

ANALYSIS OF MATHEMATICAL REASONING ABILITY BASED ON INTROVERTED AND EXTROVERTED PERSONALITY TYPES AMONG TADRIS MATHEMATICS UNDERGRADUATE STUDENTS

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ABSTRAK

Kemampuan penalaran matematis merupakan aspek penting dalam pendidikan matematika, terutama bagi mahasiswa Tadris Matematika yang dipersiapkan sebagai calon pendidik. Salah satu faktor internal yang dapat memengaruhi kemampuan ini adalah tipe kepribadian. Mahasiswa introvert dan ekstrovert memiliki perbedaan dalam cara memproses informasi dan mengambil keputusan, sehingga berpotensi menghasilkan karakteristik penalaran yang berbeda. Penelitian ini bertujuan untuk menganalisis kemampuan penalaran matematis mahasiswa dalam menyelesaikan masalah program linear dengan mempertimbangkan tipe kepribadian introvert dan ekstrovert di Institut Agama Islam Negeri Kerinci. Penelitian ini menggunakan pendekatan kualitatif dengan desain deskriptif. Subjek dipilih menggunakan teknik purposive sampling dan terdiri dari empat mahasiswa Tadris Matematika yang telah diidentifikasi tipe kepribadiannya melalui tes Myers-Briggs Type Indicator (MBTI). Instrumen penelitian meliputi angket kepribadian, tes penalaran matematis, dan pedoman wawancara. Analisis data dilakukan melalui reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa mahasiswa berkepribadian introvert cenderung menunjukkan penalaran yang lebih teliti, mendalam, dan sistematis dalam menyelesaikan masalah. Mereka lebih berhati-hati dalam memilih metode dan menarik kesimpulan. Sebaliknya, mahasiswa berkepribadian ekstrovert cenderung melakukan penalaran dengan lebih cepat dan langsung. Mereka lebih fokus pada hasil akhir, menyajikan jawaban secara ringkas, dan lebih fleksibel dalam memilih strategi penyelesaian masalah, meskipun terkadang kurang memperhatikan detail proses.

Kata kunci: kemampuan penalaran, matematis, tipe kepribadian.

ABSTRACT

Mathematical reasoning ability is an essential aspect of mathematics education, especially for Tadris Mathematics students who are prepared as future educators. One internal factor that may influence this ability is personality type. Introverted and extroverted students differ in the way they process information and make decisions, which may lead to distinct characteristics in their reasoning abilities. This study aims to analyze the mathematical reasoning abilities of students in solving linear programming problems by considering introverted and extroverted personality types at the State Islamic Institute of Kerinci. This research employs a qualitative approach with a descriptive design. The subjects were selected using purposive sampling and consisted of four Tadris Mathematics students whose personality types had been identified through the Myers-Briggs Type Indicator (MBTI) test. The research instruments included a personality questionnaire, a mathematical reasoning test, and interview guidelines. Data analysis was carried out through data reduction, data display, and conclusion drawing. The findings reveal that introverted students tend to demonstrate more thorough, in-depth, and systematic reasoning when solving problems. They are more careful in choosing methods and drawing conclusions. In contrast, extroverted students tend to reason more quickly and directly. They focus more on the final result, present their answers concisely, and are more flexible in selecting problem-solving strategies, although they sometimes pay less attention to process details.

Keywords: reasoning ability, mathematical, personality type.

INTRODUCTION

Mathematical reasoning ability is an essential component in mathematics education, especially for undergraduate students in the Mathematics Education (Tadris Matematika) program who are being prepared to become future educators. Mathematical reasoning refers to the ability to think logically, analyze relationships among mathematical concepts, draw valid conclusions, and justify solutions based on evidence and logical arguments (Zendrato & Mendrofa, 2025). Undergraduate students with strong reasoning tend to be more capable of identifying problems, selecting appropriate strategies, and evaluating the accuracy of their solutions (Molerov et al., 2020). However, studies have shown that many university undergraduate students still struggle with these aspects (Aizpurua et al., 2018). These conditions illustrate that undergraduate students' mathematical reasoning ability is still at an unsatisfactory level, highlighting the need for increased attention and targeted efforts to enhance their reasoning and problem-solving skills.

Currently, undergraduate students' mathematical reasoning ability is considered low. This can be seen from the difficulties they experience when solving problems, particularly in applying mathematical concepts systematically and logically to solve problems and draw conclusions (Marzuki et al., 2021). Many factors contribute to this issue. One major factor is the lack of optimal logical, analytical, and critical thinking processes (Muslimin & Sunardi, 2019). In addition, undergraduate students often have a limited understanding of mathematical concepts, making it difficult for them to generate ideas for solving mathematical problems (Aprilianti & Zanthi, 2022). As a result, the low level of mathematical reasoning ability among undergraduate students is influenced by various factors.

The low level of mathematical reasoning ability, if not addressed promptly, not only hinders the cognitive development of undergraduate students but also has the potential to reduce the overall quality of mathematics learning. Undergraduate students who have weaknesses in reasoning will experience difficulties in understanding mathematical concepts deeply and may be unable to teach mathematical concepts effectively, which will ultimately influence undergraduate students' mathematical understanding (Apriani & Sudiansyah, 2024). Therefore, without proper intervention, future educators may lack the necessary skills to teach mathematics effectively, particularly in topics that require higher levels of reasoning, such as linear programming (Marissa & A, 2024).

Mathematical reasoning ability is also influenced by internal factors, one of which is personality differences. Each undergraduate student possesses unique characteristics such as

appearance, traits, temperament, ways of thinking, and communication styles (Molerov et al., 2020). At the same time, personality differences influence the way undergraduate students process information and construct mathematical reasoning (Sholekhah et al., 2024; Zebua et al., 2024). Therefore, educators must understand undergraduate students' personality (Marissa & A, 2024; Rudianti et al., 2021). Thus, research analyzing mathematical reasoning ability based on personality types is essential (Satya et al., 2022).

Understanding personality types is essential in the learning process because undergraduate students differ in how they receive, process, and respond to information (Marissa & A, 2024). This study focuses on introverted and extroverted personality types, where introverts tend to be reflective and prefer independent learning, while extroverts are more active, communicative, and responsive to learning stimuli (Nisa & Mirawati, 2022). Personality types are also closely linked to mathematical reasoning skills, as introverts typically demonstrate deeper analytical processing, whereas extroverts are more flexible in exploring ideas through social interaction (Sholekhah et al., 2024). Therefore, recognizing personality types enables educators to design more adaptive instructional strategies.

This research is important because a deeper understanding of the relationship between personality types and mathematical reasoning can provide significant contributions to mathematics education. By identifying the characteristics of undergraduate students' reasoning abilities based on their personality types, educators can design more effective teaching methods that align with the needs of each undergraduate student (Mahmuad, 2021). Consequently, the quality of mathematics education in Indonesia can continue to improve, and graduates of the Mathematics Education program can become competent educators, particularly in understanding and enhancing undergraduate students' reasoning abilities by considering their personality types when solving linear programming problems (K. Putri et al., 2018). Therefore, it is essential to examine undergraduate students' mathematical reasoning within specific mathematical topics, one of which is linear programming.

Linear programming is a topic in mathematics that involves solving problems using systems of linear equations or inequalities, aimed at finding optimal solutions among various alternatives. It is a method for determining the optimum (maximum or minimum) value of a linear problem based on a set of solutions (Monariska & Komala, 2021). The results showed that extroverted undergraduate students fulfilled only three indicators of mathematical reasoning, presenting mathematical statements verbally, in writing, with images or graphs, performing mathematical manipulations, and constructing arguments and justifying solutions (Yanty et al., 2025). The novelty of this study lies in its focus on analyzing the

mathematical reasoning abilities of undergraduate students in the Mathematics Education program in solving linear programming problems by considering their introvert and extrovert personality types. Although previous studies have examined mathematical reasoning from various perspectives such as gender, specific mathematical topics, or general cognitive ability, most have focused on reasoning outcomes rather than the actual reasoning process in solving linear programming problems. No research has provided a detailed comparison of how undergraduate students with different personality types understand problems, choose strategies, and justify their solutions. This gap highlights the need for research that not only measures reasoning ability but also describes qualitative differences in undergraduate students' reasoning processes based on their personality types.

This study aims to identify differences in mathematical reasoning characteristics among undergraduate students with different personality types. Additionally, this research seeks to provide insights for lecturers and educators in designing more adaptive teaching strategies tailored to undergraduate students' personality traits. In this way, the findings of this study are expected to contribute to improving the effectiveness of mathematics learning.

METHODOLOGY

This study employed a qualitative approach with a descriptive method because it aims to analyze undergraduate students' reasoning abilities in depth, particularly to understand how introverted and extroverted undergraduate students reason when solving mathematical problems. The subject selection technique used in this study was purposive sampling, where subjects were chosen based on predetermined research criteria. To identify the subjects, the Myers-Briggs Type Indicator (MBTI) test was administered to determine the undergraduate students' personality types. The research subjects were selected from 11 fourth-semester Tadris Mathematics undergraduate students who had enrolled in the Linear Programming course. The selection process followed specific criteria. First, all 11 undergraduate students completed the MBTI test in the form of a personality questionnaire to determine their personality types. Based on the questionnaire results, four undergraduate students were chosen as the research subjects, consisting of two undergraduate students with the highest extroversion scores and two undergraduate students with the highest introversion scores.

The research instruments used in this study included a personality questionnaire, a single mathematical reasoning test item, and an interview guide. The personality questionnaire was employed to identify the undergraduate students' personality types based

on the MBTI test results. The mathematical reasoning test item was specifically designed to assess the undergraduate students' abilities in solving linear programming problems according to defined indicators of mathematical reasoning.

The indicators of mathematical reasoning used in this study refer to those developed by (Mutiah, 2023; Rohmah et al., 2020). which were subsequently modified and validated to suit the context of this research. By combining questionnaires, tests, and interviews, this study aimed to provide a comprehensive understanding of the relationship between personality types and undergraduate students' mathematical reasoning abilities in solving linear programming problems.

The data analysis in this study was carried out using the Miles and Huberman model, which provides a systematic and rigorous framework for analyzing qualitative data. This model consists of three interconnected stages. The first stage, data reduction, involves selecting, simplifying, and organizing the raw data to focus on the most relevant information and than the final stage, conclusion drawing and verification, includes interpreting the displayed data, identifying meaningful findings, and continuously verifying them to ensure their accuracy and credibility (Qomaruddin & Sa'diyah, 2024).

RESULTS AND DISCUSSION

The data for this study were collected through the Myers-Briggs Type Indicator (MBTI) personality questionnaire, which comprised 22 items. Based on the questionnaire results, two undergraduate students with the extrovert personality type and two with the introvert personality type who achieved the highest scores were chosen as research participants. The selected subjects are displayed in the table below. Selecting two undergraduate students with the highest extroverted tendencies and two with the highest introverted tendencies enabled the researcher to clearly compare the characteristics of mathematical reasoning between the two personality types when solving linear programming problems.

Table 1. Research Subjects

Student Code	Category	Subject Code
SM	Ekstrovert	Responden 1
FV	Ekstrovert	Responden 2
SV	Introvert	Responden 3
ZE	Introvert	Responden 4

This study investigates the mathematical reasoning ability of undergraduate students in solving linear programming problems, taking personality type as an independent variable. The personality types in question are introvert and extrovert, which influence how undergraduate students approach and solve mathematical problems, especially in the context of linear programming, which is commonly found in applied mathematics and engineering fields. All of the undergraduate students shared similar educational backgrounds and were at the same stage in their academic studies.

One of the indicators of mathematical reasoning ability analyzed in this study is (the way undergraduate students present mathematical problems in written form). Extroverted undergraduate students tend to find it easier to present problems in a concise and to the point manner, focusing on the most relevant aspects needed to solve the problem. This is reflected in Respondent 1 and Respondent 2, who prefer to formulate problems efficiently and directly address the core of the question, without elaborating too much on detailed technical explanations. For example, Respondent 1, who has an extroverted personality, stated: “I prefer to note only the key points rather than write everything in detail” This attitude reflects the extrovert tendency to engage directly and make quick decisions (Nisa & Mirawati, 2022).

On the other hand, Respondent 3 and Respondent 4, who have introverted personalities, demonstrated a different tendency in presenting mathematical problems. Respondent 3 (introvert) stated: “I feel more comfortable writing in detail because it helps me remember and verify the steps I’ve taken.” This reflective and cautious nature of introverted personalities is evident in how they present problem solutions, prioritizing accuracy and thoroughness over speed and efficiency (Rahayu & Aoyama, 2024; SAHRIZAL, 2024).

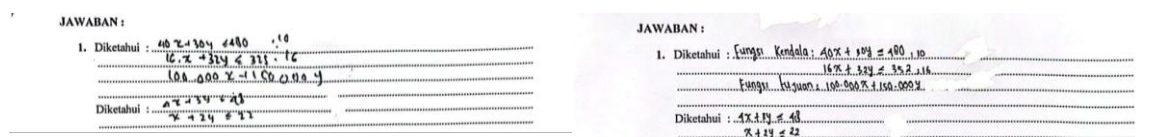


Figure 1. Mathematical Reasoning Test – First Indicator of Extrovert Respondent

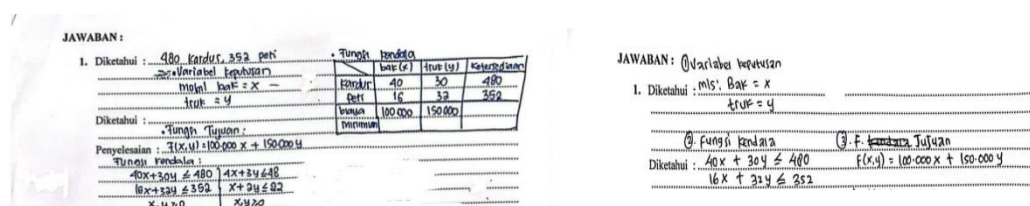


Figure 2. Mathematical Reasoning Test – First Indicator of Introvert Respondent

Based on the analysis of Figure 1 (extroverted respondent) and Figure 2 (introverted respondent), consistent differences can be observed in how both groups present mathematical statements in written form. Overall, this indicator evaluates aspects such as the level of detail in writing, the sequence of steps, the use of mathematical notation, and the clarity of explanations accompanying equations or graphs. The differences identified indicate that personality type influences undergraduate students' written representational styles when expressing mathematical (Rihyanti, 2023).

In Figure 1, which represents the extroverted respondents, it can be seen that undergraduate students tend to present mathematical statements in a more concise manner and get straight to the core of the problem. Extroverted respondents prefer to solve problems quickly and efficiently, without providing much additional explanation that is not directly related to the solution steps. The extroverted personality, which is more result-oriented and sometimes pays less attention to lengthy explanations, is reflected in the way they solve problems directly, with minimal elaboration. This is in line with the theory that extroverts tend to complete tasks more openly and are less detailed in providing explanations (Subtinanda & Yuliana, 2023).

On the other hand, in Figure 2, which illustrates the introverted respondents, undergraduate students with this personality type show a tendency to present mathematical statements in a more detailed and complex manner. They are more likely to explain each step thoroughly and demonstrate a deep understanding of the concepts used to solve the problem. Introverted respondents usually provide more structured and in-depth explanations, incorporating more cautious analytical thinking, and often describe the problem-solving process with detailed, step-by-step reasoning. They are more comfortable with introspective thinking, paying close attention to every detail and considering solutions from multiple perspectives. Research by Putri & Masriyah (2020)

This difference confirms that personality type influences the way undergraduate students solve mathematical problems, particularly in linear programming tasks (Ana & Munawir, 2024). Extroverts tend to approach problems in a more direct and efficient manner, while introverts provide more in-depth and detailed explanations of their solution steps. The next analysis focuses on the second indicator, namely (performing calculations based on specific rules or formulas), as illustrated in Figures 3 and 4.

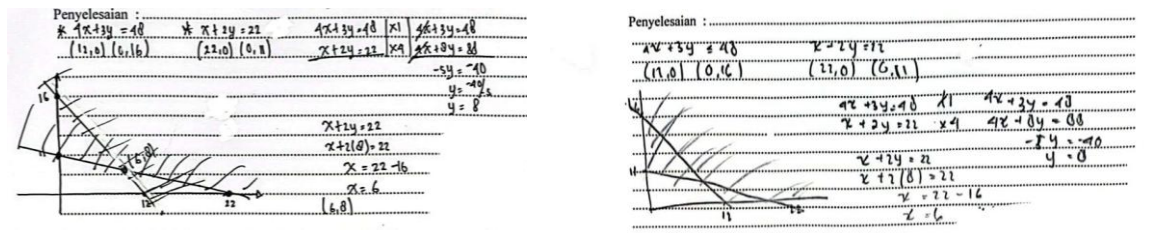


Figure 3. Mathematical Reasoning Test for the Second Indicator – Extrovert Respondent

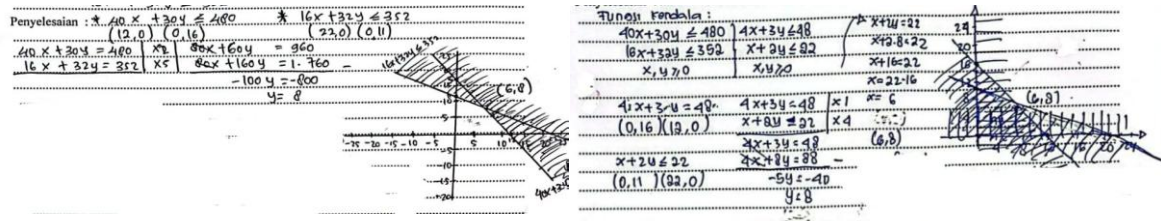


Figure 4. Mathematical Reasoning Test for the Second Indicator – Introvert Respondent

Based on the analysis of Figure 3, which represents the extroverted respondents, it can be observed that undergraduate students with extroverted tendencies perform calculations using specific rules or formulas in a more concise and direct manner. They are able to quickly identify the relevant method or formula and immediately apply it to solve linear programming problems. The primary focus of extroverted respondents is to achieve the final solution efficiently, resulting in a more streamlined calculation process. This aligns with findings that suggest extroverts tend to solve mathematical problems more quickly and pragmatically, often without involving deeper analytical steps (Laksana et al., 2020).

In Figure 4, which depicts the introverted respondents, a much more structured and in-depth calculation pattern is observed. Undergraduate students with introverted personality types are more meticulous in determining the formulas or methods to be used before performing calculations. They not only select the appropriate formulas but also provide detailed explanations regarding the rationale for choosing the formulas, the connection of the formulas to the problem context, and how the formulas are applied at each stage of the solution. This indicates that individuals with introverted personalities are more likely to analyze problems more carefully and offer longer, more complex explanations for each step of their problem-solving process.

When facing linear programming problems that require the application of specific formulas or rules, both extroverted and introverted undergraduate students demonstrate excellent ability in applying their knowledge. Extroverted undergraduate students, such as Respondent 1 and Respondent 2, will use, and they are not hesitant to try various approaches to solve the problem. Respondent 1 stated: "If a method I choose doesn't work smoothly, I immediately switch to another method or use software to help simplify the calculations."

In contrast, introverted undergraduate students like Respondent 3 and Respondent 4 tend to approach calculations more carefully and thoroughly. They ensure that every step taken in the calculation follows the applicable rules or formulas, and if there is an error, they will meticulously review their calculation process. Respondent 4 explained: "I tend to double-check every step and formula I use to avoid making mistakes."

This contrast indicates that personality type significantly influences how undergraduate students determine the appropriate method for solving mathematical problems and how they perform mathematical calculations based on specific rules or formulas (Murphy et al., 2020). Extroverts tend to choose more direct and efficient methods, while introverts delve deeper and elaborate on each step with careful calculation and analysis. The next analysis, concerning the third indicator (Ability to perform mathematical manipulation) and the fourth indicator (Ability to draw logical conclusions), is illustrated in Figures 5 and 6.

Handwritten mathematical reasoning for an extroverted student. The student defines a function $f(x,y) = 100.000x + 150.000y$. They list points $(0,11)$, $(12,0)$, and $(6,8)$ and calculate their values: $f(0,11) = 1.650.000$, $f(12,0) = 1.200.000$, and $f(6,8) = 1.800.000$. They conclude that the minimum cost is 1.200.000.

Figure 5. Mathematical Reasoning Test for the Third and Fourth Indicators – Extrovert

Handwritten mathematical reasoning for an introverted student. The student defines a function $f(x,y) = 100.000x + 150.000y$. They list points $(0,11)$, $(12,0)$, and $(6,8)$ and calculate their values: $f(0,11) = 1.650.000$, $f(12,0) = 1.200.000$, and $f(6,8) = 1.800.000$. They conclude that the minimum cost is 1.200.000.

Figure 6. Mathematical Reasoning Test for the Third and Fourth Indicators – Introvert

In Figure 5, which illustrates the extroverted respondents, undergraduate students tend to provide brief answers that go straight to the core of the problem. When performing mathematical manipulations, they quickly determine the appropriate formula or method for the problem at hand, prioritizing efficiency. However, although these respondents successfully solve the problem correctly, they make mistakes in drawing conclusions. Extroverts tend to be more pragmatic and efficient in solving mathematical problems, resulting in simpler mathematical manipulations that do not involve much detailed discussion. Research by Ana & Munawir (2024) suggests that extroverted students are more results-oriented and focused on problem-solving efficiency, which is reflected in the way they manipulate mathematical formulas.

On the other hand, in Figure 6, which depicts the introverted respondents, undergraduate students are more detailed and complex in their mathematical manipulation process. They not only determine the most appropriate formula or method, but also provide detailed explanations for each step they take. In this context, introverted students are more cautious and tend to conduct in-depth analyses before deciding on the appropriate method or formula, based on observations that they consistently demonstrate a careful and systematic approach when solving mathematical problems. This behavior aligns with research indicating that introverted individuals are more reflective and analytical in their problem-solving strategies, often engaging in deep reasoning before taking action (Yanty et al., 2025). They often discuss various alternatives and consider smaller details in the problem-solving process. This reflects their ability to handle mathematical manipulations with greater precision and complexity. Introverted individuals prefer to analyze and understand problems thoroughly before making decisions, which is reflected in the way they handle mathematical problems with more detail and complexity (Sari & Kurniasari, 2022).

Mathematical manipulation in solving linear programming problems, such as variable substitution or the use of specific methods like the Simplex Method, also provides an interesting insight into the differences between extroverted and introverted students. Extroverted undergraduate students tend to be more willing to take risks in trying new approaches or changing steps they have already outlined if the initial method they selected does not work. Respondent 1 stated, "If I feel the path I've chosen is wrong, I'm not hesitant to try another approach or use software to tackle the problem." This flexible approach demonstrates that extroverted undergraduate students are more open to experimentation and open discussions in seeking more effective solutions (Rudianti et al., 2021).

Meanwhile, introverted undergraduate students like Respondent 3 are more cautious in this regard. Respondent 4 expressed, "I tend to evaluate the steps I take to ensure there are no mistakes before moving on to another method."

In terms of evaluating results and drawing conclusions, respondents with extroverted personalities (Respondent 1 and Respondent 2) are more likely to draw quick conclusions and move on to the next problem. Respondent 1 revealed that they usually feel satisfied with the solution obtained within a relatively short time. "Once I find the answer, I immediately feel confident and don't feel the need to check it too much," said Respondent 1. This suggests that extroverts tend to rely on intuition and make decisions quickly (Apriliyani et al., 2025). Respondent 2 also expressed a similar sentiment, stating that they feel more comfortable with conclusions drawn quickly without needing much revision.

Meanwhile, respondents with introverted personalities (Respondent 3 and Respondent 4) are more cautious in drawing conclusions. Respondent 3 stated that they often revisit the steps taken and verify the results to ensure their accuracy. "I feel more confident when I have checked all the steps and calculations again. It makes me more confident with the solution I have found," said Respondent 3. This reflects the introverted tendency for deeper thinking and greater caution when drawing conclusions (Fiqhiyah et al., 2022). Respondent 4 also expressed that they more frequently recheck each step and compare the results with alternative solutions to ensure that the conclusion drawn is the most accurate.

This difference suggests that the distinct thinking styles of undergraduate students with introverted and extroverted personalities influence how they solve mathematical problems (Ana & Munawir, 2024). Extroverts tend to be more efficient and quick in solving problems, but are less detailed in explaining the steps and methods they choose. In contrast, introverts are more thorough, meticulous, and complex in selecting methods and drawing logical conclusions, as well as more detailed in explaining the steps taken to solve problems. The implications of this study suggest that mathematics instruction should take into account undergraduate students personality types introverted and extroverted to enhance learning effectiveness. Extroverted undergraduate students tend to quickly determine solutions and therefore benefit from activities that challenge critical thinking and collaborative skills. Conversely, introverted students are more cautious and analytical, benefiting from reflection time, detailed explanations, and structured practice. By tailoring teaching strategies according to personality types, educators can improve student engagement, conceptual understanding, and overall mathematical reasoning abilities.

CONCLUSION

The findings of this study indicate a significant difference in mathematical reasoning abilities between extroverted and introverted undergraduate students when solving linear programming problems. They demonstrate greater flexibility in selecting problem-solving approaches and are more likely to utilize software tools or adopt new strategies when their initial method proves ineffective. In contrast, introverted undergraduate students approach problem-solving in a more meticulous and systematic manner. Carefully evaluating each step before proceeding to the next. Their reasoning process is more structured and in-depth, as they prioritize accuracy and completeness in every stage of the solution.

RECOMMENDATION

Based on these findings, the author recommends that future research further explore other factors that may influence undergraduate students mathematical reasoning abilities, such as learning styles, levels of mathematics anxiety, or the use of metacognitive strategies. In line with these recommendations, mathematics lecturers or teachers are also advised to pay attention to undergraduate students personality differences both introverted and extroverted when teaching, as each personality type has distinct learning preferences. Whereas introverted students tend to focus more effectively when given time for independent thinking, individual tasks, and reflection.

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