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Polya's Stages in Students' Mathematical Problem Solving of Linear Programming Word Problems: A Qualitative Study

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Abstrak

Penelitian ini bertujuan untuk mengidentifikasi kemampuan pemecahan masalah matematis siswa SMA Muhammadiyah 1 Pontianak dalam menyelesaikan soal cerita program linear berdasarkan tahapan Polya. Penelitian ini menggunakan pendekatan deskriptif kualitatif. Subjek penelitian terdiri dari 6 siswa kelas XI IPS yang dipilih berdasarkan kategori kemampuan awal matematis (KAM) tinggi. Penentuan KAM didasarkan pada rata-rata nilai harian, nilai akhir semester pada materi program linear, serta rekomendasi guru matematika dari 34 siswa kelas XI IPS. Data penelitian dikumpulkan melalui tes pemecahan masalah matematis dan wawancara. Instrumen dikembangkan berdasarkan indikator tahapan Polya, yaitu: (1) memahami masalah, (2) merencanakan penyelesaian, (3) melaksanakan rencana, dan (4) memeriksa kembali hasil. Analisis data dilakukan melalui tahapan reduksi data, penyajian data, penarikan kesimpulan, serta triangulasi teknik untuk memastikan keabsahan data. Hasil penelitian menunjukkan bahwa kemampuan pemecahan masalah matematis siswa bervariasi pada setiap tahapan Polya. Pada tahap memahami masalah, siswa berada pada kategori sangat baik, ditunjukkan dengan kemampuan mengidentifikasi informasi yang diketahui dan yang ditanyakan secara sistematis. Pada tahap merencanakan penyelesaian, kemampuan siswa berada pada kategori cukup baik, ditandai dengan kemampuan membuat tabel bantu, menentukan variabel, dan membentuk model matematika meskipun belum sistematis. Pada tahap melaksanakan rencana, kemampuan siswa berada pada kategori sangat kurang, karena siswa mengalami kesulitan dalam menentukan titik koordinat, menggambar daerah solusi, menentukan titik pojok, serta menghitung nilai optimum. Pada tahap memeriksa kembali, kemampuan siswa juga berada pada kategori sangat kurang, ditunjukkan dengan ketidakmampuan mengevaluasi kembali langkah penyelesaian dan menyimpulkan jawaban secara tepat.

Kata Kunci: Kemampuan; Pemecahan Masalah Matematis; Soal Cerita; Program Linear; Tahapan Polya

Abstract

This study aims to identify senior high school students' mathematical problem-solving abilities in solving linear programming word problems based on Polya's problem-solving stages. This research employed a descriptive qualitative approach. The participants consisted of six Grade XI Social Science students from SMA Muhammadiyah 1 Pontianak, selected based on high Mathematical Prior Ability (MPA). The MPA classification was determined from students' average daily scores, final semester examination results in linear programming, and recommendations from the mathematics teacher among 34 students. Data were collected through problem-solving tests and semi-structured interviews. The instruments were developed based on Polya's four problem-solving stages: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. Data analysis followed the procedures of data reduction, data display, conclusion drawing, and technique triangulation to ensure data validity. The findings reveal variations in students' problem-solving performance across Polya's stages. In the understanding stage, students demonstrated very good performance, as they were able to identify known and required information systematically. In the planning stage, students showed fairly good performance by constructing tables, defining variables, and forming mathematical models, although their work lacked systematic structure. In the execution stage, students performed poorly, as they encountered difficulties in determining coordinate points, graphing feasible regions, identifying corner points, and calculating optimal values. In the checking stage, students also showed very poor performance, indicated by their inability to re-examine procedures and draw accurate conclusions.

Keywords: Mathematical Ability; Mathematical Problem-Solving; Word Problems; Linear Programming; Polya's Stages

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Introduction

This study stems from the need to improve the quality of mathematics learning at the senior high school level, particularly students' mathematical problem-solving ability through word problems on Linear Programming. In mathematics learning, problem solving is not merely viewed as the ability to obtain a final answer, but also as a systematic thinking process (Riyani & Hadi, 2023). However, in practice, students' achievement in mathematical problem-solving ability remains a serious issue. Based on the results of PISA 2022, Indonesia ranked 68th out of 81 countries, with a mathematics score of 366, far below the international average of 472. Furthermore, approximately 72% of Indonesian students were below Level 2, indicating that most students still experience difficulties in dealing with problems that require the use of mathematics to solve real-world problems (OECD, 2023). According to Indrawati et al. (2019), mathematical problems often involve tasks that require conceptual understanding and appropriate problem-solving strategies, which must be identified accurately through logical thinking and understood through systematic procedures (Lilisantika & Roesdiana, 2023). Providing mathematics word problems can train and develop students' abilities while also giving them experience in solving mathematical problems by translating the meaning of the word problems into appropriate mathematical sentences (Jedaus et al., 2019).

In this context, mathematical problem-solving ability needs to be understood as a gradual process, consisting of the ability to understand the problem, devise a solution plan, carry out the plan, and review the result. In line with the demands of mathematics learning stated by the Ministry of Education and Culture in the Ministerial Regulation of Education and Culture (2016), students are expected to be able to understand problems and construct mathematical models, solve these models accurately, and obtain appropriate solutions. However, in Linear Programming material presented in the form of word problems, students often encounter obstacles from the initial stage of the process. These obstacles are not only related to conceptual mastery, but also to students' ability to interpret the information contained in the problem, translate it into mathematical form, and determine a logical solution strategy.

One of the main challenges that needs to be examined is students' ability to understand problems in Linear Programming word problems. When students are unable to identify important information, determine what is being asked, and understand the relationships among the concepts presented in the problem, the problem-solving process tends to be incorrect or may even stop at the initial stage. This condition reinforces the need for research that clearly describes how students' problem-understanding ability occurs in real learning situations, rather than merely assessing the final results.

Beyond understanding the problem, the urgency of this study is also reflected in students' ability to design a solution plan. Linear Programming word problems require students to select appropriate steps, construct mathematical models, and determine solution strategies that align with the structure of the problem. In reality, some students are able to grasp the general meaning of the problem, yet they are not capable of developing a systematic plan that fits the problem requirements. As a result, the obtained answers tend to be inaccurate, illogical, or inconsistent with the objectives posed in the problem.

In addition, the importance of this study also lies in the stage of implementing the solution plan. Although students may have attempted to design a strategy, successful problem solving still depends on their ability to execute the steps correctly and consistently. This stage involves accuracy in computation, proper application of Linear Programming concepts, and an organized solution process to ensure alignment with the previously constructed plan. If the implementation stage is not carried out in accordance with the intended procedures, errors are likely to occur and may significantly affect the quality of the final solution.

Furthermore, this study is necessary to assess students' ability to review their solutions. The habit of checking answers is an essential aspect, enabling students to recognize errors, correct incorrect steps, and ensure that the results are consistent with the context of the problem. Without this verification stage, conceptual and computational errors are more likely to persist until the final outcome, thereby reducing opportunities for meaningful learning from mistakes.

Based on interviews with a mathematics teacher at SMA Muhammadiyah 1 Pontianak conducted in January 2025, and supported by an analysis of the written responses of 28 students, it was found that most students experienced difficulties in translating word problems into mathematical language in the topic of Linear Programming. The analysis of the findings revealed obstacles in identifying relevant information, constructing mathematical models, executing solution procedures correctly, and drawing appropriate conclusions. These conditions are consistent with previous studies (Rianto et al., 2017; Imannia et al., 2022), which reported deficiencies in procedural completeness, accuracy, stepwise implementation, and students' lack of habit in rechecking their answers. These findings strengthen the urgency of investigating students' problem-solving patterns based on clearly defined process stages.

Therefore, the study entitled "Mathematical Problem-Solving Ability of Senior High School Students Based on Polya's Stages in Linear Programming Word Problems: A Qualitative Approach among Grade XI Social Science Students at SMA Muhammadiyah 1 Pontianak" is considered relevant and necessary. This research is expected to provide an in-depth description of students' abilities at each stage of Polya's problem-solving framework in a structured manner, so that the most dominant difficulties can be identified. The results are also expected to serve as a basis for designing more effective instructional strategies to enhance students' mathematical problem-solving ability in Linear Programming.

Theoretical Review

A problem is a question or situation that is challenging in nature and cannot be solved using routine procedures that are commonly applied or already known (Wahyudi & Anugraheni, 2017). Such problems require students to engage in deeper thinking and utilize their mathematical abilities to construct solutions through indirect or non-standard procedures. In addition, a mathematical problem is subjective in nature, meaning that a task considered a problem for one individual may not necessarily be perceived as a problem by another, depending on each individual's level of competence in solving it. In this study, the mathematical problems used are non-routine tasks in the form of word problems.

Mathematical problem solving is the process of finding solutions to mathematical problems by applying students' prior knowledge to achieve correct results. A characteristic of problem-solving tasks is the presence of challenges presented in contextual or narrative form, requiring the integration of two or more concepts or principles in their solution. According to Polya, problem solving is the process of finding a solution to a mathematical problem to obtain a result that cannot be achieved immediately (Saiful et al., 2024). Furthermore, Kania and Arifin (2019) explain that mathematical problem solving is a process that utilizes the power and advantages of mathematics to solve problems and involves methods for finding solutions through systematic steps. Thus, mathematical problem solving can be understood as the process of finding solutions to mathematical problems by using the knowledge possessed by each student to achieve accurate results.

In this study, mathematical problem-solving ability refers to students' competence in solving linear programming word problems, as reflected in the accuracy and completeness of solution steps based on Polya's stages. Referring to Polya (in Hidayah, 2016), mathematical problem-solving ability consists of four indicators: understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. In the understanding the problem stage, students are

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expected to be able to identify and write down the known and unknown information and relate these elements systematically. In the planning stage, students are required to develop solution strategies by constructing supporting tables, defining variables, formulating mathematical models, and distinguishing between constraint functions and objective functions. Next, in the carrying out the plan stage, students determine the coordinates of constraint functions, draw the feasible region, identify corner points of the feasible region, and calculate the objective function values to obtain the optimal solution. Finally, in the reviewing stage, students are expected to re-evaluate all computational steps and draw conclusions that align with the problem statement, ensuring that the obtained solution is both valid and mathematically verified.

According to Ilmiyana (2018), mathematical problem-solving ability is an individual's effort to find solutions to problems encountered in order to obtain knowledge and conceptual understanding through scientific reasoning (Novianti & Roesdiana, 2022). Similarly, Ahmad et al. (Saputra et al., 2020) define mathematical problem-solving ability as an action undertaken to resolve problems or a process that utilizes the power and usefulness of mathematics in solving problems, which also functions as a method of discovering solutions through systematic stages of problem solving.

In this study, word problems refer to mathematical tasks presented in the form of sentences using everyday language, embedded in narrative contexts within senior high school mathematics on the topic of Linear Programming based on the 2024 Merdeka Curriculum. These problems involve model formulation, determining the feasible region of constraints using graphical methods, finding optimal values, and interpreting the objective function results.

Linear Programming word problems are a type of mathematical problem that presents real-life situations that can be modeled into a system of linear inequalities, particularly at the secondary school level. The system of inequalities referred to here is a system of two-variable linear inequalities (SPtLDV). The purpose of these problems is to determine the optimal value (maximum or minimum) of a linear function, known as the objective function, while satisfying all given constraints defined by the system of inequalities.

Research Methods

This study was conducted at SMA Muhammadiyah 1 Pontianak, located on Jalan Parit H. Husin II, Pontianak Tenggara District, Pontianak City, West Kalimantan. The data collection techniques employed in this study were measurement techniques and direct communication techniques. The measurement technique was implemented through a written descriptive test, which was used to assess students' mathematical problem-solving ability. Meanwhile, the direct communication technique was conducted through interviews, in which data were collected through oral questions in the form of dialogues between the researcher and the participants.

This study used a descriptive qualitative research design. The use of a descriptive qualitative approach was intended to describe and identify the mathematical problem-solving abilities of students at SMA Muhammadiyah 1 Pontianak in solving Linear Programming word problems based on Polya's stages. This type of research is classified as descriptive research because it enables the researcher to obtain an in-depth and detailed understanding of the phenomenon from the participants' perspectives within a context aligned with the research objectives. According to Purba & Simanjuntak (2012), descriptive research is a type of study aimed at providing a systematic description of a particular phenomenon.

The research procedure in this study followed a series of stages carried out during the research process (Lestari & Yudhanegara, 2015), namely the preparation stage, implementation stage, and completion stage. In the preparation stage, the researcher developed research instruments in the form of a mathematical problem-solving test and interview guidelines, which were then validated by two lecturers of Mathematics Education at FKIP Tanjungpura University and one mathematics teacher at SMA Muhammadiyah 1 Pontianak. After the instruments were declared valid, a trial test was conducted with students of class XI MIPA 1 at SMA Muhammadiyah 1 Pontianak to examine the validity and reliability of the test items. The results of the analysis showed that all six items were valid, with correlation coefficients ranging from 0.677 to 0.827, most of which fell into the good category, namely Item 1 (0.727), Item 2 (0.827), Item 3 (0.760), Item 4 (0.764), and Item 6 (0.777), while Item 5 (0.677) was categorized as moderately good but still valid. Subsequently, all valid items were used for reliability and difficulty level analysis, and the reliability test yielded a coefficient of 0.849, which was categorized as good; therefore, the instrument was considered appropriate for use in the study.

After the test instrument had been validated, the implementation stage of the study was carried out by administering the mathematical problem-solving test to the research subjects and conducting interviews to obtain more in-depth data. The selection of research subjects was based on students' learning achievement scores, obtained from the average daily scores on Linear Programming material and previous semester final exam scores, representing students' initial mathematical ability (KAM) from 34 students of class XI Social Science at SMA Muhammadiyah 1 Pontianak. Furthermore, students were grouped into three categories based on the criteria of Lestari & Yudhanegara (2015), namely the high-ability group with KAM ≥ 83.99, the medium-ability group with 70.16 < KAM < 83.99, and the low-ability group with KAM ≤ 70.16. This grouping was then used as the basis for analyzing students' mathematical problem-solving abilities.

To explore students' mathematical problem-solving abilities in depth, based on the analysis of their initial mathematical ability (KAM) and recommendations from the mathematics teacher, six students from the high-ability group were selected as research subjects. These students were given three mathematical problem-solving tasks, and each participant was interviewed in accordance with the prepared interview guidelines. The following presents the data of the selected students based on research considerations, the researcher's needs, and student availability.

Table 1. Category KAM

Student Code	Score	Category
PZA	89	High
NS	86,5	High
NMA	85	High
NP	84	High
SF	84	High

The final stage of this study, namely data analysis, was conducted by analyzing the collected data based on Polya's problem-solving steps. The data analysis employed the qualitative model proposed by Miles and Huberman. Miles and Huberman stated that qualitative data analysis consists of three stages, namely data reduction, data display, and conclusion drawing and verification (Sugiyono, 2023).

Data reduction in this study refers to the process of selecting, focusing on the essential aspects, and simplifying the data in order to provide a clearer picture of the findings. This process was carried out through several steps: grouping students into three ability categories (high, medium, and low) based on the average scores of Linear Programming learning outcomes and previous semester final exam scores using the criteria of Lestari & Yudhanegara (2015); examining and analyzing students' written work based on Polya's stages; using students' written responses as the basis for interview activities; and processing interview results by aligning students' responses with their test answers and then simplifying them into analyzable data.

The reduced data were then presented in narrative descriptive form, containing both test and interview results to illustrate students' mathematical problem-solving abilities in Linear Programming. In the final stage, conclusions were drawn through a verification process by comparing the results of students' written work analysis with interview data in order to obtain a valid and comprehensive description of the research subjects' mathematical problem-solving abilities.

Research Results

Data collection in this study was carried out through tests designed to measure students' mathematical problem-solving ability and interviews conducted to explore in greater depth the results obtained from the students' completed test responses. The following presents a summary of the processed data, as shown in Table 2.

Table 2. Results of Mathematical Problem-Solving Test

Aspects	PZA	NS	NMA	NP	SF	VA
Understanding the Problem	7	7	4	5	5	6
Planning the Solution	7	4	6	6	4	5
Implementing the Plan	5	1	4	4	4	3
Looking Back	3	1	2	0	2	0
Total Score	22	13	16	15	15	14
Percentage (%)	61	36	44	42	42	39

NB: Maximal score = 36

Based on Table 2, the results of the Linear Programming test completed by the students show that mathematical problem-solving ability was assessed through four aspects, namely understanding the problem, planning a solution, implementing the solution plan, and checking the final result. The scores presented represent the accumulation of three test items, with a maximum score of 3 points for each aspect per item. Thus, the maximum score for each aspect across the entire test is 9 points. The total scores presented in the table are the aggregated scores of all aspects from the three problems solved by each student.

In the aspect of understanding the problem, it was found that students PZA and NS obtained the highest scores, namely 7, indicating that these students were able to identify important information in the Linear Programming problems and understand the objectives that needed to be achieved.

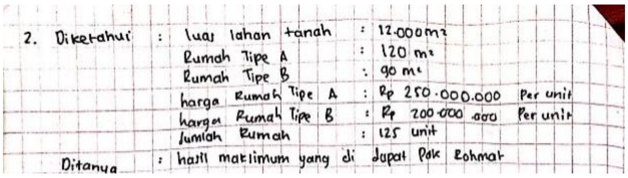

Figure 1. NS's Understanding the Problem Response

Meanwhile, student NMA obtained a score of 4, NP and SF each obtained a score of 5, and VA obtained a score of 6. These results indicate that most students were not yet fully consistent in comprehending all information contained in the problems, although in general they were able to grasp the core of the problem.

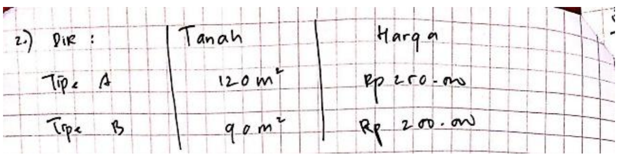

Figure 2. NMA's Understanding the Problem Response

Next, in the aspect of planning the solution, PZA again achieved the highest score, namely 7. Students NMA and NP each obtained a score of 6, indicating that both students were able to develop a reasonably good solution plan, although they did not work on question number 3, and their planning had not yet fully met all indicators. Meanwhile, NS and SF obtained a score of 4, while VA obtained a score of 5. This condition indicates that several students were not yet able to determine the most appropriate solution steps comprehensively, resulting in solution plans that were still not optimal.

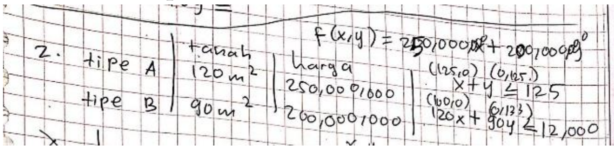

Figure 3. PZA's Solution Planning Response

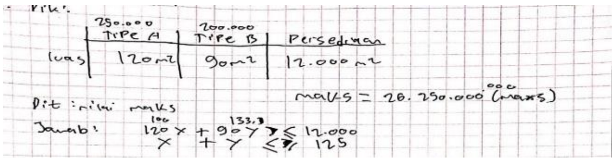

Figure 4. SF 's Solution Planning Response

In the aspect of implementing the solution plan, the results show a clearer variation in students' abilities compared to the previous aspects. PZA obtained a score of 5, while NMA, NP, and SF each obtained a score of 4. Similarly, VA only obtained a score of 3, and NS obtained a score of 1. These findings indicate that at the implementation stage, students still experienced difficulties in executing the solution plan accurately, both in terms of procedural correctness, adherence to systematic steps, and the completeness of the Linear Programming solution process.

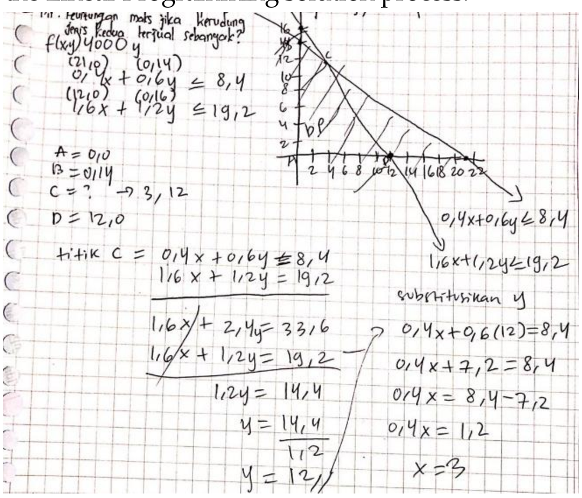

Figure 5. PZA's Implementing the Plan Response

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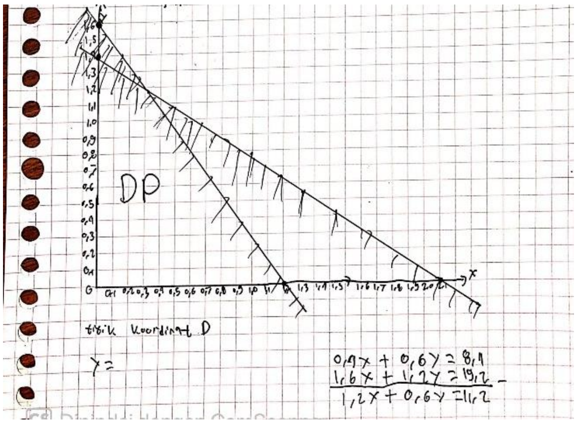

Figure 6. SF's Implementing the Plan Response

In the aspect of reviewing the solution, students' scores tended to be lower. PZA obtained a score of 3, while NMA and SF each obtained a score of 2, and NS obtained a score of 1. Meanwhile, NP and VA obtained a score of 0, indicating that at the verification stage, these two students did not demonstrate any meaningful checking activities, or their verification efforts were extremely minimal. These findings show that students' ability to review the correctness of their solutions and ensure the consistency of their answers with the problem requirements remains a significant weakness.

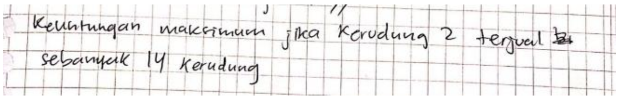

Figure 7. PZA's Looking Back Response

The total scores of students' mathematical problem-solving performance in solving Linear Programming problems were PZA (22), NS (13), NMA (16), NP (15), SF (15), and VA (14), with a maximum possible score of 36. Based on these results, it can be concluded that students' problem-solving abilities varied, where PZA demonstrated the highest achievement by obtaining relatively strong scores across almost all aspects, whereas NS showed the lowest performance, particularly in the stages of implementing the solution plan and reviewing the final result.

Table 3. Mathematical Problem-Solving Ability

Aspect	**Percentage (%)**	Category
Understanding the Problem	83,3%	Very Good
Planning the Solution	64,8%	Very Good
Implementing the Plan	38,9%	Very Poor
Looking Back	16,7%	Very Poor

Based on Table 3, which presents the results of the interview data analysis, students' mathematical problem-solving abilities were categorized based on the average score of each aspect. The categories used indicate the level of students' ability in solving problems through Polya's stages, namely understanding the problem, planning a solution, carrying out the plan, and reviewing the solution.

In the aspect of understanding the problem, students were categorized as Very Good. This condition indicates that students were able to identify important information in Linear Programming problems, understand what is known and what is asked, and interpret the problem accurately. This finding is consistent with the previous explanation that the understanding stage yielded relatively higher scores compared to other aspects, indicating that students' initial ability to comprehend the problem is a major strength.

Next, in the aspect of planning the solution, students were categorized as Fairly Good. This means that students were able to develop solution strategies; however, they were not yet fully able to ensure that the selected steps were the most appropriate and complete for solving Linear Programming problems. This tendency is also consistent with previous results, where several students showed moderate scores in the planning aspect, but these were not evenly distributed and did not demonstrate consistency across all planning indicators.

In the aspect of implementing the solution plan, students were categorized as Very Poor. This indicates that when students began to apply the planned steps, various obstacles emerged that prevented the solution process from running optimally. These obstacles included procedural errors, calculation inaccuracies, and incomplete implementation of the planned steps. This finding is also aligned with the previous assessment results, which showed that the implementation aspect had the lowest achievement among most students, with some students demonstrating very minimal scores at this stage.

Finally, in the aspect of reviewing the solution, students were categorized as Very Poor. This condition indicates that students rarely rechecked their answers, both in terms of verifying the correctness of procedures and ensuring that the results matched the question requirements. This strengthens the previous finding that the reviewing stage is the weakest aspect, as some students did not perform any meaningful verification after completing the problems.

Thus, the interview results clarify the pattern of students' abilities previously identified in the test scores: students are relatively strong in understanding the problem, moderately able in planning the solution, but still very weak in implementing the plan and reviewing the final solution.

Discussion

Based on the data analysis presented, it was revealed that many students were not yet able to solve Linear Programming word problems accurately. Among the six students selected as research subjects from class XI Social Science at SMA Muhammadiyah 1 Pontianak, two students were at level 2, meaning they were only able to complete one or two initial stages and begin the planning process, but experienced significant difficulties in the implementation stage or in reaching the correct solution. Meanwhile, the other four students were at level 3, indicating that they were able to complete up to three stages, namely understanding the problem, planning the solution, and implementing the plan; however, they still encountered difficulties or inaccuracies in reviewing or interpreting the final answer.

From the description of students' written responses and interviews, it can be concluded that the achievement of several indicators of mathematical problem solving was not yet optimal. The following provides a detailed discussion of students' mathematical problem-solving abilities in solving Linear Programming word problems at SMA Muhammadiyah 1 Pontianak based on Polya's stages.

Understanding the Problem

Based on the analysis of data from the research subjects, it was found that the average students' ability to understand Linear Programming word problems was categorized as very good. This is because the research subjects were able to identify and extract known information, determine what was asked, and recognize other relevant information from the problem accurately. In addition, students were able to restate the problem using their own words clearly and appropriately. According to Dewi & Saharuddin (2024), students are considered to have reached the understanding stage when they are able to correctly identify what is known and what is being asked in the problem.

However, the difficulties faced by students in understanding mathematical problems, as revealed in this study, include the tendency not to write down complete information from the mathematical problem. Some students also tend to proceed directly to calculations without first organizing the given information, which leads to difficulties in problem solving. This is consistent with Azzahra & Pujiastuti (2020), who also emphasize that some students may understand the problem conceptually but still struggle to initiate the problem-solving process by systematically recording the information provided in the problem.

Planning the Solution

Based on the analysis of data from the research subjects, it was revealed that the average students' ability to design a solution plan for Linear Programming word problems was categorized as fairly good. This indicates that the research subjects were able to understand parts of the given problems, connect the obtained information, and transform the information into a mathematical model. This ability demonstrates that students possess a basic understanding of Linear Programming concepts and are able to apply them in word problem contexts, although not yet at an optimal level. In line with this, research by Zulkarnain & Budiman (2019) shows that conceptual understanding has a positive and significant influence on students' mathematical problem-solving ability.

However, the results also indicate aspects that need improvement, as there are still minor errors in formulating constraint functions and objective functions, which are not fully complete. This finding is supported by Nuryana & Rosyana (2019), who state that students' inability to fully understand the problem leads to errors in determining or constructing solution plans, resulting in answers that are inaccurate and incomplete.

Implementing the Plan

Based on the analysis of data from the research subjects, it was found that the average students' ability to implement the solution plan in Linear Programming word problems was categorized as very poor. This is due to the fact that many students experienced errors in drawing the solution graph, determining the points within the feasible region, and substituting these points into the objective function. Ayuningsih et al. (2020) indicate that contextual and procedural errors are the most frequently made mistakes by students in solving Linear Programming problems. This is further supported by the study conducted by Utami et al. (2022), which states that difficulties in determining the feasible region and corner points are part of the challenges students face in solving Linear Programming problems.

Looking Back

Based on the analysis of data from the research subjects, it was found that the average students' ability to review the solution in Linear Programming word problems was categorized as very poor. This condition is caused by several fundamental issues in students' problem-solving processes and their lack of habit in checking their answers, resulting in final solutions that are often inaccurate. Zulkarnain (2019) states that the ability to review solutions is an important indicator in the mathematics learning process. In addition, Sari et al. (2021) found that students who are not accustomed to rechecking their solutions tend to produce less accurate answers, indicating the need for serious attention in developing this skill. Therefore, it is necessary to build students' awareness and habit of reviewing their solutions to identify errors and improve their overall mathematical problem-solving ability.

Conclusion

Based on the research findings and discussion, it can be concluded that the average mathematical problem-solving ability of students at SMA Muhammadiyah 1 Pontianak in solving Linear Programming word problems based on Polya's stages is still relatively low. This is evident from the incomplete and inaccurate achievement of the problem-solving stages among some students.

In detail, students' ability in the understanding the problem indicator is categorized as very good, as students were able to write down the known and unknown information and relate them systematically. However, in the planning a solution indicator, students' ability is categorized as fairly good, although mathematical models can be constructed, they are still not fully systematic. Furthermore, the implementing the plan and reviewing the solution indicators are both categorized as very poor, indicating that students are not yet able to determine graphs or feasible regions and corner points, compute objective function values, or recheck information and calculations, including drawing appropriate conclusions in line with the problem requirements. It is suggested that teachers provide more practice emphasizing the implementation and review stages, as these two stages represent the main weaknesses of the students.

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