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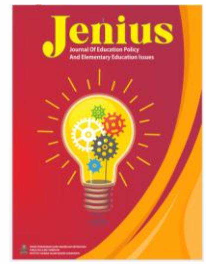

Analysis of Students' Difficulties in Story Problems Division Reviewed from Mathematical Representation and Pólya's Stages In Elementary School

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ABSTRACT

The ability to solve story problems in division depends heavily on students' mathematical representation and structured problem-solving skills, yet many students still experience difficulties in this area. This study aims to describe the difficulties 5th-grade students experience when solving division story problems in terms of mathematical representation and Pólya's stages. This study used a descriptive qualitative research design. The participants consisted of 18 fifth-grade students from SD Negeri 4 Gamping, all of whom were included in the primary analysis using a written test. Based on their combined scores in mathematical representation and Pólya's stages, students were classified into high, middle, and low categories. Using purposive sampling, three students representing each category were selected as subjects for subsequent in-depth qualitative interviews The results show: (1) high-category students have no difficulty in using symbolic, visual, or verbal representation; middle-category students can use symbolic and visual representation but are more proficient verbally in oral form than in writing; and low-category students experience difficulty in using all three forms of representation; (2) in terms of Polya's stages, students tend to skip the first stage of understanding the problem and proceed directly to planning and implementing solutions; (3) students' mathematical representation ability significantly influences their thinking process in solving story problems. This study concludes that students' difficulties in solving story problems involving division stem from their limited mathematical representation skills, which, in turn, impede their progress through Pólya's problem-solving stages. Practically, these findings help teachers see exactly why students get confused by functional texts, allowing them to provide the right help in class.

INTRODUCTION

Mathematics is the science of logical thinking that underpins technological development and is essential for human life (Kemendikdasmen, 2025). At the elementary school level, mathematics content, in accordance with the latest learning outcomes (CP) circular for the Merdeka Curriculum, consists of elements of numbers, algebra, measurement, geometry, and data analysis and probability. Mathematics is taught in stages across Phases A (Grades 1–2), B (Grades 3–4), and C (Grades 5–6), progressing from fundamental to more complex material. Within the domain of numbers, addition, subtraction, multiplication, and division constitute the basic mathematical skills that elementary school students must master.

In mathematics learning, five process standards must be developed: reasoning, connections, representation, problem-solving, and communication. According to Noraini et al. (2022), representation refers to the expression of mathematical ideas or concepts by students to solve the problems at hand. Representation is important to cultivate from elementary school because it enables students to make connections, develop, and deepen their understanding of mathematical concepts through various representational forms (Putra et al., 2020). Representations may take the form of real objects, images, diagrams, graphs, and mathematical symbols that help students communicate their thought processes (NCTM, 2000). Mastery of various representational forms is therefore a prerequisite for students to communicate their reasoning effectively at each stage of problem-solving.

Alongside representation, problem-solving skills are equally important. Polya (1973) identified four stages of mathematical problem-solving: understanding the problem, devising a plan, carrying out the plan, and checking the result. Problem-solving is significant because it develops general cognitive skills, encourages creativity, applies mathematics to real-world contexts, and motivates students to engage with the subject (Efendi et al., 2022). In the context of 21st-century competencies, problem-solving skills are also critical for navigating rapid social and technological change.

Despite its importance, mathematics learning at the elementary school level continues to face various challenges. Students frequently encounter difficulties when solving word problems, mathematical problems presented in narrative form that relate to everyday situations (Nailia et al., 2023). Division is among the most challenging topics. Imbo & Vandierendonck (2008) noted that multiplication and division are considered difficult because they require memorization and a strong working memory. Manar et al. (2025) further explained that the causes of students' difficulties in solving division problems include both internal factors (e.g., dislike of mathematics, poor conceptual understanding, lack of motivation) and external factors (e.g., unsupportive learning environments, inadequate use of instructional media by teachers).

Students' difficulties in solving division story problems are also evident from their mathematical representation abilities. Utami et al. (2019) found that only 21.21% of students demonstrated a high level of mathematical representation ability, 33.33% were at a middle level, and 45.56% were at a low level. Putra et al. (2020) reported that only 15% of students were able to answer questions on visual representations completely, while Handayani (2019) found that 61% of students still had low verbal representation ability. With respect to problem-solving, Azizah et al. (2025) found that 60% of fifth-grade students experienced difficulty applying concepts to everyday problem contexts, and Ramadhani et al. (2023) similarly reported that fifth-grade students' problem-solving performance remained low, with many struggling at the implementation stage.

The selection of SD Negeri 4 Gamping as the research site is driven by empirical urgency documented in the school's official Education Report Card (*Rapor Pendidikan*) over the past three years. The data reveals a consistent downward trend in the percentage of students achieving minimum competency in numeracy. In 2023, 95% of students achieved the minimum competency standard; however, this figure dropped to 87,5% in 2024 and further declined to 83% in 2025 (Kemendikdasmen, 2026). This continuous decline underscores a systemic barrier in mastering basic mathematical concepts.

Previous studies have examined either representation or problem-solving in isolation, and few have explored their interrelationship among elementary school students working on division word problems. To address this gap, the present study investigates the difficulties 5th-grade students have in solving division story problems from the perspectives of both mathematical representation and Pólya's stages of problem solving. The research questions are: (1) What are the difficulties related to symbolic, visual, and verbal representation experienced by 5th-grade students when solving division story problems? (2) How do students engage in problem-solving based on Pólya's stages? (3) What is the relationship between representational abilities and students' problem-solving processes?

The objectives of this study are to describe these aspects and provide clear information to improve elementary mathematics teaching. Theoretically, this study contributes to the mathematics education literature by demonstrating how representational abilities and Pólya's problem-solving stages interact, a relationship that is still rarely studied in elementary division topics. Practically, this research is important because it helps teachers see exactly where and why students get confused when reading story problems. By understanding these specific student difficulties, teachers can provide targeted support and design better lessons rather than just asking students to memorize division formulas. Ultimately, these findings can serve as a practical strategy to improve students' math skills and help raise the school's scores on the national education report card (*Rapor Pendidikan*).

METHOD

This study employed a descriptive qualitative research design. Qualitative research is an approach used to explore and understand the meaning individuals ascribe to social or human problems (Creswell & Creswell, 2023). The descriptive approach aims to present symptoms, facts, or events systematically and accurately (Hardani et al., 2020). This study was conducted entirely within a descriptive qualitative research framework. Descriptive quantitative data, such as test scores, averages, and percentages, were not used for statistical hypothesis testing or generalizations. Instead, they served a supportive role within the qualitative paradigm to provide an initial screening of the students' work. These numerical data were used to categorize the 18 students into capability levels and to map the general patterns of their mistakes. This initial mapping then guided the researcher in purposefully selecting the three primary subjects for the in-depth qualitative interviews.

The participants were 18 fifth-grade students of SDN 4 Gamping in the 2025/2026 academic year. Using purposive sampling, three subjects were selected for in-depth interviews based on their representational and problem-solving performance, representing the high, middle, and low categories. Specifically, these classifications were determined based on combined scores from the mathematical representation and Pólya's stages, using standard deviations. From each tier, the researcher purposively selected one student who showed the most dominant and clear error patterns on their answer sheet, ensuring they could well represent the specific difficulties of their respective groups. Interviews were conducted on Monday, 9 March 2026, during the school break period and lasted approximately 30 minutes. The study adhered to research ethics guidelines, including obtaining permission from the school, obtaining parental consent, and ensuring participant anonymity.

Data were collected through three techniques: written tests, semi-structured interviews, and documentation. The written test comprised nine story problems in division presented in an open-ended format, and students were allotted 60 minutes to complete it on Wednesday, 4 March 2026. The nine items were specifically distributed to target different representation types: number 1, 2, and 7 assessed symbolic representation; number 3 and 6 assessed visual representation; and number 4, 5, 8, and 9 assessed verbal representation. Semi-structured interviews were conducted with the selected subjects to explore their reasoning, obstacles, and thought processes that were not evident from the written test results. Interview questions focused on how subjects planned and executed their problem-solving strategies. To ensure data validity, method triangulation was employed by cross-checking and comparing students' written test responses with qualitative insights from their semi-structured interviews.

The primary instrument in this study was the researcher herself, supported by validated written test questions reviewed by expert validators comprising university lecturers and two Phase C classroom teachers. Validation addressed both alignment with indicators and question readability through a qualitative review format. The outcomes of this process showed that all nine items were conceptually valid and suitable for use after minor revisions based on the validators' qualitative feedback, which included simplifying word choices to match fifth-grade reading levels better. Two scoring rubrics were used: one based on representation indicators (Table 1) and one based on Pólya's problem-solving stages (Table 2).

Table 1. Scoring Guidelines Based on Representation Indicators

Representation Indicators	Criteria	Score
Symbolic	Students write down ideas or concepts using correct mathematical symbols and the calculation results are correct	3
	Students write ideas or concepts using correct mathematical symbols, but the calculation results are wrong	2
	Students write down ideas or concepts incorrectly using mathematical symbols	1
	No attempt to write down ideas in the form of mathematical symbols	0
Visual	Students write down ideas or concepts using pictures correctly	3
	Students write down ideas or concepts using pictures, but the interpretation of the pictures is wrong	2
	Students only write down ideas or thoughts using simple pictures without meaning	1
	No attempt to write down ideas or thoughts in the form of pictures	0
Verbal	Students write down the whole idea or concept using correct and easily understandable words	3
	Students write down some ideas or thoughts using words, but still assisted by symbols or pictures (more portions of other representations)	2
	Students only write words as conclusions or copy words from the questions	1
	Students make no effort to write down ideas or thoughts in the form of words	0

Table 2. Scoring Guidelines Based on Pólya's Problem-Solving Stages

Polya's Problem-Solving Stage	Criteria	Score
Understanding the problem	Students write down what is known and asked from the story problem correctly	2
	Students only write down what is known or what is asked	1
	Students do not write down what is known and asked from the story problem	0
Planning solution	Students write down a problem-solving plan using symbols, pictures, and words correctly	2
	Students write down plans to solve problems using symbols, pictures, or words, but the procedure chosen is wrong	1
	Students do not write down problem-solving plans	0
Implementing solution plan	Students carry out the solution plan and write answers correctly	2
	Students carry out the solution plan, but the procedures/answers written are wrong	1
	Students do not carry out the solution plan	0
Checking answers	Students write a conclusion correctly, and the final answer is logically consistent with the context of the problem	2
	Students write a conclusion, but the statement or the final answer is wrong or incomplete	1
	Students do not write any conclusion or final statement	0

Note: While the written rubric assessed the presence and correctness of the conclusion on the answer sheet (as a proxy for the checking-answer stage), the students' actual cognitive engagement in verifying their solutions was cross-validated during semi-structured interviews.

Data analysis followed the Miles and Huberman interactive model, which consists of three operational stages: data condensation, data presentation, and conclusion drawing. During data condensation, the researcher not only summarized the text but also explicitly coded and categorized students' written tests and interview transcripts. The data were coded into two main matrices: (1) representation indicator (symbolic, visual, and verbal) and (2) Pólya's problem-solving stages (understanding, planning, implementing, and checking). In the data presentation stage, these coded data were presented as descriptive narratives that cross-referenced specific representational difficulties with breakdowns in Pólya's stages. For example, the narrative described how a student's failure to represent the problem verbally led to an inability to understand the problem (Polya Stage 1). Finally, in the conclusion, the researcher analyzed these connection patterns to map exactly how low representational abilities limit a student's success in completing Pólya's problem-solving process.

RESULTS AND DISCUSSION

The initial data were obtained from written test results on division story problems. Scores were evaluated using representation indicators and Pólya's problem-solving stages. Student categories were determined based on the mean score (M) and standard deviation (SD) of total scores. For representation indicators, the mean score was 63,75 with a standard deviation of 15,72. Meanwhile, for Polya's stage, the mean score was 38,81 with a standard deviation of 15,10. The score intervals were established using the standard three-tier grouping formula: High (X ≥ M + 1. SD), Middle (M – 1. SD ≤ X < M + 1. SD), and Low (X < M – 1. SD). Table 3 presents the resulting ability categories.

Table 3. Student Ability Categories

Category	Based on Representation Indicators	Based on Polya's Stages	Number of Students
High	≥ 79	≥ 54	3
Middle	49 – 78	24 – 53	12
Low	≤ 48	≤ 23	3

Based on the data analysis, three students were classified in the high category, 12 in the middle category, and three in the low category. One student from each category was selected for in-depth interviews: R2 (high category), R11 (middle category), and R17 (low category).

Difficulties in Division Reviewed from Mathematical Representation

Based on the analysis of test results, fifth-grade students most frequently employed symbolic representation. This was evident from student answer sheets, where mathematical symbols were used to solve story problems even when visual or verbal representations were being measured. The percentage of symbolic representation achievement was 67.2%, indicating that students were able to express ideas using mathematical symbols but still encountered calculation errors. Table 4 presents the average scores and the dominant difficulties for each representation indicator. The achievement percentage for each indicator was calculated by dividing the average score by the maximum possible score for that category and multiplying the result by 100%.

Table 4. Average Score Per Representation Indicator

Representation Indicators	Question Number	Average Score	Achievement (%)	Dominant Difficulties
Symbolic	1, 2, 7	2.01	67.2%	Wrong choice of arithmetic operation; calculation errors
Visual	3, 6	1.83	61.0%	Non-operational images that do not convey the student's intent
Verbal	4, 5, 8, 9	1.875	62.5%	Inability to explain steps using words

Question 7 involved the Program Indonesia Pintar (PIP) context, in which students were told that a PIP recipient receives Rp225,000.00 per semester and were asked to calculate the monthly amount. This question required contextual knowledge of the semester duration, meaning errors could stem from either computational difficulties or unfamiliarity with the temporal context.

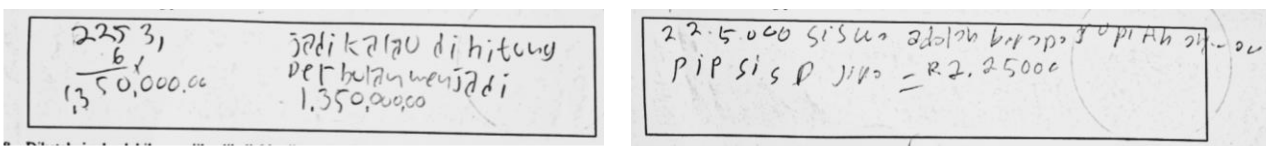

Figure 1. Answer R11 (left) and R17 (right) to Question 7

Subject R2 (high category) correctly wrote a mathematical model (symbolic representation) and was able to explain during the interview that one semester consists of six months. According to Picture 1, subject R11 (middle category) multiplied rather than divided the numbers in Question 7. During the interview, R11 stated that he did not know that a semester is six months, which he explained as why the mathematical model was incorrect. Subject R17 (low category) merely wrote down random information from the question without constructing a mathematical model, and during the interview also expressed unfamiliarity with the term 'semester.'

This finding reveals an interesting phenomenon. The failure to realize that "1 semester equals 6 months" is not merely rooted in a lack of mathematical or computational understanding of division. Instead, this obstacle highlights a critical deficiency in students' financial and contextual literacy, specifically their poor reading habits with respect to functional texts. Story problems embedded with real-world public assistance programs, such as PIP, demand more than operational arithmetic skills. They require functional literacy, in which students must decode time-based and contextual variables before translating them into symbolic representations.

Visual representation ability was assessed using Questions 3 and 6. The average score was 1.83 out of 3, meaning that most students used only simple, non-operational images that did not meaningfully represent their mathematical reasoning. In Question 6, students were asked to draw a grouping of beads to determine how many bracelets could be made from a given quantity of beads. Subject R2 correctly depicted the bead grouping and explained the division process underlying her drawing. Subject R11 produced a visually similar answer but during the interview revealed that he had drawn each bracelet iteratively using the given quantities rather than applying division, suggesting that visual representation served as a scaffolding strategy. Subject R17 only drew three circles labeled as bracelets and was unable to explain during the interview how he arrived at that number, indicating a low level of visual representation ability.

Verbal representation was assessed using Questions 4, 5, 8, and 9. The average score was 1.875 out of 3, indicating that many students had difficulty expressing their mathematical ideas in words. In Question 8, which required students to write the steps for determining an unknown number, Subject R2 articulated ideas clearly both on the answer sheet and during the interview. Subject R11 did not write verbal steps but used symbols alone, and during the interview explained the solution through trial and error rather than applying the concept of division. Subject R17 employed addition rather than division and was unable to explain his reasoning verbally, demonstrating low verbal representation ability.

Difficulties in Division Reviewed from Pólya's Stages

Using the same test instrument, the researchers also examined how fifth-grade students at SDN 4 Gamping engaged with each stage of Pólya's problem-solving framework. The average overall problem-solving score was 38.81, which falls within the low category. The stage that performed best was implementing the solution plan, while the stage that performed the worst was understanding the problem. Table 5 presents the average achievement at each stage.

Table 5. Average Achievement of Pólya's Problem-Solving Stages

Polya's Problem-Solving Stage	Average Achievement (%)	Dominant Error
Understanding the problem	27.0%	Not writing down what is known and asked in the question
Planning solutions	33.3%	Wrong choice of mathematical operation

Polya's Problem-Solving Stage	Average Achievement (%)	Dominant Error
Implementing solution plan	68.2%	Miscalculation
Checking answers	51.5%	Not verifying answers or not writing conclusions as a reflection

The highest problem-solving achievement was recorded for Question 2 (average score 2.5), which required only a single arithmetic operation and was therefore accessible to both high- and middle-ability students. In contrast, the most prevalent errors occurred at the problem-understanding stage. This aligns with the findings of Buyung and Sumarli (2021), who reported that only 6 out of 15 students wrote down what was known and what was asked in a given problem. Students tended to bypass the first stage and proceed directly to writing mathematical expressions as a solution plan. At the answer-checking stage, students' reflections were often limited or absent.

Subjects R2, R11, and R17 all omitted the problem-understanding stage for Question 2. When interviewed, R2 and R11 were able to articulate the known verbally and asked for information but had not written it on the answer sheet, suggesting habituation factors rather than conceptual misunderstanding. Subject R2 wrote a correct mathematical model and arrived at the correct answer; R11 proceeded directly to the long-division algorithm (porogapit) without first writing a plan. Both R2 and R11 wrote sentence-form conclusions as a form of checking. Subject R17, however, wrote an incorrect mathematical model (subtraction instead of division), which also led to an incorrect implementation and a conclusion that was difficult to interpret.

The lowest problem-solving achievement was for Question 3 (average score 1.5), which required drawing a spatial arrangement of flowerpots in a garden. All three subjects failed to write the problem-understanding stage. Subject R2 skipped the plan but drew the correct arrangement, yet did not write a conclusion. Subject R11 wrote a plan in the form of a long-division expression (24 ÷ 2) but did not follow through, and also omitted a conclusion—partly attributed to time constraints during the session. However, this factor was not systematically controlled. Subject R17 wrote random numbers without operational symbols and interpreted the problem incorrectly (as subtraction), with no conclusion written.

Difficulty Analysis Reviewed from Mathematical Representation

High-category students were able to express ideas and concepts flexibly using symbols, images, and words. This finding aligns with Adeyemi et al. (2025), who found that high-ability students can effectively employ visual, verbal, and symbolic representations and transition flexibly among them. Middle-category students showed an interesting phenomenon in which visual representations (pictures) functioned as scaffolding or temporary cognitive aids, consistent with Bruner's theory of a transition from the iconic to the symbolic stage (Suyono & Hariyanto, 2017). Their trial-and-error use of images suggests that these students are attempting to bridge mathematical abstraction through visualization, though not yet in a fully consistent manner. Their weakness in written verbal representation left their problem-solving accounts incomplete. These results align with Adeyemi et al. (2025), who reported that middle-category students use symbolic and visual representations adequately but fall short in verbal representation. Low-category students demonstrated signs of difficulty comprehending question language, leading them to engage in 'number grabbing'-simply extracting numerical values from the question without understanding the context. Their drawings were non-operational and without meaningful intent. Maryanti et al. (2025) attributed this difficulty to limited opportunities in daily instruction for students to develop mathematical illustrations, which impaired their ability to identify relationships among problem elements and visual representations.

Difficulty Analysis Reviewed from Pólya's Stages

At the problem-understanding stage, the most significant difficulty was students' failure to write down what was known and what was asked in the story problem. Low-category students also had difficulty comprehending the language of the problem, which impaired their ability to select the appropriate operation at the planning stage. This finding aligns with Utaminingtyas et al. (2025), who identified errors at the understanding stage as instances where students have read the problem but do not grasp what is being asked. According to Labibah et al. (2021), errors at this first stage can cascade through subsequent problem-solving stages.

Two categories of causes for these errors were identified: internal factors (e.g., inattentiveness and difficulty understanding story problems) and external factors (e.g., potential reliance on teacher assistance during regular lessons, which might limit students' independent problem-solving skills). At the planning stage, the difficulty shifted to selecting the correct mathematical operation. Middle-category students relied on visual representations as scaffolding to compensate for limitations in symbolic abstraction, yet this trial-and-error approach sometimes led them to apply incorrect arithmetic operations. This pattern is consistent with Bruner's theory of the transition from iconic to symbolic thinking (Suyono & Hariyanto, 2017), and with Maharni et al. (2025), who found that middle-category students understand most of the information but cannot consistently connect it to form a coherent solution plan.

During the implementation stage, procedural difficulties and calculation errors were the main obstacles. Even when the selected plan was correct, students frequently made arithmetic errors, likely due to cognitive load during multi-step division. This reinforces Azizah et al. (2025), who argued that failure at the execution stage is often not caused by procedural ignorance per se, but by students' difficulty sustaining consistent symbolic representations from the beginning to the end of a solution. At the checking stage, the dominant difficulty was that students wrote conclusions without mathematically verifying their answers. Maharni et al. (2025) reported that middle-category students write conclusions without re-examining results, while low-category students omit this stage entirely.

The Relationship Between Mathematical Representation and Problem-Solving

Representation and problem-solving are closely interrelated. Cahya et al. (2022) argued that students who possess symbolic, visual, or verbal representation skills are generally better equipped to solve problems using Pólya's stages. Verbal and symbolic representations, for example, facilitate the problem-understanding stage by helping students identify what is known and what is being asked. Sari and Manoy (2022) confirmed that at the problem-understanding stage, verbal representation supports comprehension and the expression of ideas in written and numerical form. Visual representations-in the form of images, graphs, or diagrams-assist the planning and implementation stages, as evidenced by R11's reliance on visual aids to bridge symbolic abstraction. At the answer-checking stage, symbolic representation (e.g., using the inverse operation of multiplication to verify division) and verbal representation (e.g., writing a concluding sentence) both play important roles. Sari and Manoy (2022) confirmed that at the checking stage, both verbal and symbolic representations are employed by students. Overall, students' flexibility in using diverse representations is a key facilitator of success in solving division story problems.

CONCLUSION

Students' difficulties in solving division story problems are rooted in their mathematical representation skills and are reflected across each stage of Pólya's problem-solving framework. High-category students demonstrate representational flexibility across symbolic, visual, and verbal forms. Middle-category students rely on visual representations for scaffolding and may miscalculate during implementation. Low-category students experience difficulties across all representational forms and fail to comprehend the language of story problems. Across all categories, the most prevalent difficulty lies in neglecting the problem-understanding stage (Polya's Stage 1), followed by errors in selecting the correct arithmetic operation at the planning stage, and by writing conclusions without mathematical verification at the checking stage. Overall, mathematical representation ability serves as the foundational cognitive tool in problem-solving: failures to translate information from story problems into an appropriate representational form disrupt subsequent stages and increase the likelihood of incorrect final answers. Future research is recommended to examine the effectiveness of representational instruction as an intervention to improve both representation and problem-solving performance among elementary school students.

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