**Al-Madrasah: Jurnal Ilmiah Pendidikan Madrasah Ibtidaiyah**
Vol. 10, No. 3, 2026
DOI 10.35931/am.v10i3.5902
**P-ISSN: 2620-5807; E-ISSN: 2620-7184**

# ANALYSIS OF THE THINKING PROCESS OF GRADE V STUDENTS OF SDI AL GHAFFAAR IN SOLVING MATHEMATICAL PROBLEMS

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## Abstract

*Math problem-solving skills are essential to train students' logical and analytical thinking, but they are often challenging at the elementary school level due to students' difficulties in understanding initial concepts and digesting the material. This study aims to analyze the thinking process of grade V students of SDI Al Ghaffaar Malang in solving problems of KPK and FPB materials through written tests, student interviews, and documentation. The results showed that the test questions on mathematical problem-solving ability of KPK and FPB materials were tested to be very valid (validity of 90.90%) for grade V students. The main strength of the two students lies in the instrumental understanding in planning and execution of strategies, as evidenced by the high ability to choose methods and apply algorithms. However, students experience significant limitations in relational understanding, particularly in comprehensively understanding problems and verifying results. This pattern of difficulty includes a failure to identify contextual information and conceptual justification, which indicates reasoning is limited to instrumental-procedural aspects. The implications of learning emphasize the need to develop relational understanding through habituation of contextual problem identification, strengthening conceptual reasoning and verification, and optimizing teaching strategies.*

*Keywords: Thought Process, Problem-Solving Skills, Mathematics, Elementary School*

## INTRODUCTION

Mathematics subjects at the elementary school level are often considered challenging, especially when students are faced with problem-solving problems. Success in mathematics is determined not only by the correct final result, but also by the reasoning process and thinking strategies that students use to find solutions. Anggoro, efines problem-solving as a cognitive process to find a way out of difficulties, in line with Cooney who emphasizes students to think, reason, predict and find solutions.[1] Anggoro, categorize it as a high-level cognitive process that requires the regulation and control of basic skills.[2] This ability is essential to train logical, analytical and creative thinking, as well as equip students to face various complex problems in the future.[3] However, students often face difficulties in understanding the initial concept, which has an impact on students' inability to digest the material and solve problems.[4] Therefore, problem-solving skills receive special attention in the learning process, because they are not only an integral part of the Mathematics curriculum, but also the core of mathematics learning as a whole as explained by Siswanto and Meiliasari.[5]

Referring to NCTM in Anggoro, mathematical problem-solving ability is measured through four indicators: (1) identifying the elements of the problem (known, asked and completeness of the data), (2) compiling a mathematical model, (3) applying the model to solve the problem, and (4) explaining the results in the context of the initial problem.[6] Sumarno (in Putri, et al.) measured mathematical problem-solving ability through five indicators: (1) identifying the adequacy of data, (2) creating and solving mathematical models of real situations/problems, (3) choosing and applying strategies to solve mathematical/non-mathematical problems, (4) explaining and validating results according to the initial problem, and (5) applying mathematics meaningfully.[7] Meanwhile, Polya

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[1] Abdurrobbil Falaq Dwi Anggoro, Heris Hendriana, dan Anik Yuliani, *Kemampuan Pemecahan Matematika, Koneksi Matematika, dan Penalaran Matematis Siswa Sekolah Menengah* (GUEPEDIA, 2023); Wahyu Ridlo Purwanto, Y. L. Sukestiyarno, dan Iwan Junaedi, "Proses Berpikir Siswa Dalam Memecahkan Masalah Matematika Ditinjau Dari Perspektif Gender," *Prosiding Seminar Nasional Pascasarjana* 2, no. 1 (2019).

[2] Anggoro, Hendriana, dan Yuliani, *Kemampuan Pemecahan Matematika, Koneksi Matematika, dan Penalaran Matematis Siswa Sekolah Menengah*.

[3] Aisyah Setiawati, Citra Megiana Pertiwi, dan Wahyu Hidayat, "Kemampuan Pemecahan Masalah Matematis, Model Problem Based Learning, Platform Book Creator: Muatan Pembelajaran Inovatif Abad 21 Bagi Siswa SMP," *JPMI (Jurnal Pembelajaran Matematika Inovatif)* 7, no. 3 (Agustus 2024), https://doi.org/10.22460/jpmi.v7i3.23002.

[4] Ahmad Faidhullah Akbar, Wahyu Henky Irawan, dan Abdussakir, "Pengaruh Media Pembelajaran Ular Tangga Terhadap Pemahaman Konsep Matematika Peserta Didik | JIIP - Jurnal Ilmiah Ilmu Pendidikan," *JIIP (Jurnal Ilmiah Ilmu Pendidikan)* 7, no. 8 (2024).

[5] Eko Siswanto dan Meiliasari Meiliasari, "Kemampuan Pemecahan Masalah Pada Pembelajaran Matematika: Systematic Literature Review," *JURNAL RISET PEMBELAJARAN MATEMATIKA SEKOLAH* 8, no. 1 (April 2024), https://doi.org/10.21009/jrpms.081.06.

[6] Anggoro, Hendriana, dan Yuliani, *Kemampuan Pemecahan Matematika, Koneksi Matematika, dan Penalaran Matematis Siswa Sekolah Menengah*.

[7] Hafiziani Eka Putri dkk., *Kemampuan-Kemampuan Matematis dan Pengembangan Instrumennya* (Sumedang: UPI Sumedang Press, 2020), https://books.google.co.id/books?id=FmD4DwAAQBAJ.

divides the problem-solving process into four steps with specific indicators: (1) *Understanding the problem* (write down what is known and asked), (2) *Planning a Strategy* (write down the right conceptual formula/step), (3) *Implement the strategy* (implement the procedure correctly according to the algorithm), and (4) *Check back* (write a final answer that is appropriate and relevant to the question).[8] Each of these stages represents a different cognitive flow, but they complement each other in producing accurate solutions.

Complementing the previous view, the Ministry of National Education expanded the indicator of mathematical problem-solving ability by adding aspects of non-routine problem delivery.[9] The indicators of the Ministry of National Education include: (1) problem understanding, (2) data organization and selection of relevant information, (3) presentation of mathematical problems, (4) selection of appropriate approaches and models, (5) strategy development, (6) creation and interpretation of mathematical models, and (7) presentation of irregular problems. In contrast to formula-based routine problems, non-routine problems are novelties that demand specific solving strategies through modification, exploration of various mathematical models and algorithms, or reformulating problems by relating real-world contexts.[10] In conclusion, the various indicator frameworks affirm the fundamental stages in solving mathematical problems, namely understanding, planning, implementation and evaluation. The emphasis of the Ministry of National Education on the ability to solve problems does not routinely imply the need to develop flexibility and creativity in thinking in applying mathematical concepts in the context of new and unfamiliar problems.

However, the implementation of the stages of solving mathematical problems often encounters obstacles in the field. Reinforcing the picture of existing difficulties, Initial interview with teachers and grade V students of SDI Al-Ghaffaar Malang reveals that some math materials are consistently a significant challenge. Smallest Federal Multiples (LCM) and Largest Federal Factors (FPB), build flat, as well as statistical data are identified as difficult to understand. Specifically in the KPK and FPB materials, students often have difficulty in determining FPB in large numbers using the prime factor and factoring table method, whose roots lie in Understanding the concept of prime numbers that is not yet solid. In addition, Limited allocation of math learning time As a result of school activities or holidays, it also aggravates the condition, limiting students' opportunities to explore these essential concepts. These field findings directly validate the urgency of this research in analyzing students' thinking processes on KPK and FPB materials.

[8] Putri dkk.
[9] Putri dkk.
[10] Onwardono Rit Riyanto dkk., *Kemampuan Matematis* (CV. Zenius Publisher, 2024); Susi Yati, *Strategi Jitu Pembelajaran Matematika Asyik dan Seru* (Yogyakarta: Ananta Vidya, 2022).

Meanwhile, previous studies have consistently identified similar patterns of difficulty in elementary school students of the same level. At the problem understanding stage, students often have problems with the interpretation of the question and the identification of relevant information, as found by Saleha et al., in the long unit material, and Rismadani et al., in the fractional material with an error percentage of 20%.[11] Nailia et al., adding difficulty to fractional material also includes the use of concepts, arithmetic skills and turning sentences into mathematical models.[12] In the strategy planning stage, the study by Rismadani et al., and Sintika et al., showed the dominant error with percentages of 62% and 52.5%, respectively.[13] Kurniasari further explained the difficulties at the strategy planning stage in solving mathematical problems related to the identification of problems (distinguishing between KPK and FPB) and determining the right calculation operations.[14] Errors in the implementation of the strategy are also significant according to Sintika et al., and Rismadani et al., with percentages of 50% and 60% respectively.[15] Difficulties in algebraic calculation and factorization in solving mathematical problems of KPK and FPB materials;[16] It is also included in the obstacles at the strategy implementation stage. Finally, the stage of checking the answer results, with an error percentage of 35% Rismadani and 40% Sintika which shows that students often do not re-verify students' answers.[17]

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[11] Zahra Saleha dkk., *Analisis Kesulitan Siswa Dalam Menyelesaikan Bentuk Soal Cerita Satuan Panjang Kelas III SD*, 6, no. 2 (Januari 2024), https://doi.org/10.31004/joe.v6i2.4966; Risky Ari Rismadani, Filia Prima Artharina, dan Fajar Cahyadi, "Kesulitan Siswa Menyelesaikan Soal Cerita Matematika Pada Materi Pecahan Kelas V SDN Jomblang 03 Semarang Berdasarkan Langkah – Langkah Pemecahan Masalah Menurut Polya," *DWIJALOKA Jurnal Pendidikan Dasar Dan Menengah* 2, no. 3 (November 2021), https://doi.org/10.35473/dwijaloka.v2i3.1207.

[12] Vika Nailia, Deka Setiawan, dan Imaniar Purbasari, "Studi Analisis Kesulitan Penyelesaian Soal Cerita Pada Pembelajaran Matematika Sekolah Dasar | JIIP - Jurnal Ilmiah Ilmu Pendidikan," *JIIP (Jurnal Ilmiah Ilmu Pendidikan)* 6, no. 4 (2023).

[13] Rismadani, Artharina, dan Cahyadi, "Kesulitan Siswa Menyelesaikan Soal Cerita Matematika Pada Materi Pecahan Kelas V SDN Jomblang 03 Semarang Berdasarkan Langkah – Langkah Pemecahan Masalah Menurut Polya"; Usi Dian Sintika, M. Yusuf Setia Wardana, dan Ervina Eka Subekti, "Analisis Kesulitan Belajar Siswa Ditinjau Dari Kemampuan Pemecahan Masalah Matematika Materi FPB Dan KPK Kelas IV SD Negeri Karangtempel," *DWIJALOKA Jurnal Pendidikan Dasar Dan Menengah* 2, no. 4 (2021), https://doi.org/10.35473/dwijaloka.v2i4.1524.

[14] Risma Budi Kurniasari, "Analisis Kesulitan Siswa Dalam Mengerjakan Soal Matematika Pada Materi KPK Dan FPB Siswa Kelas V SDN Sidomulyo 04 Kecamatan Ungaran Timur" (undergraduate, UNDARIS, 2024), http://repository.undaris.ac.id/id/eprint/1804/.

[15] Sintika, Wardana, dan Subekti, "Analisis Kesulitan Belajar Siswa Ditinjau Dari Kemampuan Pemecahan Masalah Matematika Materi FPB Dan KPK Kelas IV SD Negeri Karangtempel"; Rismadani, Artharina, dan Cahyadi, "Kesulitan Siswa Menyelesaikan Soal Cerita Matematika Pada Materi Pecahan Kelas V SDN Jomblang 03 Semarang Berdasarkan Langkah – Langkah Pemecahan Masalah Menurut Polya."

[16] Kurniasari, "Analisis Kesulitan Siswa Dalam Mengerjakan Soal Matematika Pada Materi KPK Dan FPB Siswa Kelas V SDN Sidomulyo 04 Kecamatan Ungaran Timur."

[17] Rismadani, Artharina, dan Cahyadi, "Kesulitan Siswa Menyelesaikan Soal Cerita Matematika Pada Materi Pecahan Kelas V SDN Jomblang 03 Semarang Berdasarkan Langkah – Langkah Pemecahan Masalah Menurut Polya"; Sintika, Wardana, dan Subekti, "Analisis Kesulitan Belajar Siswa Ditinjau Dari Kemampuan Pemecahan Masalah Matematika Materi FPB Dan KPK Kelas IV SD Negeri Karangtempel."

Given this complexity, this study aims to conduct an in-depth analysis of the thinking process of grade V students of SDI Al Ghaffaar Malang in solving mathematical problems in KPK and FPB materials. By focusing on how students manage each stage of problem solving, i.e. identifying effective strategies, as well as recognizing patterns of difficulty and factors that affect students' success or failure. This research is expected to provide insight and become a concrete guide for teachers to develop more targeted and effective teaching strategies, in order to optimize students' mathematical problem-solving skills.

## RESEARCH METHODS

This study uses a qualitative approach of case studies to identify and describe the stages of the thinking process that students go through in solving mathematical problem solving problems in the context of Islam, the material of the smallest common multiples (KPK) and the largest common factor (FPB) of class V SDI Al Ghaffaar. This study uses sampling techniques, namely *purposive sampling* (sampling purpose), Types *typical case sampling* namely the researcher selected several samples that were considered representative of the case from the total number of students in grade V of SDI Al Ghaffaar Malang 14 people. Data collection involves questionnaire activities to validate test questions using the Likert scale, written tests, student interviews, and documentation (such as modules and teaching materials). The aspects of problem-solving skills in the KPK and FPB materials that will be assessed through this test are described in the following question grid:

**Table 1**. Grid of Math Problem-Solving Test Questions

| Indicators of Educational Achievement | Indicators of Mathematical Problem-Solving Ability | Max Score. Ideal Per Question | Question No. | Enjoyment Level |
|---|---|---|---|---|
| **Learning Outcomes:** Solving problems related to KPK and FPB | | | | |
| Solving routine and non-routine problems related to the KPK and FPB | **Understand the problem:** students write down the information known, asked and the completeness of the data correctly and completely. | 4 | 1, 2 | Easy |
| | **Plan problem-solving strategies:** students select and compile relevant mathematical models to solve the problem correctly and completely. | 4 | 1, 2 | Medium |
| | **Implement problem-solving strategies:** students apply mathematical models correctly and completely according to their algorithms | 4 | 1, 2 | Medium |
| | **Explain and re-examine the results according to the initial problem:** students interpret the results obtained in the context of the initial problem and verify the correctness of the results correctly and completely. | 4 | 1, 2 | Difficult |

| | |
|---|---|
| **Scoring** | $Total\ Skor\ Siswa = \sum_{i=1}^{n} Skor\ Indikator\ Ke - i$ |
| **Final Score Determination** | $Nilai\ Akhir = \frac{Total\ Skor\ Siswa}{Total\ Skor\ Maksimal} \times 100$ |

The collected data will be analyzed qualitatively and quantitatively. Qualitative analysis was carried out on the results of post-test interviews with students and documentation. This qualitative data will be analyzed using Miles and Huberman techniques (data reduction, data presentation and drawing of conclusions); to understand students' experience in solving test problems.[18] The quantitative analysis in this study focuses on the validity of test questions and test results of students' problem-solving skills. For the validity of the questions, data from the Likert scale questionnaire will be analyzed through the calculation of the average item score and percentage. The criteria for the validity of test questions will be further explained in Table 2.[19]

**Table 2.** Instrument Validity Percentages and Criteria

| Percentage | Validity Criteria |
|---|---|
| $80{,}01\% \leq skor \leq 100\%$ | Very valid, can be used without any revision |
| $60{,}01\% < skor \leq 80{,}00\%$ | Quite valid, can be used after minor revisions |
| $40{,}01\% < skor \leq 60{,}00\%$ | Invalid, can be used after moderate revision |
| $20{,}01\% < skor \leq 40{,}00\%$ | Invalid, recommended not to be used as it needs major revisions |
| $0\% < skor \leq 20{,}00\%$ | Very invalid, cannot be used for research. |

Meanwhile, the data on the results of the mathematical problem-solving ability test from the selected students will be processed using descriptive statistics including individual scores, average scores per indicator and the percentage of each indicator. This technique aims to describe the specific performance of the selected students and become supporting data for the qualitative analysis of students' thinking processes. Furthermore, the results of the problem-solving ability test of the selected students will be categorized based on the assessment scale presented in Table 3.[20]

[18] Endang Widi Winarni, *Teori dan Praktik Penelitian Kuantitatif, Kualitatif, PTK, R & D* (Bumi Aksara, 2021).

[19] Nurul Izhan Pepridel Yulanda dkk., "Pengembangan E-LKPD Berbasis PBL Dalam Kurikulum Merdeka Di SD Al-Baitul Amien Jember," *Pendas : Jurnal Ilmiah Pendidikan Dasar* 8, no. 2 (September 2023), https://doi.org/10.23969/jp.v8i2.10290.

[20] Siti Mukarromah, Kustiana Arisanti, dan Loviga Denny Pratama, "Profil Kesulitan Siswa Dalam Menyelesaikan Soal AKM Ditinjau Dari Teori Van Hielle," *Tematik : Jurnal Konten Pendidikan Matematika* 1, no. 1 (Agustus 2024), https://doi.org/10.55210/tematik.v1i1.1153.

**Table 3**. Assessment Scale and Category of Students' Problem-Solving Ability

| Rating Scale | Category Student Problem-Solving Ability |
|---|---|
| $80{,}00 \leq skor \leq 100$ | Height |
| $60{,}00 < skor < 80{,}00$ | Medium |
| $0{,}00 < skor \leq 60{,}00$ | Low |

The categorization of the results aims to provide an initial picture of the ability level and position the profile of individual students' scores, which will be the basis for a more in-depth qualitative analysis of students' thinking processes. The calculation of averages and percentages in this analysis will use the following formula:

$$Rumus\ Rata - rata \rightarrow \bar{X} = \frac{\sum X_i}{n}$$

$$Rumus\ persentase \rightarrow Persentase = \frac{Frekuensi}{Total\ Data} \times 100\%$$

**Description:**

$\bar{X}$ : Average score or calculated score

$\sum X_i$ : The total sum of all scores or values present in the dataset

$n$ : The total number of data or many individuals in the dataset

## RESULTS AND DISCUSSION

This study involved two students of class V SDI AL Ghaffaar Malang, LJ Students and AK Students, who were selected from a total of 14 students through the technique of *typical case sampling*. The selection of the two aims to represent a variety of thinking processes in solving mathematical problems of KPK and FPB materials in the class. Based on daily test data, LJ students' scores show stability, which tends to be above the class average, although it is not always the highest. Meanwhile, AK students' scores show instability, sometimes reaching the average and sometimes below the average, which shows that there are challenges in understanding mathematical concepts.

### Validity of Problem-Solving Ability Test Questions

The validity of test questions is measured through the process of filling out a validation sheet by an expert validator. The results of the assessment are then analyzed and presented in Table 4.

**Table 4**. Test Results of Validation of Test Questions by Validators

| Assessment Aspects | Average Item Score | Percentage Validity | Remarks |
|---|---|---|---|
| Material feasibility | 0,916 | 91,66% | Highly Valid |
| Construction of the problem | 0,850 | 85,00% | Highly Valid |
| Language Use | 1,000 | 100% | Highly Valid |
| **Overall Average** | 0,909 | 90,90% | Highly Valid |

Based on Table 4, the average item score for the validity of the problem-solving ability test question is 0.909. With a validity percentage of 90.90%. These results show that the test questions used in this study are in the category of being very valid and feasible to measure the mathematical problem-solving ability of KPK and FPB materials in grade V students.

**Students' Thinking Process in Solving Mathematical Problems KPK and FPB Materials: Analysis of Test and Interview Results**

To gain an initial understanding of the strategies and stages of problem solving applied by students to the KPK and FPB material tests, an analysis of student worksheets was carried out. First, as seen in the Figure 1, LJ students show quite good ability in presenting steps to solve problem-solving test questions. For the FPB question (question about the division of cakes), students are able to use the factor tree correctly to determine the prime factor of 24 and 36. LJ students divide 24 in stages with the smallest prime factor, as well as the number 36. The process of identifying the common factors and determining the FPB was carried out systematically, resulting in the correct final answer, which is 12. Meanwhile, for the KPK question (a question about the bell ringing at the same time), LJ students chose the manual multiples list method (doing repeated summing for each number of multiples) to find multiples of 8, 12, and 15. Although this method is less efficient than the prime factorization for KPK, students managed to find the correct KPK, which is 120. Then, students also show an understanding of the time conversion step from 120 minutes to 2 hours. The process is continued by adding the initial time (at 07.00) with the time of the conversion result, so that the correct final answer is obtained, which is 09.00.

Second, Figure 2 show the efforts made by AK students in solving problem-solving test questions on the same material. For the FPB question, Ak students also used the factor tree to find prime factorization 24 and 36. AK students divide 24 gradually with the smallest prime factor. But for the number 36, students start by dividing 36 by 6, resulting in two numbers 6s. These two numbers are then subdivided by the smallest prime factor, which is 2, which results in 3. Nonetheless, this process still leads to the correct prime factorization for 36, i.e. $2 \times 2 \times 3 \times 3 = 2^2 \times 3^2$, shows that students understand the basic concepts of prime factorization. AK students successfully identified the common factors and correctly determined the FPB. Furthermore, in the

KPK question, AK students, similar to LJ students, chose the manual multiples list method (multiplying for each multiple) to find the KPK from 8, 12, and 15. AK students managed to correctly determine the FPB (i.e. 120), although there were some lacking multiples in the calculation for the numbers 12 and 15. However, in determining the time when the bell rings at the same time, the AK student only converts the time () and writes the final answer "09.00", without including the time addition step () in his worksheet. $120\ menit = 2\ jampukul\ 07.00 + 2\ jam$.

**Image 1.** LJ Student Worksheets

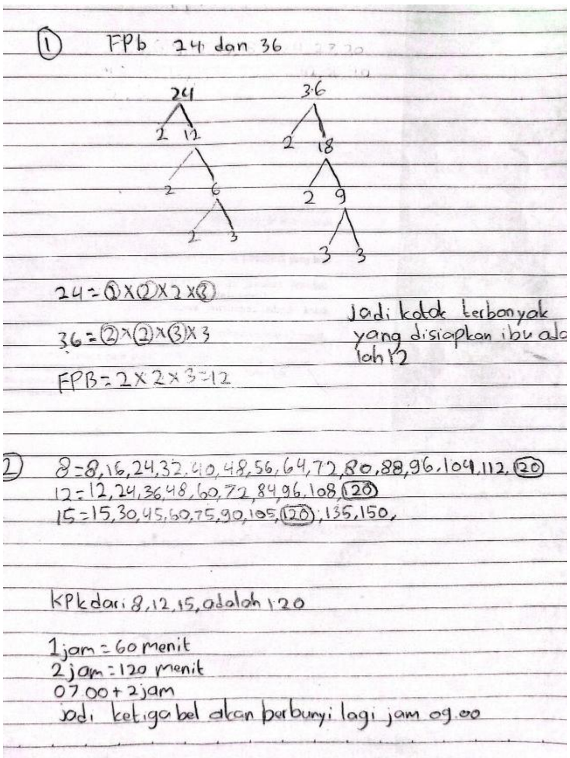
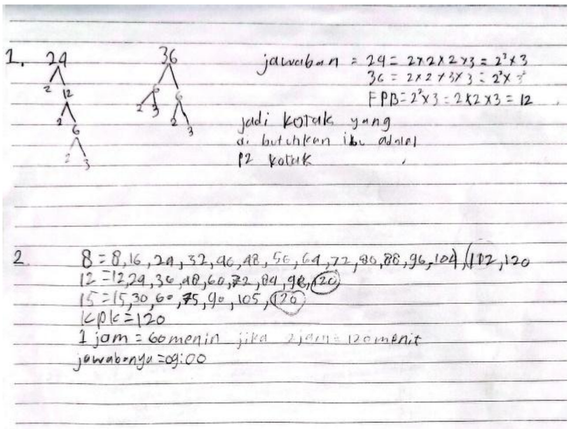



**Image 2**. AK Student Worksheet




On the worksheets of the two students, both LJ students and AK students, a similar pattern can be seen, namely: students do not explicitly write down the information that is known and asked from the questions on the worksheet but immediately switch to the work process. In addition, there are times when students do not interpret the final result of the calculation in the context of the initial problem (do not provide conclusions relevant to the story problem). Based on Polya's problem-solving indicators, the tendency of students to focus on the instrumental aspects of calculation indicates Relational Understanding Gap, especially seen at the stage of comprehensively understanding the problem and re-examining the results.[21] Furthermore, in order to gain a comprehensive understanding of the thinking process underlying the problem-solving steps and

[21] Putri dkk., *Kemampuan-Kemampuan Matematis dan Pengembangan Instrumennya*.

answers in the worksheet, post-test interviews were conducted with LJ Students and AK Students. Table 5 presented a summary of the results of the interview, describing the characteristics of the thinking process of the two students at each stage of solving the KPK and FPB material problems.

**Table 5**. Summary of Interview Results of Students' Thinking Process in Problem Solving

| Troubleshooting Indicators | Characteristics of LJ Students' Thinking Processes | Characteristics of AK Students' Thinking Processes |
|---|---|---|
| | **FPB Materials** | |
| Understanding the problem | • Students correctly identify orally known information, but it is incomplete. Students only mention the numbers (i.e. 24 and 36), without associating them with the contextual details of the problem (i.e. the type of cake).<br>• When asked about the information asked, the student immediately mentioned the operation in question as "FPB of 24 and 36".<br>**Score: 2**<br>**Justification:** Students are able to identify some known information (numbers) but are incomplete and do not relate it to context. Students are also not precise in identifying the information asked, going straight to the method of completion. This shows that students' understanding of the problem still needs improvement. | • Students correctly and completely identify the information known orally (i.e. 24 chocolate cakes and 36 vanilla cakes).<br>• When asked about the information asked, students immediately mentioned the question in the question, namely "how many boxes did the mother prepare". Students have not yet concluded FPB here, considering that it is the next stage of problem-solving.<br>**Score: 4**<br>**Justification:** Students are able to identify and explain known and questioned information accurately, completely, and relevant to the context of the problem. Students' oral explanations demonstrate a deep understanding of the initial problem before getting into a solution strategy. This corresponds to the "Excellent" criteria in the rubric. |
| | **KPK Materials** | |
| | • Students correctly identify orally known information, but it is incomplete. Students only mention numbers (i.e. 8, 12, and 15), without relating to the contextual details of the question (i.e. the time interval of the third bell).<br>• When asked about the information asked, the students immediately mentioned the operation in question as "KPK from 8, 12 and 15" and mentioned "When will the three bells ring again after 07.00". | • Students correctly identify orally known information, but it is incomplete. Students only mention numbers (i.e. 8, 12, and 15), without relating to the contextual details of the question (i.e. the time interval of the third bell).<br>• When asked about the information asked, the student immediately mentioned the operation in question as "KPK of 8, 12 and 15" and mentioned "When is the nearest time when the three bells ring after 07.00". |

| | | |
|---|---|---|
| | **Score: 2**<br>**Justification:** The student only identifies a portion of the known information (numbers without context) and jumps right into the solving operation while also mentioning the question asked. This shows that students' understanding of the problem still needs improvement to be more complete and structured. | **Score: 2**<br>**Justification:** This condition is almost identical to condition 1. Although students can name numbers and core questions, the incompleteness in relating numbers to the context of the problem and the tendency to directly mention the operation (KPK) indicate that the understanding of the problem is not fully mature. |
| Devising problem-solving strategies | **FPB Materials** | |
| | • Students determine that the problem must be solved using the FPB method and plan the procedure for doing it.<br>**Score: 4**<br>**Justification:** Students are able to choose the relevant mathematical model (FPB) and also have a plan or procedure to implement it. It demonstrates a strong understanding of planning problem-solving strategies. | • Students determine that the problem must be solved using the FPB method and plan the procedure for doing it.<br>**Score: 4**<br>**Justification:** Students are able to choose the relevant mathematical model (FPB) and also have a plan or procedure to implement it. It demonstrates a strong understanding of planning problem-solving strategies. |
| | **KPK Materials** | |
| | • Students determine that the problem must be solved using the KPK method and plan the procedure to calculate the time of the incident at the same time the second time based on the KPK results obtained.<br>**Score: 4**<br>**Justification:** Students choose a highly relevant mathematical model (KPK) and develop a detailed working strategy, including follow-up steps to interpret the KPK results in the context of the time of the concurrent event. This reflects excellent strategy planning abilities. | • Students determine that the problem must be solved using the KPK method and plan the procedure to calculate the time of the incident at the same time the second time based on the KPK results obtained.<br>**Score: 4**<br>**Justification:** Students choose a highly relevant mathematical model (KPK) and develop a detailed working strategy, including follow-up steps to interpret the KPK results in the context of the time of the concurrent event. This reflects excellent strategy planning abilities. |
| Implementing problem-solving strategies | **FPB Materials** | |
| | • Students procedurally carry out the FPB method. The process includes: **(1)** the use of factor trees to find prime factorization of 24 () and 36 (); $2 \times 2 \times 2 \times 32 \times 2 \times 3 \times 3$**(2)** identifying | • Students procedurally carry out the FPB method. The process includes: **(1)** the use of factor trees to find prime factorization of 24 () and 36 (); $2 \times 2 \times 2 \times 3 = 2^3 \times 3^1 2 \times 2 \times 3 \times 3 =$ |

and circling the same common factors, and **(3)** calculating the results of FPB correctly, namely $2 \times 2 \times 3 = 12$.

**Score: 4**

**Justification:** Students demonstrate the correct application of the mathematical model (FPB) in accordance with its algorithm (through factor trees, identification of common factors, and final calculations). All critical steps in finding FPB are carried out accurately.

$2^2 \times 3^2$**(2)** identify the same factor with the smallest rank, and **(3)** calculate the FPB results correctly, namely $2^2 \times 3^1 = 2 \times 2 \times 3 = 12$.

**Score: 4**

**Justification:** Just like the LJ condition, students apply the mathematical model (FPB) correctly, completely, and according to the algorithm. The use of rank notation and the identification of factors with the smallest rank indicate a strong understanding and precise execution.

**KPK Materials**

- Students procedurally implement the KPK method. The process includes: **(1)** the use of the multiple list method to find multiples of 8, 12 and 15; **(2)** repeated summing of each number of multiples is done to determine the same number of commons; and **(3)** circling the same number and correctly determining the LCM of 120.
- Then, students determine the time of the next simultaneous bell after 07.00. The procedure involves converting the KPK results (120 minutes) into hours (2 hours), followed by the addition of the initial time with the conversion results to get the next time (i.e. ). $07.00 + 2\,jam = 09.00$

**Score: 4**

**Justification:** The student successfully applied the mathematical model (KPK) correctly and completely according to the algorithm. In addition, students also continue the implementation of the strategy by converting the results of the KPK and using it to answer time questions in the context of the initial problem, demonstrating a comprehensive understanding from the beginning to the end of the implementation.

- Students procedurally implement the KPK method. The process includes: **(1)** the use of the multiple list method to find multiples of 8, 12 and 15; **(2)** multiplying each number of multiples is done to determine the same number of commons; and **(3)** circling the same number and correctly determining the KPK which is 120.
- Then, students determine the time of the next simultaneous bell after 07.00. The procedure involves converting the KPK results (120 minutes) into hours (2 hours) and mentally adding them to the initial time. When asked, the students also did not explain the procedure for adding the initial time with the results of the KPK conversion, only mentioning the final answer "09.00".

**Score: 3**

**Justification:** The student is able to correctly apply the mathematical model (KPK) according to the algorithm and take steps to find the final answer. However, because students could not explain the procedure for combining the KPK results with the initial time orally, there was a slight shortfall in the completeness or clarity of the delivery of the process (as per the point "few details are missed or less

| | | |
|---|---|---|
| | | explicit" in score 3). While the end result is correct, the ability to articulate the entire strategy implementation process is essential. |
| | **FPB Materials** | |
| Explain and re-check the results according to the original problem | • Students not only write down the numbers of the calculations, but explain in sentences that answer questions about the story, namely "So the most boxes prepared by the mother are 12".<br>• Students double-check the calculations to make sure there are no calculation errors.<br>• Students have difficulty explaining the conceptual reasons behind the selection of the FPB method or identifying the characteristics of the questions that lead to its use, which has an impact on their inability to verify the correctness of the final results.<br>**Score: 3**<br>**Justification:** Students are able to interpret the results well into the context of the question and perform partial verification (checking calculations). However, the failure to explain the conceptual rationale behind the method and verify the correctness of the results from the conceptual point of view of the problem suggests that the verification is not yet fully comprehensive or "complete" as per the score criterion 4. There are "few details that are missed or less explicit" regarding conceptual verification. | • Students not only write down the numbers of the calculations, but also explain in sentences that answer questions about the story, namely "So the boxes that mothers need are 12 boxes".<br>• Students double-check the calculations to make sure there are no calculation errors.<br>• Students have difficulty explaining the conceptual reasons behind the selection of the FPB method or identifying the characteristics of the questions that lead to its use, which has an impact on their inability to verify the correctness of the final results.<br>**Score: 3**<br>**Justification:** This condition is almost identical to Condition 1. Students demonstrate good interpretive and computational verification skills, but lack in conceptual verification and method selection reasons, resulting in verification of the correctness of results not yet reaching the "complete" level of a score of 4. |
| | **KPK Materials** | |
| | • Students not only write down the numbers of the calculations, but explain in sentences that answer questions about the story, namely "So the three bells will ring again at 09.00".<br>• Students double-check the calculations to make sure there are no calculation errors. | • Even if students only write "The answer 09.00" on the worksheet. However, when asked, he explained the result contextually "If 2 hours is 120 minutes, the answer is 9:00 a.m. all three bells will ring at the same time."<br>• Students did not double-check the calculation so that |

| | | |
|---|---|---|
| | • Students have difficulty explaining the conceptual reasons behind the selection of the KPK method or identifying the characteristics of the questions that require its use. Furthermore, students were unable to explain the relationship between the KPK results obtained and the determination of the time of the next simultaneous incident, thus hampering the process of comprehensively verifying the correctness of the final results.<br>**Score: 2**<br>**Justification:** Although students are able to interpret the results into context and re-check the calculations, the major failure to explain the conceptual reasons for the selection of the KPK method and the relationship of the KPK results to the final time shows that the process of verifying the correctness of the results **is far from complete.** This shows an understanding that still needs to be improved in the verification and explanation stages. | deficiencies were found in multiples of 12 and 15.<br>• Students have difficulty explaining the conceptual reasons behind the selection of the KPK method or identifying the characteristics of the questions that require its use. Furthermore, students were unable to explain the relationship between the KPK results obtained and the determination of the time of the next simultaneous incident, thus hampering the process of comprehensively verifying the correctness of the final results.<br>**Score: 1**<br>**Justification:** Despite the poor ability of oral interpretation, the failure to double-check the calculations (which even led to the discovery of deficiencies in the multiples) combined with the inability to explain the conceptual reasons for the KPK and its relationship to the final result, suggests that the student's verification process **is very weak**. The existence of "fatal (or at least significant) errors in the verification process due to the absence of checks and conceptual misunderstandings, puts it at the lowest score. Verification is not only a matter of explaining, but also ensuring its accuracy and validity, which is not fulfilled here. |

Based on an in-depth analysis of the results of the worksheets and post-test interviews, the scores of mathematical problem-solving ability of KPK and FPB materials for each indicator for the two students are presented as follows:

**Table 6**. Student Score on the Math Problem-Solving Ability Test

| Troubleshooting Indicators (Routine and Non-Routine Issues) | Max Score. | Total Student Score (KPK and FPB) LJ Students | AK Students | Average Score | Percentage (%) |
|---|---|---|---|---|---|
| Understanding the problem | 8 | 4 | 6 | 5 | 62,50% |
| Plan a problem-solving strategy | 8 | 8 | 8 | 8 | 100% |
| Implement problem-solving strategies | 8 | 8 | 7 | 7,5 | 93,75% |
| Explain and re-check the results according to the original problem | 8 | 5 | 4 | 4,5 | 56,25% |
| **Total Test Score** | **32** | **25** | **25** | **25** | |
| **Final Score** $\left(\frac{Total\ skor\ siswa}{32} \times 100\right)$ | **100** | **71,42** | **71,42** | **71,42** | |
| **Ability Categories** | | **Medium** | **Medium** | **Medium** | |

**Table 6** indicates that LJ Students and AK Students are in the category of moderate problem-solving ability, with a final score of 71.42. Both of them consistently excel in planning problem-solving strategies, as can be seen from the maximum score (i.e. 8) on the indicator. This indicates that students choose methods and arrange work procedures well and completely. However, indicators that understand the problem and explain and re-examine the results show relatively lower percentages (i.e. 62.50% and 56.25%), suggesting that these areas need further attention.

**The Power of Students' Thought Processes: Dominant Instrumental Understanding (Planning and Executing Problem-Solving Strategies)**

The analysis showed that LJ Students and AK Students had Significant ability to plan and execute problem-solving strategies KPK and FPB material. This is confirmed by a perfect score (8) on the indicator "Planning a problem-solving strategy" and a high score (LJ students: 8; AK Students: 7) on "Implementing problem-solving strategies" (Table 5). These findings indicate the presence of instrumental understanding that is effective in both students. According to Richard Skemp, instrumental understanding is the ability to apply mathematical procedures to solve problems without understanding the conceptual reasons behind them (*rules without reasons*), which emphasizes the implementation of algorithms.[22] Consistent with this definition, LJ Students and AK Students show high competence in planning strategies. Students successfully identify the right

[22] Heris Hendriana, Euis Eti Rohaeti, dan Utari Sumarmo, *Hard Skills dan Soft Skills Matematik Siswi* (Bandung: Refika Aditama, 2017); Fajri Elang Giriansyah, Heni Pujiastuti, dan Ihsanudin Ihsanudin, "Kemampuan Pemahaman Matematis Siswa Berdasarkan Teori Skemp Ditinjau Dari Gaya Belajar," *Jurnal Cendekia: Jurnal Pendidikan Matematika* 7, no. 1 (2023), https://doi.org/10.31004/cendekia.v7i1.1515.

mathematical model (FPB for cake sharing and KPK for concurrent time) and develop a conceptual plan, such as the use of factor trees by LJ Students or time conversion by AK Students. This ability, in line with the stages of Polya regarding the preparation of plans, emphasizes the mastery of students in applying procedures that are relevant to the context of KPK and FPB problems.[23]

At the stage Strategy Execution, consistent with Polya's emphasis on the correct application of procedures, both students demonstrated adequate precision and accuracy.[24] For the FPB questions, LJ students managed to utilize the factor tree for prime factorization of 24 and 36, accurately identify the common factor, and obtain FPB 12. Even though AK students started factoring 36 with a non-prime factor (6), the students still managed to achieve the correct prime decomposition, thus still determining FPB 12. In the case of the KPK, both students effectively used the manual multiples list method, albeit less efficient, to get the correct KPK of 120. LJ students explicitly convert 120 minutes to 2 hours and integrate it with the start time (07.00) to obtain the final answer 09.00. AK students also performed a similar conversion and recorded the 9:00 a.m. answer, although the addition step was not explicitly written. The success at this stage clearly confirms instrumental understanding students who are strong in applying the algorithm and calculation steps of the KPK and FPB.

**Areas That Need Attention: Limitations of Relational Understanding (Understanding Problems and Re-Examining Problem-Solving Outcomes)**

In contrast to the strengths in instrumental understanding, in-depth analysis on worksheets and interviews reveals Significant limitations LJ students and AK students at the stage Understand the problem comprehensively and Double-check the results as per the original problem**.** This indicator shows a relatively low percentage (62.50% to understand the problem and 56.25% to double-check the results) (Table 5), indicates the need for improvement Relational understanding**.** Relational understanding includes the ability to recognize the relationship between mathematical concepts and procedures, as well as provide the right justification for each step of solving the problem, as mentioned by Murtalib in Sudrajat.[25] Specifically, according to Skemp (in Giriyansyah, et al.), relational understanding is the ability to apply mathematical procedures derived from the integration of various relevant concepts, accompanied by a comprehensive understanding of their validity (*knowing what to do and why*).[26] The formation of this understanding is progressive,

[23] Putri dkk., *Kemampuan-Kemampuan Matematis dan Pengembangan Instrumennya*.

[24] Putri dkk.

[25] Sudrajat Sudrajat, "Pemahaman Relasional Dan Instrumental: Bagaimana Pengaruhnya Dalam Pembelajaran Matematika Ditinjau Dari Pemecahan Masalah Matematis?," *ELIPS: Jurnal Pendidikan Matematika* 3, no. 1 (Maret 2022), https://doi.org/10.47650/elips.v3i1.393.

[26] Giriansyah, Pujiastuti, dan Ihsanudin, "Kemampuan Pemahaman Matematis Siswa Berdasarkan Teori Skemp Ditinjau Dari Gaya Belajar."

requiring continuous reasoning so that students can internalize the rational relationship between concepts, as explained by Rivian and Hidayati.[27]

Consistently, the main difficulty patterns identified in both students were primarily centered in the early and late stages of the problem-solving process**,** reflecting deficiencies in relational understanding**.** This pattern includes difficulties in identifying and representing problems contextually**.** Observation of worksheets and interviews showed that students did not explicitly write down the information known and asked, tending to only record numbers (e.g., 24, 36 for FPB; 8, 12, 15 for KPK) without associating them with the narrative details of the question (e.g., "type of cake" or "bell time interval"). Further, students' responses to questions about what were asked directly referred to mathematical operations (FPB/KPK) rather than formulating the problem in context. These limitations indicate that students' focus is more on "what to count" (instrumental aspects) than on "the meaning and relevance of information" (relational aspects), so students' initial understanding of the problem is immature and structured.

In addition, students show significant limitations in validating solutions with conceptual reasoning**.** Despite being able to complete the procedure, students have difficulty justifying the "*why"* of a method (FPB/KPK) being chosen or identifying the characteristics of the relevant problem, indicating a lack of a deep connection between the concept and its application. This is exacerbated by the lack of a thorough habit of verification and validation of results. For example, LJ students were unable to articulate the relationship between the KPK results (120 minutes) and the timing of the next concurrent event, hindering comprehensive verification. Similarly, AK students do not even recheck their calculations on the KPK questions, which results in the identification of incomplete or inaccurate multiples. These failures cumulatively confirm that students' reasoning processes are still limited to instrumental aspects, ignoring the validity of solutions and conceptual interconnections that are essential for deep relational understanding.

**Implications for Math Learning**

This study highlights the contrast between effective instrumental understanding in LJ Students and AK Students, which enables students to succeed in planning and implementing KPK and FPB procedures with significant limitations in students' relational understanding. This gap is observed in the difficulty of understanding the problem thoroughly, relating information in context, providing conceptual reasons for method selection, and verifying results comprehensively. As emphasized by Sholihah, relational understanding is essential to solve mathematical problems

[27] Disi Rivian dan Nita Hidayati, "Analisis Kemampuan Pemahaman Relasional Siswa Dalam Menyelesaikan Trigonometri Ditinjau Dari Jenis Kelamin," *Didactical Mathematics* 6, no. 1 (April 2024), https://doi.org/10.31949/dm.v6i1.8528.

effectively.[28] Although instrumental understanding is also necessary and the two are interrelated (as described by Utomo and Huda) and students with high problem-solving skills typically master both (in line with Sudrajat's view), the data show that students' reasoning tends to be fluent in "how to perform a procedure" but less deep in "why" or "how concepts are interconnected".[29] Therefore, mathematics learning strategies, especially in KPK and FPB materials, need to shift from just emphasizing procedural aspects to developing a more holistic relational understanding**.**

The practical implications are as follows: First, develop a contextual and relational understanding of the problem. Teachers need to systematically guide students in identifying and representing the information of the question in a contextual manner. This can be done through triggering questions, encouraging problem reformulation, and training students to identify keywords that indicate the use of FPB or KPK, accompanied by conceptual discussions to build students' relational understanding. This kind of contextual approach has been proven to be effective in improving understanding and mathematical problem-solving skills, according to research conducted by Muhsin et al.[30] Second, improveconceptual reasoning skills and verify results. Learning strategies must shift from simply an emphasis on true/wrong answers to justification and reasoning. Teachers need to get students used to explaining the choice of method and the relevance of the results, supported by class discussions and conceptual explanatory assignments. In addition, students should be encouraged to independently verify and validate the results, not only checking the calculations, but also questioning the feasibility of the answer in the context of the problem. The emphasis on mathematical reasoning, as explained by Dhiman, allows students to make conjectures, construct evidence, and draw appropriate conclusions in problem solving.[31] Third**,** optimizing teaching strategies in limited time. Although time allocation is limited, teachers can optimize learning by applying a problem-based approach or cooperative learning. These strategies have proven to be effective in encouraging students' active involvement in problem-solving and building conceptual understanding, supported by research conducted by Sanda et al.; Zainal; Izza and Diansyah; and Hidayat et al.[32]

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[28] Aminatus Sholihah, "Analisis Pemahaman Relasional Siswa Dalam Memecahkan Masalah Matematika Berdasarkan Teori APOS Ditinjau Dari Kemampuan Awal Matematika" (undergraduate, UIN Sunan Ampel Surabaya, 2020), http://digilib.uinsa.ac.id/43316/.

[29] Dwi Priyo Utomo dan Muhamad Huda, *Pemahaman Relasional: Analisis Proses Pembuktian Menggunakan Induksi Matematika*, ed. oleh Akhsanul In'am (BILDUNG, 2020), https://eprints.umm.ac.id/id/eprint/6053/; Sudrajat, "Pemahaman Relasional Dan Instrumental."

[30] Muhsin, Rahmah Johar, dan Elah Nurlaelah, "Peningkatan Kemampuan Pemahaman dan Pemecahan Masalah Matematis melalui Pembelajaran dengan Pendekatan Kontekstual," *Jurnal Peluang* 2, no. 1 (2013).

[31] Adi Herdiansyah, Rustanto Rahardi, dan Santi Irawati, "Pengembangan LKS Beracuan Problem Based Learning Untuk Mendeskripsikan Kemampuan Penalaran Matematika Siswa SMK," *Jurnal Cendekia : Jurnal Pendidikan Matematika* 8, no. 1 (2024), https://doi.org/10.31004/cendekia.v8i1.1893.

[32] Nabila Sanda, Putri Yuanita, dan Elfis Suanto, "Penerapan Model Problem Based Learning Untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa Kelas VIII SMP Negeri 42 Pekanbaru," *Jurnal*

Finally, to optimize the effectiveness of the strategies described earlier, digital media integration is recommended as an essential practical step. This strategy has been proven to be able to strengthen and accelerate the development of relational understanding through the use of digital media, such as visualization applications (Geogebra and VBA Excel), online learning platforms (Google Classroom), quiz and interactive design applications (Quizizz and Canva), as well as electronic teaching materials (learning videos and e-modules) in KPK and FPB materials; an innovative approach that is effective to support learning comprehensively and contextually as described by Assagaf and Subekti.[33] This function of digital media is particularly relevant to the previous three implications: digital media supports contextualization by presenting problems in an immersive visual context, which facilitates contextual learning as described by Rahmatyas.[34] In addition, according to Assagaf and Subekti, digital media enhances reasoning through the provision of immediate feedback and concept visualization features that are oriented towards conceptual justification as well as the development of high-level thinking skills.[35] Digital media also contributes to time optimization because it is able to increase student engagement and enthusias, as well as enable flexible, thus optimizing time allocation and effectively improving understanding and skills *problem solving.*[36] Thus, the adoption of digital media is an efficient way to enrich learning strategies and ensure a more holistic understanding is achieved.

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*Cendekia : Jurnal Pendidikan Matematika* 9, no. 1 (2024), https://doi.org/10.31004/cendekia.v9i1.3210; Nur Fitriani Zainal, "Problem Based Learning pada Pembelajaran Matematika di Sekolah Dasar/ Madrasah Ibtidaiyah," *Jurnal Basicedu* 6, no. 3 (2022), https://doi.org/10.31004/basicedu.v6i3.2650; Sinta Nur Izza dan Muhammad Rakhma Diansyah, "Penerapan Metode Pembelajaran Kooperatif Untuk Meningkatkan Hasil Belajar Matematika Di Sekolah Dasar," *Khatulistiwa: Jurnal Pendidikan Dan Sosial Humaniora* 1, no. 3 (September 2021), https://doi.org/10.55606/khatulistiwa.v1i3.4145; Adityawarman Hidayat, Erni Anika, dan Kasman Ediputra, "Pengaruh Model Pembelajaran Kooperatif Tipe Teams Games Tournament (TGT) Terhadap Pemahaman Konsep Matematika Siswa Kelas VIII SMP Negeri 1 Bangkinang," *Jurnal Cendekia : Jurnal Pendidikan Matematika* 2, no. 2 (Agustus 2018), https://doi.org/10.31004/cendekia.v2i2.53.

[33] Syafa Helena Assagaf dan Fitrianto Eko Subekti, "Efektivitas Media Digital Terhadap Kemampuan Berpikir Matematis Siswa," *Proximal: Jurnal Penelitian Matematika Dan Pendidikan Matematika* 8, no. 3 (Agustus 2025), https://doi.org/10.30605/proximal.v8i3.6070.

[34] Sri Rahmatyas, "Pengaruh Penggunaan Media Digital Interaktif Terhadap Pemahaman Konsep Matematika Siswa," *DIKMAT: Jurnal Pendidikan Matematika* 5 (Oktober 2025), https://doi.org/10.56842/dikmat.v5i01.510.

[35] Assagaf dan Subekti, "Efektivitas Media Digital Terhadap Kemampuan Berpikir Matematis Siswa."

[36] Vivi Tri Wulandari dkk., "Pengembangan E-Modul Interaktif Sebagai Upaya Meningkatkan Kemampuan Problem Solving Dalam Pembelajaran Matematika," *Jurnal Cendekia : Jurnal Pendidikan Matematika* 9, no. 2 (Mei 2025), https://doi.org/10.31004/cendekia.v9i2.3803; Nur Khilya Maulida, Iswahyudi Joko Suprayitno, dan Venissa Dian Mawarsari, "Inovasi Pembelajaran Digital: Pengaruh Media Interaktif Terhadap Kemampuan Pemecahan Masalah Matematis Siswa," *Jurnal Genta Mulia* 16, no. 2 (Juli 2025).

## CONCLUSION

This study uses the KPK and FPB material problem-solving test questions which were tested to be very valid (90.90% validity) in grade V students. Analysis of the thinking process of LJ students and AK students showed that the problem-solving ability of both was in the medium category (final score of 71.42). The main strength of students lies in the effective instrumental understanding to plan and implement KPK and FPB procedures. However, the key findings identified a significant contrast, namely serious limitations in students' relational understanding. This gap manifests as difficulties in: (1) Comprehensively understanding the problem and identifying contextual information, (2) Providing a conceptual justification for method selection, and (3) Re-examining (verifying) the results thoroughly. This pattern of difficulty indicates that students' mathematical reasoning is still limited to instrumental-procedural aspects. Therefore, optimizing students' problem-solving abilities requires the implementation of strategies that focus on strengthening relational understanding. Recommended strategies include habituation of contextual problem identification, development of verification and conceptual reasoning skills, and optimization of teaching strategies through problem-based or cooperative approaches in time constraints. Furthermore, the integration of interactive digital media (such as *e-modules* and *educational games*) is highly recommended as a practical step to strengthen this strategy, as it has proven effective in facilitating concept visualization, conceptual feedback, and increasing student engagement flexibly, thus encouraging the achievement of a more holistic understanding.

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