

The Effect of Indonesian Realistic Mathematics Education on Students' Mathematics Learning Outcomes

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ABSTRACT This study examined the effect of Indonesian Realistic Mathematics Education on sixth-grade students' mathematics learning outcomes. A quantitative pre-experimental method with a one-group pretest-posttest design was employed. The participants were 30 sixth-grade students at State Elementary School 1 Kasugengan Kidul, selected through total sampling. Data were collected using pretest and posttest essay tests, observation sheets assessing affective and psychomotor learning activities, and documentation. The data were analyzed using the Shapiro-Wilk normality test, a paired-samples t -test, and normalized gain. The mean learning-outcome score increased from 34.00 on the pretest to 84.67 on the posttest. The paired-samples test indicated a statistically significant difference between the scores, $t(29) = -42.497, p < .001$. The mean normalized gain was 0.779, or 77.86%, which was categorized as high and effective. Affective-domain achievement increased from 26.67% before the intervention to 93.33% afterward, while psychomotor-domain achievement increased from 26.67% to 96.67%. These findings indicate that the approach was associated with substantial improvements in students' mathematics learning outcomes and learning activities. However, because the study used a single-group design without a control group, the findings should be interpreted within the context of the participating class.

Keywords: Indonesian Realistic Mathematics Education, mathematics learning outcomes, elementary education, contextual learning, pre-experimental study

INTRODUCTION

Elementary education supports the gradual development of students' knowledge, foundational skills, attitudes, and character through contextual and active learning. At this level, students study literacy, numeracy, science, social studies, and character education in ways that correspond to their cognitive and social development. Ramadanti (2021, as cited in Rahma et al., 2025) explained that elementary-school students are generally in the concrete operational stage and therefore learn most effectively

through tangible objects and experiences related to daily life. Mathematics is one of the subjects that should be taught in this developmentally appropriate manner.

Elementary mathematics instruction is intended to develop conceptual understanding, numeracy, and problem-solving skills (Ekgiyoga et al., 2025). It also plays an important role in developing logical, systematic, and critical thinking (Zulviani et al., 2024). However, Indonesian students obtained a mean mathematics score of 366 in the 2022 Programme for International Student Assessment, substantially below the Organisation for Economic Co-operation and Development average of approximately 472. This result indicates continuing difficulties in mathematical literacy and problem solving, partly because instruction often remains theoretical and overly focused on memorizing formulas.

These national findings are consistent with the difficulties observed among sixth-grade students at State Elementary School 1 Kasugengan Kidul. In particular, students had difficulty visualizing cube nets and identifying valid patterns, indicating weaknesses in spatial reasoning, conceptual understanding, and contextual problem solving. Addressing these difficulties requires instruction that connects mathematical ideas with situations familiar to students. Indonesian Realistic Mathematics Education offers such an approach by using meaningful real-life contexts as a basis for mathematical exploration. Indonesian Realistic Mathematics Education was adapted from Realistic Mathematics Education and contextualized for Indonesian culture. Ulya et al. (2019, as cited in Nabilah et al., 2023) described the approach as beginning with realistic situations that enable students to participate directly in the learning process. It views mathematics as a human activity and begins with meaningful situations familiar to students (Oktalina et al., 2025). Consistent with constructivist principles, students develop knowledge through the exploration of contextual problems and interactive discussion rather than through the passive receipt of information (Hartono, 2014, as cited in Lumahu et al., 2025).

The approach is characterized by guided reinvention and progressive mathematization, didactical phenomenology, and self-developed models (Gravemeijer, 1994, as cited in Rangkuti, 2019). Its instructional features include the use of contexts and models, students' own constructions, interaction, and connections among mathematical ideas (Treffers, as cited in Pratiwi & Meiliasari, 2025). Together, these principles support the gradual movement from informal strategies toward formal mathematical understanding.

A hadith narrated by al-Bukhari states (Atsira et al., 2025):

أَصَلِّ يَ رَأَيْتُمْ مُونِي لَمْ أَصَلُّوا

Meaning:

"Pray as you have seen me pray" (narrated by al-Bukhari, as cited in Atsira et al., 2025).

The hadith emphasizes learning through observation, concrete examples, and direct practice. This pedagogical value is consistent with instruction that begins with real-world contexts and engages students in observation, exploration, problem solving, and modeling. Nevertheless, the theoretical foundation of Indonesian Realistic Mathematics Education remains Realistic Mathematics Education, particularly its principles of contextual mathematization and knowledge construction. The hadith therefore serves as pedagogical reinforcement for experiential learning rather than as the conceptual basis of the approach.

Learning outcomes refer to changes in cognitive, affective, and psychomotor competence following an instructional process (Sudjana and Ibrahim, 2010, as cited in [Yandi et al., 2023](#)). These changes emerge through students' interaction with a deliberately designed learning environment and the instructional model implemented by the teacher ([Iqbal et al., 2024](#)). They may therefore be understood as the knowledge, attitudes, and skills developed through participation in learning activities (Rusmono, 2014, as cited in [Rahmawati & Sati, 2021](#)).

Previous studies have reported improved mathematics outcomes following the implementation of Indonesian Realistic Mathematics Education. [Hutagalung et al. \(2024\)](#) found that the experimental class increased from a pretest mean of 51.73 to a posttest mean of 85.70, whereas the control class increased from 51.63 to 61.78. Similarly, [Lestari and Muryaningsih \(2025\)](#) reported an increase in the mean score from 69.47 in the first cycle to 80.26 in the second cycle, accompanied by an increase in mastery from 52.17% to 86.95%. These findings suggest that contextual and student-centered mathematics instruction can improve learning achievement.

Although previous studies have demonstrated improvements in learning outcomes and conceptual understanding, many have focused primarily on cognitive achievement. Contemporary learning also requires critical thinking, collaboration, and independent learning. However, elementary mathematics instruction often remains teacher-centered, limiting students' opportunities to construct understanding actively. The present study therefore considered both test performance and observed affective and psychomotor learning activities.

Preliminary observations in the sixth-grade class at State Elementary School 1 Kasugengan Kidul indicated that learning outcomes required improvement. Daily geometry-test scores averaged 60.21, with scores ranging from 38 to 100, while the learning objective achievement criterion was 70. Classroom observations, teacher interviews, and document analysis suggested that instruction was insufficiently connected to realistic contexts and remained focused on formula memorization. Consequently, students had limited opportunities to develop concepts independently, compare solution strategies, and reason about cube nets.

Given these conditions, a contextual approach closely connected to students' daily experiences was needed. This study therefore aimed to examine sixth-grade students' mathematics learning outcomes after the implementation of Indonesian Realistic Mathematics Education at State Elementary School 1 Kasugengan Kidul. It also examined changes in affective and psychomotor learning activities during the intervention.

RESEARCH METHOD

This quantitative study employed a pre-experimental one-group pretest–posttest design. Quantitative methods use numerical data and statistical analysis to examine research questions through strategies such as surveys and experiments (Emzir, 2009, as cited in Julhadi et al., 2022). The selected design enabled a comparison of students' performance before and after the intervention (Nopita et al., 2024).

The study was conducted on May 11 and 13, 2026, at State Elementary School 1 Kasugengan Kidul, Depok District, Cirebon Regency. The population comprised all 30 sixth-grade students, and all students were included through total sampling. This technique includes every member of the population in the sample (Suriani et al., 2023).

Data were collected using test and non-test instruments. The test instrument consisted of pretest and posttest essay questions designed to assess cognitive learning outcomes. The non-test instruments comprised observation sheets for affective activities, including critical thinking, collaboration, and independence, and psychomotor activities, including motivation, active participation, and cooperation. Documentation provided supporting evidence throughout the study. The data were analyzed using the Shapiro–Wilk normality test, a paired-samples *t*-test, and normalized gain.

Table 1. Decision Rules for the Paired-Samples *t*-Test

Significance Level	Decision
$p \geq .05$	Fail to reject H_0
$p < .05$	Reject H_0 in favor of H_1

Notes:

H_0 : The implementation of Indonesian Realistic Mathematics Education does not affect the mathematics learning outcomes of sixth-grade students at State Elementary School 1 Kasugengan Kidul.

H_1 : The implementation of Indonesian Realistic Mathematics Education affects the mathematics learning outcomes of sixth-grade students at State Elementary School 1 Kasugengan Kidul.

The procedure consisted of planning, instrument preparation, administrative approval, and classroom implementation. Students first completed a pretest to establish their initial performance. They then participated in mathematics instruction using Indonesian Realistic Mathematics Education and completed a posttest after the intervention.

Before data collection, the test items were evaluated for validity using the product-moment correlation and for reliability using Cronbach's alpha. The observation sheets were reviewed through expert validation rather than statistical item testing.

Table 1. Validity Test Results for the Mathematics Learning Outcome Items

Item	Calculated r	Critical r	Decision
1	0.861	0.361	Valid
2	0.849	0.361	Valid
3	0.939	0.361	Valid

As shown in Table 1, the calculated correlation coefficient for each item exceeded the critical value of 0.361. The coefficients ranged from 0.849 to 0.939, indicating that all three items were valid and suitable for measuring mathematics learning outcomes.

Table 2. Reliability Test Result for the Mathematics Learning Outcome Test

Cronbach's Alpha	Critical Value	Decision
0.848	0.361	Reliable

Table 2 shows a Cronbach's alpha coefficient of 0.848, indicating high internal consistency. The mathematics learning-outcome test was therefore considered reliable and suitable for data collection.

RESULTS AND DISCUSSION

The study involved 30 sixth-grade students at State Elementary School 1 Kasugengan Kidul on May 11 and 13, 2026. Mathematics learning outcomes were measured through a pretest and posttest, while affective and psychomotor learning activities were assessed through observation before and after the implementation of Indonesian Realistic Mathematics Education.

Table 3. Descriptive Summary of Pretest Scores

Score	Category	Frequency	Maximum	Minimum	Mean
≥ 70	Met criterion	0	55	15	34.0000
< 70	Did not meet criterion	30			

Table 3 shows that the pretest mean was 34.00, with scores ranging from 15 to 55. None of the 30 students met the learning objective achievement criterion of 70. Consequently, the initial proportion of students meeting the criterion was 0%, below the research target of 80%.

Table 4. Descriptive Summary of Posttest Scores

Score	Category	Frequency	Maximum	Minimum	Mean
≥ 70	Met criterion	30	100	70	84.6667
< 70	Did not meet criterion	0			

As shown in Table 4, the posttest mean was 84.67, with scores ranging from 70 to 100. All 30 students met the learning objective achievement criterion, producing a mastery rate of 100%. This result exceeded the research target of 80%.

The descriptive results therefore indicate a substantial improvement in mathematics learning outcomes following the intervention. Inferential and normalized-gain analyses were subsequently conducted to evaluate the statistical significance and magnitude of this improvement.

The Shapiro–Wilk test was first used to assess whether the pretest and posttest scores satisfied the normality assumption required for parametric analysis.

Table 5. Shapiro–Wilk Normality Test Results for Pretest and Posttest Scores

Test	Shapiro–Wilk Statistic	df	p
Pretest	.946	30	.128
Posttest	.938	30	.082

Table 5 shows that the pretest ($p = .128$) and posttest ($p = .082$) scores did not significantly deviate from normality because both probability values exceeded .05. The normality assumption was therefore satisfied, and the analysis proceeded with a paired-samples t -test.

Table 6. Paired-Samples t -Test Results for Pretest and Posttest Scores

Pair	Mean	SD	SE	95% CI of the Difference		t	df	p
				Lower	Upper			
Pretest–Posttest	–50.667	6.530	1.192	–53.105	–48.228	–42.497	29	< .001

Table 6 indicates that posttest scores were significantly higher than pretest scores, with a mean paired difference of -50.667 , $t(29) = -42.497$, $p < .001$, and a 95% confidence interval from -53.105 to -48.228 . The null hypothesis was therefore rejected. This improvement may be explained by the opportunities the approach provided for students

to explore contextual problems, discuss alternative strategies, and construct mathematical concepts actively. Such activities can promote meaningful learning and encourage students to develop their own solution strategies (Suwarsono, 2013, as cited in Kurniasari, 2020).

The result is consistent with Islamy (2022), who reported an increase in the proportion of students scoring above 70 from 12.5% before the intervention to 85% afterward, with a calculated t value of 10.673 exceeding the critical value of 2.306. Sunedi (2023) likewise reported an increase of 9% in average achievement and 14% in learning mastery between the first and second instructional cycles. Together, these studies support the potential of realistic and contextual mathematics instruction to improve student achievement.

Table 7. Descriptive Statistics for Normalized Gain

	Descriptive Statistics				
	N	Minimum	Maximum	Mean	Std. Deviation
Normalized gain	30	.57	1.00	.7786	.10169
Normalized gain (%)	30	57.14	100	77.8635	10.16922

Table 7 shows a mean normalized gain of 0.7786, which falls within the high category. This result indicates that students' understanding of cube nets improved substantially after the intervention. The use of realistic contexts and active student involvement may have supported the gradual construction of mathematical concepts. This interpretation is consistent with didactical phenomenology, which uses relevant contextual problems as a starting point for the progressive reinvention of mathematical ideas (Gravemeijer, 1994, as cited in Rangkuti, 2019).

The corresponding mean percentage gain was 77.8635%, which met the study's criterion for effective improvement. Student-centered exploration, realistic contexts, and independent conceptual discovery are central features of the approach (Treffers, as cited in Pratiwi & Meiliasari, 2025). These features provide a plausible instructional explanation for the observed improvement, although the absence of a comparison group limits causal interpretation.

The improvement in test scores also reflects changes in the learning process. From a cognitive constructivist perspective, knowledge is developed actively through interaction with the environment and reflection on experience (Nurjamilah et al., 2025). Assimilation and accommodation occur when students connect prior knowledge with new

experiences. By beginning with contextual problems and involving students in observation, discussion, exploration, and independent discovery, Indonesian Realistic Mathematics Education supports this process and promotes meaningful conceptual understanding.

Changes in the learning process were also examined through affective- and psychomotor-domain observations. The affective indicators were critical thinking, collaboration, and independence, whereas the psychomotor indicators were motivation, active participation, and cooperation.

Table 8. Affective-Domain Learning Activity Observation Results

	Before the Intervention	After the Intervention
Number of Students	30	30
Observation Indicators	Critical thinking, collaboration, and independence	Critical thinking, collaboration, and independence
Achievement target	$\geq 80\%$	$\geq 80\%$
Students who meet the criteria	8	28
Percentage	26.6667%	93.3333%
Interpretation	Target not achieved	Target achieved

As shown in Table 8, 8 students (26.67%) met the affective-domain criteria before the intervention, whereas 28 students (93.33%) met them afterward. The post-intervention proportion exceeded the achievement target of 80%.

Table 9. Psychomotor-Domain Learning Activity Observation Results

	Before the Intervention	After the Intervention
Number of Students	30	30
Observation Indicators	Motivation, active participation, and cooperation	Motivation, active participation, and cooperation
Achievement target	$\geq 80\%$	$\geq 80\%$
Students who meet the criteria	8	29
Percentage	26.6667%	96.6667%
Interpretation	Target not achieved	Target achieved

Table 9 shows a comparable improvement in psychomotor activities. The number of students meeting the criteria increased from 8 (26.67%) before the intervention to 29 (96.67%) afterward. The post-intervention result therefore exceeded the achievement target of 80%.

Overall, the test and observational findings indicate that Indonesian Realistic Mathematics Education was associated with improved mathematics outcomes and more active learning among the participating students. The approach treats mathematics as a human activity and uses realistic problems to support longer-lasting understanding (Rosalia et al., 2022). Its emphasis on context, modeling, student contributions, and social interaction creates a learning environment aligned with elementary students' developmental needs (Iswanti & Zamzam, 2025). Thus, the approach supported both academic achievement and constructive learning behaviors in the participating class.

CONCLUSION AND RECOMMENDATIONS

The implementation of Indonesian Realistic Mathematics Education was associated with a substantial improvement in sixth-grade students' mathematics learning outcomes. The posttest mean was considerably higher than the pretest mean, and the paired-samples analysis indicated a statistically significant difference, $t(29) = -42.497$, $p < .001$. The mean normalized gain was 0.7786, or 77.8635%, which was classified as high and effective according to the criteria used in this study. Affective and psychomotor learning activities also improved and exceeded the achievement target after the intervention. These findings suggest that contextual problems, active exploration, discussion, and student-generated strategies can support mathematical understanding and productive learning behaviors. Nevertheless, the single-group design does not permit a definitive causal conclusion because no comparison group was included.

Future studies should examine this instructional approach in more diverse schools, grade levels, and mathematical topics using experimental or quasi-experimental designs with comparison groups. Longer interventions and follow-up assessments are also recommended to evaluate the durability of learning gains. Researchers and teachers should collaborate in developing context-based instructional designs that are theoretically grounded, practical, and adaptable to classroom conditions, including activities that integrate digital contexts and students' daily experiences.

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