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The Effect of Example and Non-Example Strategies in Integer Calculations on the Reasoning Competence and Conceptual Understanding of Fourth Grade Elementary School Students

Tri Saptoyo [1], Sugiman[2]

[1,2] Study Program of Elementary Education, Yogyakarta State University, Yogyakarta Indonesia

ABSTRACT: This study aims to: (1) examine the effect of applying the Example Non-Example instructional strategy on students' reasoning competence and conceptual understanding in mathematics; (2) determine the effect of the Example Non-Example strategy on students' reasoning competence in mathematics; and (3) analyze the effect of the Example Non-Example strategy on students' conceptual understanding in mathematics. The research employed a quasi-experimental design. The population of the study consisted of fourth-grade students at SD Negeri Rejosari, under the coordination of the Wonoboyo District Education and Culture Office (Koorwil Dindikpora), Temanggung Regency. The sample was selected using random purposive sampling, resulting in class IV A being assigned as the experimental group (10 students) and class IV B as the control group (11 students). Data collection techniques included observation and testing. Data analysis was conducted using hypothesis testing methods, including paired sample t-tests and independent t-tests. The findings revealed that the use of the Example Non-Example strategy had a statistically significant effect on both reasoning competence and conceptual understanding of positive integer operations among fourth-grade students at SD Negeri Rejosari, Wonoboyo District, Temanggung Regency, as indicated by a significance value ($p = 0.000 < 0.05$). Significant differences were also found based on hypothesis testing using t-tests, with t-values of 14.375 and 4.113 respectively, both exceeding the critical t-table value of 2.228 (df = 10). Based on these results, all null hypotheses (H_o) were rejected, and the alternative hypotheses (H_a) were accepted.

KEYWORDS: reasoning competence, conceptual understanding, Example Non-Example strategy

INTRODUCTION

Mathematics is a fundamental subject in elementary education, serving not only as a core academic discipline but also as a critical tool for cognitive development. At this level, students are expected to master a variety of mathematical concepts appropriate to their grade in order to support success in subsequent stages of learning (Fitrah, 2017). Mathematics is not merely about computation but functions as a means of intellectual training, enhancing students' reasoning and analytical abilities (Damayanti & Mawardi, 2018). Therefore, structured and meaningful mathematics instruction is essential to prepare students for lifelong learning.

Mathematics instruction must be grounded in two primary principles: first, the emphasis on understanding concepts for problem-solving and scientific development, and second, fostering systematic, critical, and objective thinking skills (Mujib, 2018). These principles ensure that students not only understand procedural methods but also grasp the underlying concepts. Darragh & Radovic (2018) further argue that concept development in mathematics is closely tied to students' identity and their relationship with mathematical practices. Thus, instruction should emphasize comprehension rather than rote memorization.

Understanding mathematical concepts is essential because it forms the foundation for other competencies, including reasoning, problem-solving, and communication. According to the Mathematics Educators Association (2017), teachers have a responsibility to ensure students deeply understand the concepts they teach. With strong conceptual understanding, students can solve mathematical problems more efficiently than through mere memorization. This approach is aligned with constructivist learning principles, in which learners build knowledge actively rather than passively receiving information.

Conceptual understanding is one of the primary learning outcomes in mathematics. According to Permendikbud (2014), this includes identifying concept features, connecting concepts across topics, and illustrating concepts using diagrams, tables, or

graphs. These competencies allow students to process, apply, and reflect upon mathematical ideas in various contexts (Dirgantoro, 2018). Without such understanding, students may struggle to apply mathematical knowledge beyond classroom tasks.

In addition to understanding concepts, reasoning is another critical mathematical competency. Reasoning enables students to link facts, make inferences, and draw logical conclusions. Seah & Andersson (2015) emphasize that mathematical reasoning also fosters persistence and reflective thinking. Students need reasoning skills to solve real-world problems, make judgments about solutions, and evaluate the validity of arguments. Therefore, developing reasoning ability must be an integral part of elementary mathematics instruction (Rasyid, 2017).

Unfortunately, many elementary students, including those in Temanggung, Central Java, still demonstrate low performance in mathematics. This is attributed to weak reasoning and conceptual understanding skills, which are essential for achieving numeracy literacy (Allen et al., 2020). According to the 2021 education quality report of Dindikpora Temanggung, students' numerical literacy is below standard across many schools, including those in Kecamatan Wonoboyo. Such results indicate the urgent need for instructional improvement at the classroom level.

Observations from SD Negeri Rejosari reveal that instruction remains teacher-centered, lacks engaging strategies, and fails to use varied learning resources. This method limits students' opportunities to construct knowledge and develop reasoning. Teachers focus more on covering material than on fostering conceptual mastery. As a result, students struggle with basic topics such as whole number operations, which impacts their overall mathematics achievement (Sfard, 2014).

To fill this gap, the present study investigates the effect of the Example Non-Example strategy on reasoning competence and conceptual understanding of whole number operations among fourth-grade students in SD Negeri Rejosari, Temanggung. This research aims to contribute new insights and evidence for integrating the Example Non-Example model into mathematics instruction. The focus on a rural setting also adds to the study's practical significance.

The novelty of this research lies in applying the Example Non-Example strategy specifically to the topic of whole number operations, a core topic in elementary mathematics. This study is among the first to systematically assess the strategy's impact in this subject area. Moreover, it addresses the local issue of poor performance in mathematical reasoning and understanding within an under-resourced rural school context.

To address these issues, the Example Non-Example strategy presents a promising alternative. This instructional model uses visual representations and contrasting examples to help students distinguish relevant features of mathematical concepts (Astriani, 2017). It has the potential to enhance both reasoning and conceptual understanding, particularly in abstract topics such as whole number operations. Therefore, this study seeks to examine the extent to which the Example Non-Example strategy can improve fourth-grade students' competencies in mathematical reasoning and conceptual understanding at SD Negeri Rejosari.

METHOD

This study employed a quasi-experimental research design using a pre-test and post-test control group format. This design was selected to assess the effectiveness of the Example Non-Example learning strategy in improving students' reasoning competence and conceptual understanding in the topic of whole number operations. The quasi-experimental design allows researchers to examine causal relationships between variables in real classroom settings without random assignment of participants to groups.

The population in this study consisted of all fourth-grade students at SD Negeri Rejosari, located in Wonoboyo District, Temanggung Regency, during the 2022/2023 academic year. From this population, two intact classes were selected using purposive sampling. Class IVA was assigned as the experimental group (n = 10), which received instruction using the Example Non-Example strategy. Class IVB was assigned as the control group (n = 11), and instruction was delivered using the Flipped Classroom strategy. The selection was based on the consideration of equal academic ability and teacher recommendations to ensure group comparability.

Two main instruments were used in this study to collect data: (1) a reasoning competence test and (2) a conceptual understanding test. Both instruments were developed based on indicators provided by the Indonesian curriculum and tailored to the specific topic of whole number operations. The tests consisted of structured essay questions and were validated by mathematics education experts to ensure content and construct validity. A reliability analysis was also conducted to determine the internal consistency of the test items, using appropriate statistical measures (e.g., Cronbach's alpha).

Data collection was carried out in two phases: pre-test administration to assess students' initial reasoning and conceptual understanding, and post-test after the instructional intervention to evaluate changes in performance. Both groups received equal time and instructional periods, differing only in the instructional strategy applied.

The data analysis techniques used included descriptive statistics (means and standard deviations) and inferential statistics. To test the hypotheses, the paired sample t-test was employed to analyze within-group differences between pre-test and post-test

scores. The independent sample t-test was used to compare post-test results between the experimental and control groups. All statistical analyses were conducted using SPSS software, and significance was determined at the 0.05 level ($\alpha = 0.05$).

RESULT

The descriptive statistics of reasoning competence and conceptual understanding, both pre-test and post-test scores, are presented in the following tables.

Table 1. Pretest and Posttest Mean Scores of Conceptual Understanding (Experimental and Control Groups)

Description	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
N	11	11	10	10
Mean	46.36	74.55	56.00	63.00
Median	50.00	70.00	55.00	65.00
Mode	10.00	70.00	30.00[a]	40.00[a]
SD	31.39	10.36	24.13	17.67
Minimum	10.00	60.00	20.00	40.00
Maximum	90.00	90.00	90.00	90.00
Sum	510.00	820.00	560.00	630.00

From Table 1, it can be observed that the experimental group experienced a substantial improvement in conceptual understanding. The mean score increased from 46.36 in the pretest to 74.55 in the posttest, indicating a mean gain of 28.19 points. Meanwhile, the control group only improved from a mean of 56.00 to 63.00, with a gain of 7.00 points. Additionally, the standard deviation in the experimental group significantly decreased from 31.39 to 10.36, suggesting a more consistent level of conceptual understanding among students after the application of the Example Non-Example strategy. This contrasts with the control group, where the standard deviation slightly decreased from 24.13 to 17.67.

Table 2. Pretest and Posttest Mean Scores of Reasoning Competence (Experimental and Control Groups)

Statistic	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
N	11	11	10	10
Mean	24.55	65.45	39.00	52.00
Median	20.00	60.00	30.00	45.00
Mode	20.00	60.00	20.00	40.00
Standard Dev.	10.36	6.88	26.01	16.19
Minimum	10.00	60.00	10.00	40.00
Maximum	40.00	80.00	80.00	80.00
Total Score	270.00	720.00	390.00	520.00

Table 2 shows a notable difference between the experimental and control groups in reasoning competence before and after the learning intervention. In the experimental group, the mean score rose significantly from 24.55 in the pretest to 65.45 in the posttest—an increase of 40.9 points. This improvement suggests that the Example Non-Example strategy effectively enhanced students' reasoning abilities in mathematical operations. Meanwhile, the control group showed a more moderate increase, from a pretest mean of 39.00 to 52.00 in the posttest—an increase of 13 points. Although improvement was observed, it was not as substantial as in the experimental group. The standard deviation in the experimental group decreased from 10.36 to 6.88, indicating a tighter clustering of scores and suggesting more consistent performance among students. Conversely, in the control group, the standard deviation also declined from 26.01 to 16.19, but variability remained relatively higher than in the experimental group.

Hypothesis Testing Results

The decision-making and conclusions from the hypothesis testing were based on a significance level of 0.05. The decision criteria are as follows: if the significance value (p-value) < 0.05, then the null hypothesis (H_o) is rejected. The analysis was performed using SPSS version 23.

Table 3. t-Test Results for Pretest and Posttest Reasoning Competence – Experimental Group

Data	Mean	t-value	t-table	p-value	Decision
Pretest	24.55	14.375	2.228	0.000	Significant
Posttest	65.45				

Based on the t-test results of the mean scores for the pretest and posttest reasoning competence in the experimental class as shown in Table 3, it is found that the t-value = 14.375 and the t-table value (df = 10) = 2.228, with a p-value of 0.000 < 0.05. These results indicate a statistically significant difference. Therefore, the alternative hypothesis (H_a), which states that "There is a significant effect of the Example Non-Example strategy on the reasoning competence of fourth-grade students at SDN Rejosari, Koorwil Dindikpora, Wonoboyo District, Temanggung Regency," is accepted.

Table 4. t-Test Results for Pretest and Posttest Conceptual Understanding – Experimental Group

Data	Mean	t-value	t-table	p-value	Decision
Pretest	46.36	4.113	2.228	0.002	Significant
Posttest	74.55				

Based on the results of the t-test conducted on the mean scores of the pretest and posttest for conceptual understanding in the experimental class, as shown in Table 10, it was found that the t-value = 4.113, the t-table value (df = 10) = 2.228, and the p-value = 0.002 < 0.05. These findings indicate a statistically significant difference. Therefore, the alternative hypothesis (H_a), which states that "There is a significant effect of the Example Non-Example strategy on the conceptual understanding of fourth-grade students at SDN Rejosari, Koorwil Dindikpora, Wonoboyo District, Temanggung Regency," is accepted.

Table 5. t-Test Results for Posttest Reasoning Competence – Experimental vs. Control

Group	Mean	t-value	t-table	p-value	Decision
Experimental	40.91	6.386	2.093	0.000	Significant
Control	13.00				

Based on Table 5, the results show a t-value of 6.386, a t-table value (df = 19) of 2.093, and a p-value of 0.000 < 0.05. Therefore, these results indicate a statistically significant difference. Thus, the alternative hypothesis (H_a), which states that "There is a significant difference in the reasoning competence of fourth-grade students at SDN Rejosari, Koorwil Dindikpora, Wonoboyo District, Temanggung Regency," is accepted.

Table 6. t-Test Results for Posttest Conceptual Understanding – Experimental vs. Control

Group	Mean	t-value	t-table	p-value	Decision
Experimental	28.18	2.781	2.093	0.012	Significant
Control	7.00				

Based on Table 6, it is shown that the t-value = 2.781, the t-table value (df = 19) = 2.093, and the p-value = 0.012 < 0.05. Therefore, it can be concluded that there is a statistically significant difference. Consequently, the alternative hypothesis (H_a), which states that "There is a significant difference in the conceptual understanding of fourth-grade students at SDN Rejosari, Koorwil Dindikpora, Wonoboyo District, Temanggung Regency," is accepted.

DISCUSSION

This research was conducted on the teaching material of positive integer operations for fourth-grade elementary students. The initial stage of the study involved administering a pre-test to assess students' prior conceptual appreciation. The study was

conducted using two groups: the experimental group, which was taught using the Example Non-Example strategy, and the control group, which received instruction through the Flipped Classroom model. The purpose of the intervention was to examine the effect of the Example Non-Example and Flipped Classroom strategies on students' reasoning competence and conceptual understanding in mathematics. The complete results are described below:

1. The Effect of the Example Non-Example Strategy on Reasoning Competence

The research findings indicate that the Example Non-Example strategy had a significant effect on improving reasoning competence among fourth-grade students at SDN Rejosari, Koorwil Dindikpora, Wonoboyo, Temanggung. This result is consistent with research by Oennus (2019), who found that the strategy significantly influenced mathematics achievement among fifth-grade students at SDN 1 Gedong, Bandar Lampung. Similarly, Lufri et al. (2019) concluded that the strategy positively impacted science learning outcomes in seventh-grade students at SMPN 18 Padang. Additional support comes from Amrianto & Lufri (2019), who also confirmed its effectiveness in enhancing student competence.

The core feature of the Example Non-Example strategy lies in presenting both examples and non-examples of a given concept. An "example" illustrates a correct application of the concept being taught, while a "non-example" illustrates an incorrect or unrelated application. The strategy emphasizes student-centered discussion and observation, requiring learners to investigate and compare. Group activities in this method are believed to foster active student participation, collaboration, and exchange of ideas during problem-solving tasks provided by the teacher.

Unlike passive learning approaches, the Example Non-Example strategy encourages students to actively solve problems based on principles and concepts, which significantly enhances their reasoning abilities. The strategy aims to train students in analyzing mathematical statements and identifying correct solutions. It offers several advantages: (1) students learn to identify problems; (2) define problems; (3) explain problems; (4) determine detailed data needs; and (5) prepare comprehensive problem analyses.

The structured steps of the Example Non-Example strategy provide ample time for students to collaborate, express, and defend their ideas. This builds confidence and mental readiness to contribute in group discussions. A primary skill targeted by this strategy is the student's ability to present problem-solving results clearly and logically. Time is allocated for validating the outcomes of their observations, which enhances both their communication skills and understanding of mathematical reasoning—skills that are essential for academic success in mathematics.

2. The Effect of the Example Non-Example Strategy on Conceptual Understanding

The findings also revealed that the Example Non-Example strategy significantly improved students' conceptual understanding. Fourth-grade students at SDN Rejosari showed notable gains in their ability to grasp and articulate mathematical concepts after instruction using this strategy. Sabroni et al. (2018) found similar outcomes when using the strategy alongside Poster Comment media to enhance mathematical conceptual appreciation. Fitri (2020) also demonstrated the positive impact of the Example Non-Example strategy on students' conceptual understanding at SDN Kertosari 1, with statistical support from t-tests (2.311 > 2.000).

The Example Non-Example strategy encourages critical thinking by requiring students to compare examples and analyze problems carefully. Students are guided to discover mathematical concepts independently rather than relying solely on textbook explanations. This fosters cognitive engagement and deepens understanding. Students are expected to classify concepts they understand and relate them to their reasoning outcomes, thereby reinforcing learning through observation and comparison.

This strategy employs various illustrative materials related to the concept being taught. These examples and non-examples can be derived from real-world problems aligned with learning objectives. Students engage in observation, definition, and classification to better understand the concept. As a result, students become active participants in constructing knowledge. They develop their reasoning by critically analyzing both valid and invalid examples of mathematical concepts.

Students are considered to have achieved conceptual understanding when they can (1) name multiple examples of a concept; (2) describe the characteristics of the concept; (3) distinguish between examples and non-examples; and (4) solve problems related to the concept. These indicators reflect the successful application of the Example Non-Example strategy in improving conceptual mastery.

3. Differences in Reasoning Competence Between Experimental and Control Groups

The results further show that students in the experimental group taught with the Example Non-Example strategy outperformed the control group, which received instruction using the Flipped Classroom model, in both reasoning competence and conceptual understanding. Sabroni et al. (2018) also found that the Example Non-Example strategy was superior to conventional methods in improving students' mathematical comprehension. Sembiring et al. (2021) confirmed the strategy's impact on learning outcomes at SDN 106144, with t-values of 5.858 > 1.701 at a 5% significance level.

Sari et al. (2019) observed differences in learning interest between students taught using the scientific approach with the Example Non-Example strategy and those taught using traditional methods in fourth-grade thematic instruction. Fitri (2020) also

concluded that the Example Non-Example strategy was more effective than lecture-based teaching. Kummala and Pujilestari (2020) found that the strategy provided better results in conceptual understanding than traditional teaching strategies.

The Example Non-Example strategy is inherently student-centered. Teachers facilitate observation-based learning using visual representations aligned with learning objectives. Students analyze and derive standard concepts through discussion and inquiry. The impact of this strategy is evident in increased student engagement during face-to-face instruction. Group work fosters collaboration, enhances student confidence, and strengthens their conceptual grasp (Mufit et al., 2018; Alberida et al., 2018).

Collaboration during group activities motivates students to complete tasks and promotes peer tutoring. High-performing students can assist those struggling to understand the material, contributing to more equitable learning outcomes. The success of each group depends on the capabilities of its members. The Example Non-Example strategy provides a valuable alternative for instruction, creating more opportunities for students to collaborate, analyze, and grow together academically.

CONCLUSION

Based on the results of hypothesis testing and the discussion of research findings, the conclusions of this study are as follows: (1) The Example Non-Example strategy fosters students' reasoning competence, which includes comparing calculation methods, determining appropriate methods, analyzing calculation steps, and drawing conclusions related to operations on positive integers. This is evidenced by the significance value of the hypothesis test, where 0.000 < 0.05, indicating that the alternative hypothesis (Ha) is accepted. (2) The Example Non-Example strategy also enhances students' conceptual understanding, which encompasses the application of mathematical concepts, classification of calculation methods, discovery of calculation rules, identification of relationships among concepts, and distinguishing between examples and non-examples of integer operations. This is supported by a significance value of 0.000 < 0.05, confirming the acceptance of the alternative hypothesis (Ha). (3) The difference between the Example Non-Example and Flipped Classroom strategies in terms of students' reasoning competence and conceptual understanding is reflected in the N-Gain scores. The average N-Gain for reasoning competence was 24.55 for the control group and 39.00 for the experimental group, while the average N-Gain for conceptual understanding was 63.00 and 74.55, respectively. Therefore, Ha is accepted, which means there is a significant difference in learning outcomes between the two instructional strategies. For future researchers, it is recommended to examine the implementation of the Example Non-Example strategy on other variables or to investigate different strategies in relation to reasoning competence and conceptual understanding.

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