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Analysis of Question Representation Effects on Elementary Students' Mathematical Problem-Solving Abilities

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Abstract
Students' ability to solve integer operations is a fundamental aspect in basic mathematics learning. This study aims to analyze the profile of the ability of grade II elementary school students in solving number operation problems based on three forms of representation: story, numerical, and picture-based questions. The method used is qualitative descriptive with data collection techniques in the form of tests, observations, and interviews. A total of 15 students (n = 15) participated as research subjects. The test results showed that the highest student success rate was found in picture-based questions (100%), followed by numerical questions (86.67%), and the lowest in story questions (23.33%). Observations indicate that students are more responsive to concrete visual representations compared to narrative forms that demand language understanding. Interviews with teachers supported these findings, citing low literacy integration and media limitations as the main causes of students' difficulties. This study concludes that the representation of questions greatly affects students' ability to solve integer operations. Mathematics learning at the initial level needs to integrate visual and literacy strategies in a balanced manner to build comprehensive problem-solving skills. These findings provide important implications for the development of learning media and curriculum design that is more adaptive to the cognitive needs of early childhood students.

INTRODUCTION

Mathematics is a basic discipline that plays an important role in daily life and various other fields of science. Through mathematics learning, students are trained to think logically, systematically, and solve problems analytically. One of the important aspects of mathematics learning at the elementary education level is the mastery of number operations, which includes addition, subtraction, multiplication, and division. Operational ability refers to students' skills in performing and applying these basic arithmetic operations correctly and efficiently. Mastery of these operations not only serves as the foundation for advanced mathematical concepts but also supports the numeracy skills needed in various real-life contexts (Tarigan et al., 2022). Understanding number operations is important because they are often used in daily activities such as counting items, managing time, and solving everyday problems. Numerical literacy, in this context, is defined as the ability to understand, interpret, and use numbers effectively in various situations. With good numerical literacy, students can develop critical and reflective thinking skills. However, facts in the field show that there are still many elementary school students who have difficulty understanding and solving math problems, especially in the form of story problems. This difficulty shows the need to make an effort to better understand the profile of students' abilities in solving integer operations (Megawati & Sutarto, 2021). Therefore, a comprehensive analysis of students' abilities and difficulties needs to be carried out as a basis for learning improvement.

The main problem that is often found in learning number operations is the low ability of students to solve mathematical story problems. Story questions require students to not only perform

counting operations, but also to understand the context of the information conveyed verbally. Students should be able to identify relevant information, turn it into mathematical models, and perform calculations accordingly. This process requires high-level thinking skills that have not yet been fully developed in elementary school-age children (Iswara et al., 2022). Difficulties in understanding story problems often stem from students' weak language literacy skills which affect the understanding of the content of the questions. In addition, the use of complex language and long sentence structures in the story are obstacles in itself. Many students end up trapped in the wrong interpretation of the meaning of the question resulting in incorrect answers. According to Misbahudholam et al. (2024), mistakes in solving story problems generally occur at the stages of understanding the problem and choosing a solution strategy. This shows that students' difficulties are not only caused by the numerical aspect, but also the linguistic aspect in mathematics learning. Therefore, it is important to review the learning approach that teachers use in teaching the operation of a number of numbers.

An international study through the Trends in International Mathematics and Science Study (TIMSS) 2023 shows that obstacles in solving mathematical story problems do not only occur in Indonesia, but also become a global phenomenon. The results of the 2023 TIMSS reveal that only 8% of Indonesian students are able to solve story problems correctly, far below the international average of 18% (Ridwan et al., 2023). This figure reflects a serious challenge in mastering basic mathematical concepts, especially in the context of story-based problem-solving. This ability gap shows that existing learning approaches have not been able to equip students with the skills needed to understand and solve story problems effectively. Other research also states that students' success in solving story problems is highly dependent on the teacher's learning strategy, the learning media used, and the level of students' language literacy (Pristianti & Prahani, 2022). In Indonesia itself, this problem is increasingly complex because many schools still face limited resources, both in terms of teaching materials, teacher training, and learning facilities. As a result, students are better trained to work on numerical problems that are procedural in nature rather than problems that require contextual understanding. This situation shows the importance of strengthening aspects of concept understanding and logical thinking skills through a more contextual learning approach. Therefore, analysis of students' difficulties in solving various types of problems is necessary to develop learning strategies that are more effective and responsive to student needs.

In the context of basic education, it is important to understand that each form of math problem has a different level of complexity for students. Numerical or direct count problems are usually easier to understand because they don't involve a lot of verbal information . In contrast, story problems require additional skills such as the ability to read, understand text (Rahayuningsih et al., 2021), and relate information to mathematical concepts. Based on the results of initial observations, students tend to be more successful in solving numerical and picture problems than story problems. This is strengthened by the findings of Rakhmawati & Mustadi (2022) who state that visual representation is very helpful for students in understanding the concept of numbers and counting operations. Visualization is able to bridge the gap between abstract mathematical concepts and students' concrete experiences. Thus, the presentation of questions in the form of pictures or illustrations has been proven to be more effective in improving understanding of basic concepts. On the other hand, the lack of contextual learning media and the low integration of literacy in mathematics lessons are challenges in themselves. Teachers need to be encouraged to use learning methods that combine visual, narrative, and interactive aspects. Therefore, the analysis of the students' ability profiles in various forms of questions is important to determine the appropriate pedagogical intervention.

Previous research has shown that most of students' mistakes in solving story problems occur in the early stages of problem solving. Utari & Afendi (2022) revealed that about 81% of student mistakes lie at the stage of understanding the problem and about 90% occur at the stage of the completion process. This shows that the problem does not only lie in the calculation, but also in the understanding of the information presented in the problem. Often students fail in identifying important

information and distinguishing between relevant and irrelevant information. In many cases, students also experience confusion in choosing the right math operation to solve the story problem. Lack of skills in interpreting questions has a direct impact on student learning outcomes. This weakness can be exacerbated by learning approaches that do not leave room for contextual exploration and discussion. Therefore, it is important to create a learning environment that facilitates the understanding of narratives and their application in the context of mathematics. By understanding the source of error thoroughly, teachers can design more effective and targeted teaching strategies. This research is here to answer these challenges through an in-depth student ability analysis approach.

Based on this background, this study aims to analyze the ability profile of grade II elementary school students in solving number operations. The main focus of the research is on the difference in the success rate of students in solving story, numeric, and picture problems. With a descriptive qualitative approach, this study not only looks at the final results of working on the questions, but also explores the factors that affect these abilities (Purnomo et al., 2022). Through written tests, observations, and interviews with classroom teachers, a comprehensive picture of students' abilities and difficulties is obtained. The results of the research are expected to contribute to the development of more contextual and effective learning strategies at the elementary school level. In addition, the findings of this research can also be a reference for teachers and curriculum developers in designing appropriate media and learning methods. This research is not only important to address local challenges in mathematics learning, but also relevant in a global context. Thus, the results of this research are expected to encourage improvements in the quality of mathematics education from an early age and form the basis for developing evidence-based interventions to enhance students' overall numeracy skills.

METHODS

This study uses a descriptive qualitative approach that aims to obtain an in-depth picture of the profile of students' ability to solve number operation problems. This approach was chosen because it allows researchers to explore students' thinking processes naturally, by paying attention to how they understand, interpret, and solve mathematical problems in the form of numerical, pictures, and stories. The research subjects consisted of grade II students in one of the public elementary schools in Surabaya, who were selected purposively based on the recommendations of the class teacher and consideration of various mathematical abilities (high, medium, and low). The total number of participants was 15 students (n = 15), divided into three ability categories (5 students in each category) based on their previous daily mathematics test scores. In addition, classroom teachers were also involved as informants to obtain additional information about students' learning characteristics and the teaching strategies applied.

The main instruments used in this study were diagnostic question sheets, observation guidelines, and semi-structured interview guidelines. The question sheet consists of three types of questions: 4 numerical questions (direct counting), 4 picture questions (using visual illustrations), and 4 story questions (contextual narrative-based). Each student worked on all the questions within the stipulated time, and the process of working on them was observed directly by the researcher. Observations were made to record students' strategies, confusion, and spontaneous responses while solving the questions. Meanwhile, interviews are conducted after students complete the questions to further explore their thinking process and reasons for choosing certain completion steps. Interviews with teachers are used to gain a pedagogical perspective on the general difficulties experienced by students as well as the learning approaches that have been carried out in the classroom.

Instrument validation procedures were carried out through expert judgment involving two mathematics education experts and one elementary school teacher. They reviewed the clarity, content relevance, and suitability of each question item with the learning objectives of grade II mathematics. Revisions were made based on their feedback before the instruments were used for data collection.

The validity of the data is strengthened through triangulation techniques, namely by comparing data from test results, observations, and interviews.

Data analysis was carried out inducively using the Miles Huberman model which included three main stages: data reduction, data presentation, and conclusion drawn (Miles & Huberman, 1994). Data reduction is carried out by compiling interview transcripts, recording student answer patterns, and classifying errors or strategies used by students in each type of question. Furthermore, the data is presented in the form of a descriptive narrative and a table that describes students' abilities based on the question category. Each data was analyzed thematically to identify common patterns and differences between subjects. Conclusions are drawn reflexively and continuously during the analysis process, to ensure the relationship between the data obtained. This research also pays attention to ethical aspects, by requesting written consent from the student's parents and maintaining the confidentiality of the identity of the research subject. With this method, it is hoped that a comprehensive understanding of how students solve integer operations in various forms of problems, as well as the factors that affect their success and difficulty.

RESULTS AND DISCUSSION

Result

This study reveals a striking difference in the achievement of the ability of grade II elementary school students in solving number operation problems based on the form of question presentation. The diagnostic test consisted of six questions that were evenly divided into three types: two numerical questions, two picture-based questions, and two contextual story questions. Each student is asked to complete all the questions, and the process of working is observed directly to record spontaneous responses, non-verbal expressions, and completion strategies used. Quantitative data in the form of success rates were analyzed to determine the distribution of students' understanding, while qualitative data from observations and interviews were used to interpret the context behind students' answers.

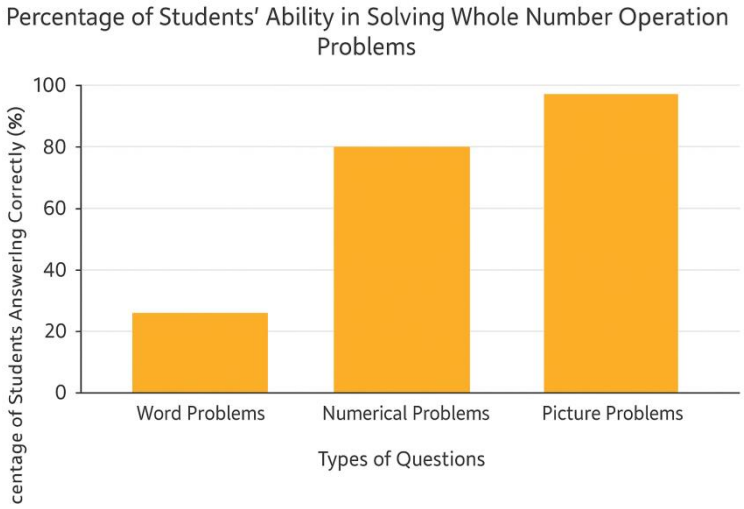

Figure 1. The percentage of students' ability to work on the problem of number operations

The results showed that out of 15 students who were the subjects of the study, as many as 13 students (86.67%) managed to solve numerical problems correctly. This shows that most students already have good basic arithmetic skills when the questions are presented directly and explicitly. On the other hand, in picture-based questions, the success rate reached 100% with all students able to answer correctly. This achievement indicates that visualization in the form of images is very helpful for students in understanding the context of calculations, because they can be directly related to concrete objects that they know in their daily lives. Picture questions also trigger a quick response from

students, which can be seen from the relatively shorter processing time compared to the other two types of questions.

However, students' performance decreased drastically when faced with story problems. Only 3 students (23.33%) were able to answer both story questions correctly. Questions in narrative form require students to read, understand the context, identify relevant information, and then convert it into appropriate mathematical calculations. Based on observations, most students seem hesitant when reading the questions, often repeat the reading, and seem to have difficulty identifying important keywords such as "amount", "difference", or "remainder". This was reinforced through interviews with classroom teachers, who explained that most students were not familiar with story questions because in daily learning is still dominant using exercises based on numbers or pictures, as well as the lack of use of media or contextual approaches.

Furthermore, the teacher also confirmed that the learning approach so far has not explored language understanding in mathematics problems, and focuses more on numerical calculation exercises. This causes a gap between numeracy skills and the ability to understand story texts that contain mathematical concepts. Students who have low reading proficiency tend to have difficulty identifying important information, which ultimately affects the accuracy of completion. Based on the overall data, it can be concluded that visualization and question explanation have a significant influence on student achievement. Therefore, learning interventions that integrate language literacy and visualization in mathematics are needed to improve students' ability to solve number operation problems, especially in the form of stories.

Discussion

The results of the study show that students' ability to solve the problem of counting number operations is highly dependent on the form of presentation of the problem. Numerical problems and picture-based questions are easier for students to solve than story problems. This indicates that concrete and visual representations are more in line with the cognitive characteristics of low-grade students. According to Kurniawan & Khotimah (2022), early childhood students are in the stage of enactive and iconic thinking, so they are more responsive to visual or concrete stimuli compared to abstract texts. Students tend to understand the operation of counted numbers through explicit forms such as numbers and images, which make it easier to process information and apply counting strategies. These findings are also in line with research by Putriani & Sukmaningthias (2023) which shows that the numerical literacy skills of elementary school students increase when accompanied by contextual visual media. Therefore, the choice of question forms and representations greatly determines the success of students in completing basic math tasks. Learning strategies that only focus on numerical problems can cause gaps in the development of overall mathematical comprehension skills.

The low performance of students in story questions shows that there are challenges in the aspects of language comprehension and the conversion of narrative information into mathematical form. Story problems require students to not only understand sentences, but also identify relationships between information in the text. This process requires literacy and logic skills at the same time, which are not yet fully developed in grade II elementary school students. Rachamwati et al. (2023) found that most of students' mistakes in solving story problems occurred at the stage of problem understanding (81%) and process skills (90%). The results of this study confirm the findings, where only 3 out of 15 students were able to solve the story problems correctly. In addition, difficulties in story problems also reflect the disintegration between teaching mathematics and reading comprehension skills. Mathematics learning at the basic level should be designed in an integrated manner with strategies to strengthen literacy, especially instructional literacy. That way, students can develop a better understanding of textual information in math problems.

Another factor that also affects the low success of students in story questions is the traditional learning method. Based on the results of the interviews, teachers often use numerical problem

exercises in daily learning and rarely give questions in the form of narratives. As a result, students are less accustomed to interpreting the context of the story and do not have a systematic strategy to solve it. According to Amalia et al. (2021), problem-solving strategies need to be explicitly trained to students, including how to extract important information from the text and structure it in a mathematical model. When this approach is not practiced in a structured manner, students are likely to experience confusion and make procedural errors. Teachers play an important role in guiding students' thought processes in order to understand and relate information to relevant computational operations. Therefore, teacher training and curriculum development that emphasizes the integration of story problems in mathematics learning are important to implement. This will strengthen students' cognitive abilities and mathematical literacy from an early age.

In the global context, the difficulties of Indonesian students in understanding story questions are also reflected in the results of the 2023 TIMSS study. Only 8% of Indonesian students are able to solve math story problems correctly, far below the international average of 18% (Norairi et al., 2022). This low result shows that the problem is not only local, but also reflects structural problems in the mathematics education system in Indonesia. Factors such as limited learning media, lack of contextual practice questions, and low quality teacher training also contributed to these results. In this study, interviews with teachers also indicated that there was no visual or contextual media available to support the understanding of stories. This hinders students in visualizing narrative information, thus failing to build an accurate mental representation. In line with (HASANAH, 2021), understanding story problems requires not only arithmetic skills, but also interpretation strategies and the application of mathematical models. Therefore, improving the quality of mathematics learning based on context understanding is an urgent need.

The finding that all students can solve picture problems correctly shows that visual media has an important role in facilitating the understanding of mathematical concepts. Visualization assists students in concretizing abstract ideas and bridging the thought process from verbal to symbolic representations. This visualization also helps reduce cognitive load because information can be processed more efficiently through the perception system. According to Lestari et al. (2024) research, the use of images, symbols, and manipulative media has been proven to improve understanding of mathematical concepts in early childhood. In this study, the picture questions also provide implicit instructions on the operations that must be used, thus simplifying the completion process. This shows that students have the potential to understand mathematical concepts when supported by appropriate visual aids. Therefore, the development of visual learning media needs to be developed and adjusted to the level of cognitive development of students. Contextual and visual mathematics learning will have a significant impact on building understanding of basic concepts from an early age (Solihin & Rahmawati, 2024).

In addition to the form of the problem, internal factors of students also affect the success of completing math tasks, especially in story problems. Reading, attention, and short-term memory skills are important cognitive components in understanding complex information. Erawati et al. (2025) explain that basic cognitive skills are an important foundation in mathematics learning that involves the processing of text and symbols. In this study, students who failed to answer the story questions had difficulty remembering information and relating it to the counting steps. Some students can't even identify what is being asked in the question. This indicates that learning interventions cannot only focus on practice questions, but also need to strengthen supporting cognitive aspects such as reading comprehension, working memory, and concentration. The integration of literacy and mathematics learning needs to be strengthened at the elementary school level, especially in the context of thematic learning (Solihin et al., 2024). With this approach, students' thinking processes can be formed completely and systematically.

From the pedagogical side, an adaptive and contextual learning approach is the key to improving students' performance in mathematical story problems. The use of local context-based media, illustrated stories, or interactive simulations can be an alternative to increase student

engagement and understanding. Ernawati & Rahmawati (2022) suggest that contextual problem-solving-based learning models need to be implemented early to improve numerical literacy and understanding of basic concepts. In practice, teachers need to train students to identify keywords in the text, organize the information into mathematical models, and interpret the results of the calculations according to the context of the story. This approach will form a critical and reflective thinking pattern that is important in the student's cognitive development. In addition, teacher training in designing literacy-based mathematics learning is also very important to support the success of this strategy. With a more contextual and inclusive approach, it is hoped that students can develop better problem-solving skills. This is one of the long-term strategies in improving the quality of mathematics education in Indonesia.

Overall, the results of this study confirm that the understanding of mathematics in elementary school students cannot be separated from literacy and visualization skills. Learning that only emphasizes numeracy exercises tends to create gaps in higher-level thinking skills such as analysis, evaluation, and reflection. Therefore, the curriculum needs to be redesigned to support the integration of language, visual, and numerical literacy in mathematics learning. In addition, infrastructure support and ongoing training for teachers need to be a top priority in basic education policies. By paying attention to the results of this study, it can be concluded that the success of students in mathematics is not only determined by their numeracy skills, but also by material delivery strategies, learning media, and synergy between other basic competencies (Datuanggoa & Bennu, 2023). Reforms in the approach to mathematics learning at the primary school level are crucial to create a generation that is able to think logically and solve problems contextually. Thus, the results of this study make an important contribution to the development of more holistic and sustainable basic education pedagogy and policies.

CONCLUSION

This study concludes that students' ability to solve problems of number operations is greatly influenced by the form of question representation. Picture-based questions are the easiest form for students to understand and solve, followed by numerical problems, while story questions show the lowest success rate. This shows that grade II elementary school students have easier access to information presented in a visually concrete way than information in the form of narrative texts. Limitations in literacy skills, problem-solving strategies, and the lack of use of visual learning media contribute to low student performance in solving story problems. Therefore, a learning approach is needed that not only emphasizes numerical exercises, but also strengthens the integration of literacy and visualization in mathematics. Adaptive, contextual, and multisensory learning strategies need to be implemented so that students have a more thorough understanding of basic math concepts. Teachers also need to be given special training in preparing questions and materials that consider the diversity of student representations and learning styles. Thus, the results of this study make an important contribution to the development of a more inclusive and effective pedagogical approach and mathematics curriculum at the primary school level.

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