared to conventional learning. To address the research questions, Hypotheses 1 and 2 were tested using Multivariate Analysis of Variance (MANOVA), hypotheses 5 and 6 were analyzed using independent sample t-tests, and hypotheses 3 and 4 were evaluated using two-way ANOVA. The impact of variables related to mathematical communication skills and students' awareness was assessed using Cohen's d to determine the effect size.

RESULTS AND DISCUSSION

Students' Mathematical Communication Skills

Data on students' mathematical communication skills were obtained from the pretest and posttest in the experimental and control classes. The mean and standard deviations of students' communication skills in the pretest and posttest for both Regular Schools and Islamic Schools are presented in Table 3.

Table 3. Mathematical communication skills of the student in the experimental and control classes in the regular and Islamic schools

	Regular School						Islamic School					
Score	Experiment			Control			Experiment			Control		
	N	$\underline{x}$	SD	N	$\underline{x}$	SD	N	$\underline{x}$	SD	N	$\underline{x}$	SD
Pretest	36	3.08	1,401	36	3.11	1.65	20	4.5	2,188	20	3.1	1,410
Posttest	36	12.94	1.86	36	9.22	1.49	20	9.7	2,408	20	7.4	1,231
Ideal score: 16												

Based on Table 3, the difference between the pretest and posttest scores indicates an improvement in students' mathematical communication skills in both the experimental and control classes, in both Regular and Islamic Schools, after the learning sessions. Furthermore, the data from the mean difference test were analyzed using MANOVA. The process for testing the hypothesis began with the normality test using Kolmogorov-Smirnov. Once the data were confirmed to be normally distributed, the analysis proceeded with MANOVA. The results of the research hypothesis test using MANOVA. Table 4 shows the results of multivariate testing to test hypotheses 1 and 2.

Table 4. Multivariate test results

	Value	F	Hypothesis df	df error	Sig.
Pillai's trace	.813	24,425	6,000	214,000	.000
Wilks' lambda	.312	27.957 [a]	6,000	212,000	.000
Hotelling's trace	1,809	31,654	6,000	210,000	.000
Roy's largest root	1,551	55.321 [b]	3,000	107,000	.000

Table 4 shows a significant difference in the improvement of students' mathematical communication skills through PBL in the context of *Sedekah*, compared to students using conventional learning in both Islamic Schools and Regular Schools ($p<0.05$). Furthermore, the Hoteliing's trace value of 1.809 ($p=0.000$) indicates a significant effect on the model. In other words, there is a significant difference in the average mathematical communication skills between Islamic school and regular school students. Although improvements were observed in both schools, the increase was greater in one school compared to the other based on the Post hoc test (Table 5).

Table 5. Post Hoc Test

	Class	N	Subset 1	Subset 2	Subset 3
Duncan [a,b,c]	CTR_IS	20	4.30		
	EX_IS	20	5.20	5.20	
	CTR_RS	36		6.11	
	EKS_RS	35			9.89
	Sig.		.105	.101	1,000

The Post hoc test results revealed that the increase in the experimental class at the Islamic School was comparable to those in the control class at the Regular School, which can also be observed from the comparable mean score between the Regular School and Islamic School control classes. Additionally, an independent sample t-test was conducted on the pretest scores to assess whether the initial abilities of students in Islamic and Regular Schools were equivalent. T-test results indicates no significant difference in the initial abilities of students in Islamic and Regular Schools (p = 0.084). Using the same analysis, a test was conducted to examine the difference in the Gain score between Islamic and Regular Schools.

The independent t-test on the gain score indicates a significant difference in gain scores between the Regular and Islamic Schools (p =0.00). In other words, there is a difference in the increase of mathematical communication skills using PBL learning in the context of *Sedekah* compared to students using conventional learning in both Regular and Islamic Schools. From this explanation, it can be concluded that hypothesis 5 is accepted. To examine the magnitude of mathematical communication skills' influence on PBL learning, the Effect Size Test was done using Cohen's d two groups and the results is presented in Table 6.

Table 6. Cohen's d values for mathematical communication skills.

Class	Islamic School				Regular School			
	Average gain score	Standard Deviation	Cohen D	Criteria	Average gain score	Standard Deviation	Cohen D	Criteria
Experiment	5.2	2.48	0.65	Currently	9.8	2.07	2.6	Tall
Control	4.3	1.30			6.1	1.81		

Table 6 illustrates the Cohen's d value calculation, derived from the difference in average gains divided by the pooled standard deviation of mathematical communication skills. The Cohen’s d value of regular school is 2.6 (SD=2.07), indicating a strong effect in Regular Schools. In contrast, in Islamic Schools shows the Cohen’s d value of 0.65 (SD=2.43), meaning that the effect of PBL learning on students' mathematical communication skills is classified as moderate. Further hypothesis testing was conducted using Two-Way ANOVA to examine the interaction between learning approaches and student levels of No-Poverty awareness. Table 7 shows the results of Analysis of variance of student mathematical communication skills gain data in regular school dan Islamic school to test hypothesis 3.

Table 7. Analysis of variance of student mathematical communication skills gain data in regular school dan Islamic school

Tests of Between-Subjects Effects (Regular School)

Dependent Variable: Value

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	288,547 [a]	5	57,709	17,217	.000
Intercept	2686.813	1	2686.813	801,561	.000
Model	165,813	1	165,813	49,467	.000
Level	40,677	2	20,339	6,068	.004
Model * level	2,578	2	1.289	.385	.682
Error	221,230	66	3.352		
Total	5054.000	72			
Corrected Total	509,778	71			

a. R Squared = .566 (Adjusted R Squared = .533)

Tests of Between-Subjects Effects (Islamic School)

Dependent Variable: Result

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	57.297 [a]	5	11,459	3.888	.007	.364
Intercept	598,339	1	598,339	203,024	.000	.857
Levels	19,477	2	9,739	3.304	.049	.163
Treatment	19,258	1	19,258	6,534	.015	.161
level * treatment	18,750	2	9.375	3.181	.054	.158
Error	100.203	34	2,947			
Total	1060.000	40				
Corrected Total	157,500	39				

a. R Squared = .364 (Adjusted R Squared = .270)

Table 7 shows hypothesis 3 wes rejected (p=0.054), it means no significant interaction between learning and student level (high, medium, low) regarding mathematical communication skills in Regular Schools (p=0.682). Similarly, there is no significant interaction between problem-based learning (PBL) and student level in Islamic Schools. Therefore, the PBL model effectively enhances the mathematical communication skills of students across all ability levels. The interaction between learning factors and student-level factors in Regular and Islamic Schools is shown in Figures 3a and 3b. Figures 3a and 3b indicate that the lines do not intersect, indicating no interaction between the learning model and the student level.

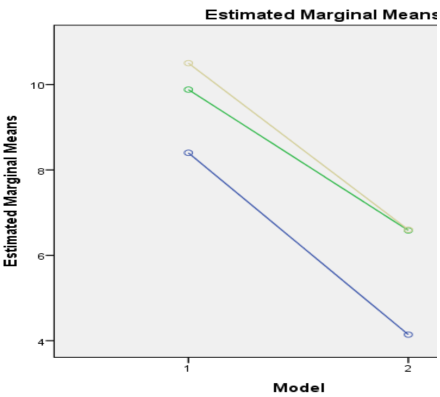

Figure 3a. Interaction between learning models and the Regular School students' ability levels towards mathematical communication skills

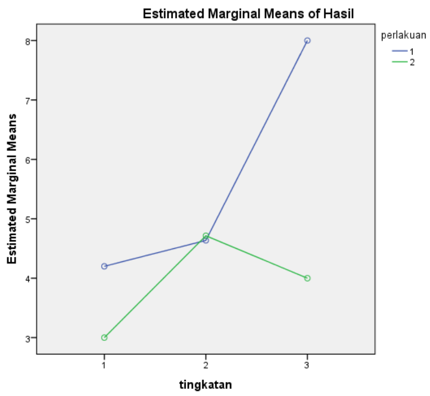

Figure 3b. Interaction between learning models and Islamic School students' ability levels towards mathematical communication skills

Student No-Poverty Awareness

Data on students' awareness of No-Poverty were obtained from the questionnaire administered before (pretest) and after learning (posttest) in the experimental and control classes. Table 8 presents the average and standard deviation of the pretest and posttest of No-poverty awareness.

Table 8. No-Poverty awareness scores of Regular and Islamic school students

score	Regular School						Islamic School					
	Experiment			Control			Experiment			Control		
	N	x	SD	N	x	SD	N	x	SD	x	N	SD
Pretest	36	130.63	8.82	36	124.94	7.13	20	133.2	14.09	124	20	16.84
Posttest	36	152.88	7.97	36	135.11	6.77	20	154.55	3.82	137.7	20	8.37

Table 8 illustrates a varying increase in No-Poverty awareness scores among students in both Islamic and Regular Schools, with the experimental class demonstrating a higher average than the control class. In the Regular School, the mean pretest score for the experimental class was 130.63 (SD=8.82), while the mean post-test score was 152.88 (SD=7.97). In contrast, the control class had a mean pretest score of 124.94 (SD=7.31), with a mean post-test score of 135.11 (SD=6.77). For the Islamic School, the experimental class had a mean pretest score of 133.2 (SD=14.09), while the mean post-test score was 154.55 (SD=3.82). The control class in the Islamic school had an average pretest score of 124 (SD=16.84), and a mean post-test score of 137.7 (SD=8.37). These values conclude that the awareness of No-Poverty among students in Islamic Schools is higher than that among students in Regular Schools. Furthermore, a comparison of the average gain scores between the experimental and control classes was conducted using multivariate analysis (MANOVA).

Table 9 presents the multivariate test results of the difference in average on No-Poverty awareness gain scores of students at Regular and Islamic Schools to test hypothesis 6.

Table 9. The Multivariate test results of the difference in average on No-Poverty awareness gain scores of students at Regular and Islamic Schools.

Multivariate Tests [a]						
Effect		Value	F	Hypothesis df	df error	Sig.
Intercept	Pillai's Trace	.804	217.634 [b]	2,000	106,000	.000
	Wilks' Lambda	.196	217.634 [b]	2,000	106,000	.000
	Hotelling's Trace	4.106	217.634 [b]	2,000	106,000	.000
	Roy's Largest Root	4.106	217.634 [b]	2,000	106,000	.000

Table 9 shows hypothesis 6 was accepted ($p < 0.005$), it means thare is a significant difference in the increase in students' No-Poverty awareness through PBL learning in the context of *Sedekah* compared to conventional learning in both Regular and Islamic Schools. This increase is particularly notable in Islamic schools, where students find it easier to understand about poverty alleviation compared to those in Regular Schools. Students in Islamic schools receive more Islamic knowledge than their counterparts in regular schools. According to the post hoc analysis, the No-Poverty awareness of Regular School students in the control class was lower than that of students in the control class of Islamic Schools. Detailed post hoc results are presented in Table 10.

Table 10. Post Hoc awareness of student poverty alleviation

Gain_PK					
			Subset		
	Class	N	1	2	3
Duncan [a,b,c]	CTR_3	36	5.67		
	CTR_IT	20		14.20	
	EKS_IT	20			21.35
	EKS_3	35			21.66
	Sig.		1,000	1,000	.924

Table 10 indicates that the poverty alleviation awareness among students in the experimental class of Regular Schools is comparable to that of students in Islamic Schools, placing both in subset 3. In contrast, the No-poverty awareness among students in the control class of Regular Schools is lower than that of the control class students in Islamic Schools. This difference is reflected in their respective subsets, with the control class in regular schools categorized in subset 1 and the control class in Islamic schools in subset 2.

An independent sample t-test was performed to determine the difference in the increase in No-poverty awareness between students in Regular and Islamic Schools using PBL learning in the context of *Sedekah* compared to those using conventional learning. The independent sample t-test on No-

Poverty awareness data indicates a significant difference in Gain scores between Regular and Islamic Schools (p = 0.00). This result suggests a variation in the increase of No-Poverty awareness among students in Islamic and Regular Schools when using PBL learning in the context of *Sedekah* compared to conventional learning. Additionally, data analysis was conducted to examine the interaction between the learning method and student level on the increase in No-Poverty awareness. A two-way ANOVA was employed to determine whether such an interaction exists and the results are displayed in Table 11 to test hypothesis 4.

Tabel 11. Tests of between-subject effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2,202 [a]	5	,440	15,307	,000
Intercept	6,826	1	6,826	237,297	,000
Student_level	,177	2	,088	3,074	,053
Learning	1,167	1	1,167	40,565	,000
Student_level * Learning	,001	2	,000	,013	,987
Error	1,899	66	,029		
Total	14,834	72			
Corrected Total	4,100	71			

a. R Squared = .537 (Adjusted R Squared = .502)

Table 11 shows hypothesis 4 was rejected (p = 0.987). It indicates no significant interaction between learning methods and student levels (high, medium, low) in increasing No-poverty awareness. This finding suggests that the learning method and student level do not interact in influencing the increase in No-poverty awareness. The learning model can enhance students' awareness, regardless of their varying ability levels high, low, or medium. These results indicate that PBL model can effectively be utilized with students of different performance levels.

Figure 4 shows interaction between learning factors and student level factors on increasing no-poverty awareness. If the lines in the figure intersect then there is interaction but if the lines do not intersect like then there is no interaction.

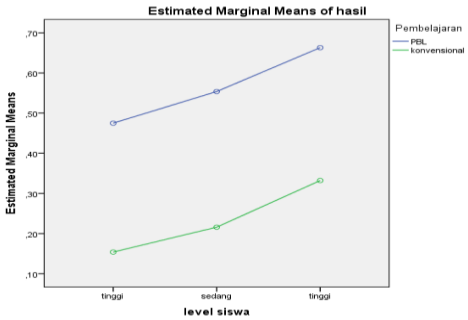

Figure 4. Interaction between learning factors and student level factors on increasing no-poverty awareness

Figure 4 shows the interaction between learning and student levels. It indicates no interaction between the two, as the lines do not intersect.

This study found that students who were taught using the PBL model in the context of *Sedekah* showed a significant improvement in their mathematical communication skills (p = 0.000) compared to those who were taught through conventional methods, both in Regular and Islamic Schools. This improvement can be attributed to the active involvement of students at nearly every stage of the PBL process. These findings align with the research by Setiawan et al. (2022), which demonstrated that the PBL model enhances student engagement in learning activities and positively impacts cognitive learning outcomes.

The *Sedekah* context not only piqued students' curiosity but also encouraged them to solve problems effectively. Research by Nufus and Mursalin (2020), supported the improvement in mathematical communication skills through PBL within this context, indicating that students taught using the PBL model performed better than those taught through traditional methods. Other studies have also demonstrated similar results, highlighting the effectiveness of PBL in enhancing mathematical communication skills. Research by Silvatama et al. (2023) indicated that integrating mathematics learning with Islamic values can improve students' mathematical communication skill. While both schools experienced an improvement in mathematical communication skills, the experimental class students in Islamic Schools performed at a level equivalent to the control class students in Regular Schools. This outcome may be due to a lack of focus and internal factors affecting students' learning, which could hinder further improvement in their skills (Fatmawati et al., 2020).

Another finding indicates a significant difference in the increase of Cohen's d value, showing that the mathematical communication abilities of students in Regular Schools are higher than those in Islamic Schools. Regular School students are more engaged and motivated to learn mathematics than their counterparts in Islamic Schools. These results align with the findings of Lomu and Widodo (2018), who suggested that students with high learning motivation tend to achieve better learning outcomes. In contrast, those with low motivation often exhibit poorer performance.

Interestingly, the findings also show that high mathematical communication skills do not necessarily correlate with high No-Poverty awareness. This study found that students in Islamic Schools demonstrated higher No-Poverty awareness scores than those in Regular schools. Specifically, when comparing the control classes, Islamic School students consistently scored higher. This aligns with Kultsum et al (2022) research, which observed that students in Islamic Schools are more aware of Islamic values than students in public schools.

Despite these differences, the implementation of the PBL model in the context of *Sedekah* during mathematics lessons, particularly on exponent, improved the No-Poverty awareness in both Regular and Islamic Schools. This finding supports Agusti et al. (2019), who highlighted that integrating the

PBL model with the context of ESD significantly enhances students' awareness after the learning process.

The study also found no interaction between learning methods and student levels of mathematical communication skills or No-poverty awareness. This indicates that the PBL model is a suitable alternative for teaching mathematics to students at all levels. In other words, having students with high, medium, and low abilities in the same class does not hinder the implementation of the PBL model. These findings align with the research of Siswadi et al. (2023), which also found no interaction between learning model factors and student levels in improving mathematical communication skills. According to McMillan and Schumacher (1997), an interaction occurs only when the effect of one variable varies across different levels of another variable. Interaction is absent when all groups exhibit similar improvements.

CONCLUSION

The study concludes that using the PBL model in mathematics positively impacts students' mathematical communication skills and awareness of poverty alleviation. PBL learning in the context of *Sedekah* led to significant improvements in these areas compared to conventional teaching methods in Regular and Islamic schools. Furthermore, PBL can benefit students of varying abilities in enhancing their communication skills and awareness of poverty alleviation both in the Regular and Islamic Schools. The study also highlights notable differences in the improvement of these skills between Regular and Islamic school students when taught with PBL versus traditional methods.

It was also observed that the mathematical communication skills of students in the experimental class at Islamic Schools are comparable to those of students in the control class at Regular Schools, despite differing instructional approaches. When the same instructional treatment was applied, a significant improvement in mathematical communication skills was evident. Cohen's d effect size for mathematical communication skills was categorized as strong for Regular Schools and medium for Islamic Schools. These findings suggest the need for further research to explore additional additional instructional materials and strategies for enhancing students' mathematical communication skills and their awareness of poverty alleviation.

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DECLARATIONS

Author Contribution	: N	: Conceptualization, Writing- Original Draft, Editing and Visualization;
	RJ	: Writing - Review & Editing, Formal analysis, Methodology, and supervision;
	A	: Editing, validation and Supervision;
	MISI	: Verification, whether as a part of the activity or separate of the overall replication/reproducibility of result;
	RO	: Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
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