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# Students' Errors in Solving Mathematical Statistics Problems Based on Sensing and Intuiting Personality Types

**Syarifa Anggraini[1*], Eline Yanty Putri Nasution[2]**
[1*,2]Program Studi Tadris Matematika, Institut Agama Islam Negeri (IAIN) Kerinci
Jalan Kapten Muradi Desa Sumur Gedang, Kec. Pesisir Bukit, Kota Sungai Penuh, Indonesia
[1*]syarifaanggraini680@gmail.com; [2]mamarumus@gmail.com

**ABSTRAK**

Kesalahan mahasiswa dalam menyelesaikan soal statistika matematika menjadi salah satu indikator rendahnya pemahaman konsep statistik di perguruan tinggi. Penelitian ini difokuskan pada analisis pola kesalahan yang dilakukan oleh mahasiswa saat mengerjakan soal statistika matematika, dengan mempertimbangkan tipe kepribadian sensing dan intuiting. Dalam studi kasus ini, sebanyak 36 siswa dengan tipe kepribadian sensing dan intuiting turut serta sebagai partisipan. Instrumen penelitian mencakup tes kepribadian MBTI (Myers-Briggs Type Indicator), tes kemampuan statistika, pedoman wawancara semi-terstruktur, dan lembar observasi. Data dianalisis melalui kondensasi data, penyajian data, dan penarikan Kesimpulan secara interaktif. Temuan penelitian mengungkapkan bahwa mahasiswa dengan tipe kepribadian sensing lebih sering melakukan kesalahan pada tahap transformasi dan encoding, sedangkan tipe intuiting lebih sering salah dalam keterampilan proses dan encoding. Temuan ini mengindikasikan bahwa tipe sensing kesulitan mengubah informasi verbal menjadi model matematika, sementara intuiting kurang sistematis dalam penyelesaian dan penyajian jawaban. Dengan demikian, pola kesalahan mahasiswa dalam mengerjakan soal statistika matematika dipengaruhi oleh tipe kepribadian mereka.

**Kata Kunci**: Analisis Kesalahan Mahasiswa; Menyelesaikan Masalah; Statistika Matematika; Tipe Kepribadian Intuiting; Tipe Kepribadian Sensing

**ABSTRACT**

Student errors in solving mathematical statistics problems are one indicator of the low level of conceptual understanding of statistics in higher education. This study focuses on analysing the patterns of errors made by students when working on mathematical statistics problems, taking into account their sensing and intuitive personality types. In this case study, as many as 36 students with sensing and intuiting personality types participated as participants. The research instruments included the MBTI (Myers-Briggs Type Indicator) personality test, a statistics ability test, semi-structured interview guidelines, and observation sheets. The data were analysed through data condensation, data display, and interactive conclusion drawing. The findings of the study revealed that students with sensing personality types are more likely to make mistakes at the transformation and encoding stages, while intuiting types more frequently made errors in process skills and encoding. These findings suggest that sensing types struggle to convert verbal information into mathematical models, while intuiting types are less systematic in their problem-solving procedures and in presenting final answers. Thus, the pattern of students' mistakes in doing mathematical statistics problems is influenced by their personality type.

**Keywords**: Student Error Analysis; Problem Solving; Mathematical Statistics; Intuiting Personality Type; Sensing Personality Type

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## 1. INTRODUCTION

Mathematical statistics is a core course in mathematics programs that integrates statistical concepts with advanced mathematical approaches (Syarifah, 2017; Sriwahyuni & Maryati, 2022). According to research by Ali and Murni (2022), more than 65% of students struggle to understand and solve mathematical statistics problems, particularly in topics such as probability distributions and statistical inference. Supporting this finding, a study by Afnenda et al. (2023) revealed that difficulties in mathematical statistics are often linked to how students process and analyze information, which is significantly influenced by their personality types. This phenomenon highlights a gap between current teaching methods and the diverse cognitive characteristics of students.

Based on the 2022 PISA results, Indonesian students' math skills remain concerning, ranking 65th out of 81 countries with an average score of 372, far below the OECD average of 472 (Hapsoh & Sofyan, 2022; OECD, 2023). Further analysis revealed a score of only 355 in statistics and probability components—among the lowest in mathematics domains (Khotimah, Hadi, & Lestari, 2024; Angriani et al., 2024). Similarly, TIMSS 2023 ranked Indonesia 44th out of 58 countries in statistical and data analysis, with a score of 420, below the international benchmark of 500 (Arnandi et al., 2023; IEA, 2024). Research by Maysani and Pujiastuti (2020) found that 72% of first-year students from 15 universities faced major difficulties in mathematical statistics, particularly in probability distributions (68%), statistical inference (75%), and regression (70%). A national survey by Kemendikbudristek (2021) involving 5,000 students reported average grades in the C range ($60 - 69$). Feronika et al. (2023) noted that common errors included conceptual (45%), procedural (35%), and interpretation (20%) mistakes. A longitudinal study by Istifadah et al. (2024) confirmed that such difficulties hinder advanced learning and research abilities. Sari and Lutfi (2024) also found that 65% of students experienced anxiety in mathematical statistics, strongly correlating with low performance. This underscores the urgent need to address issues in university-level statistics education in Indonesia.

Personality types, particularly the sensing and intuiting dimensions of the MBTI theory, play a key role in how students comprehend and solve mathematical problems (Sugianto, Darmayanti, & Vidyastuti, 2022). Purwanto and Putra (2024) found that Sensing-type students tend to process information systematically using concrete examples, while Intuiting-type students are more adept at identifying abstract patterns. However, Megawati et al. (2021) reported that a mismatch between teaching methods and personality types could reduce conceptual understanding by up to 40% in mathematical statistics. Nainggolan et al. (2022) observed that sensing students often struggle with abstraction and generalization, whereas Intuiting students tend to overlook important procedural steps. These patterns are further

supported by Feronika et al. (2023), who emphasized that such errors can hinder students' mastery of advanced concepts and their application of statistical methods in real contexts.

If these error patterns are not properly addressed, their impact can extend to various aspects of advanced mathematics learning. Research by Amdar et al. (2023) found that students who experience persistent difficulties in mathematical statistics show a significant decline in academic performance in related courses, with a failure rate reaching 45%. Furthermore, a study by Andrianingsih et al. (2024) revealed that difficulties in mathematical statistics can hinder students' development of research and data analysis skills competencies which are crucial in the digital era.

The proposed solution to address this issue is to research to analyze students' errors in solving mathematical statistics problems. This study aims to offer an in-depth insight into students' error patterns in mathematical statistics according to their Sensing and Intuiting personality types.

This research is important to address the existing gap in studies related to personality-based learning. According to Nurkhaningsih and Purwanto (2022), understanding students' error patterns based on personality types can serve as a foundation for more effective instructional strategies. Puranamasari et al. (2023) emphasized that strong mathematical statistics skills are essential in the era of big data, where statistical analysis is a key competency. Sameli et al. (2022) also highlighted that enhancing teaching methods in statistics can improve graduates' competitiveness in the global workforce. Wahyudi et al. (2018) noted a paradigm shift in higher mathematics education toward personalized learning aligned with students' individual traits. Supporting this, Muliasari and Efendi (2023) reported increasing demand for adaptive learning, especially in the context of online and hybrid education. While Arlinanda et al. (2025) found a significant correlation between MBTI personality types and statistical performance among 300 students, their study focused on overall learning outcomes rather than specific error patterns in problem-solving.

This study also makes a meaningful contribution to the advancement of mathematics education. According to Faradilla et al. (2024), analyzing students' errors based on personality types can provide valuable insights for developing more effective curricula and teaching materials. Furthermore, Nurkhaningsih and Purwanto (2022) emphasized the importance of empirical data on the relationship between personality types and mathematical error patterns in the development of AI-based adaptive learning systems.

This study uses VOSviewer and Publish or Perish (with data from Scopus, Crossref, and Google Scholar, 2015-2025) to conduct a bibliometric analysis on student error analysis in mathematical statistics based on personality types (Xu et al., 2022; Radević & Milovanović, 2024; Thi-Nga, Thi-Binh, & Nguyen, 2024). Using keywords like student error analysis, problem solving,

and sensing/intuiting personality types, the visualization reveals three main clusters: (1) mathematical error analysis, (2) MBTI personality studies, and (3) mathematics statistics learning. Node size indicates keyword frequency, while line thickness shows the strength of inter-concept relationships. The VOSviewer results can be seen in Figure 1 below.

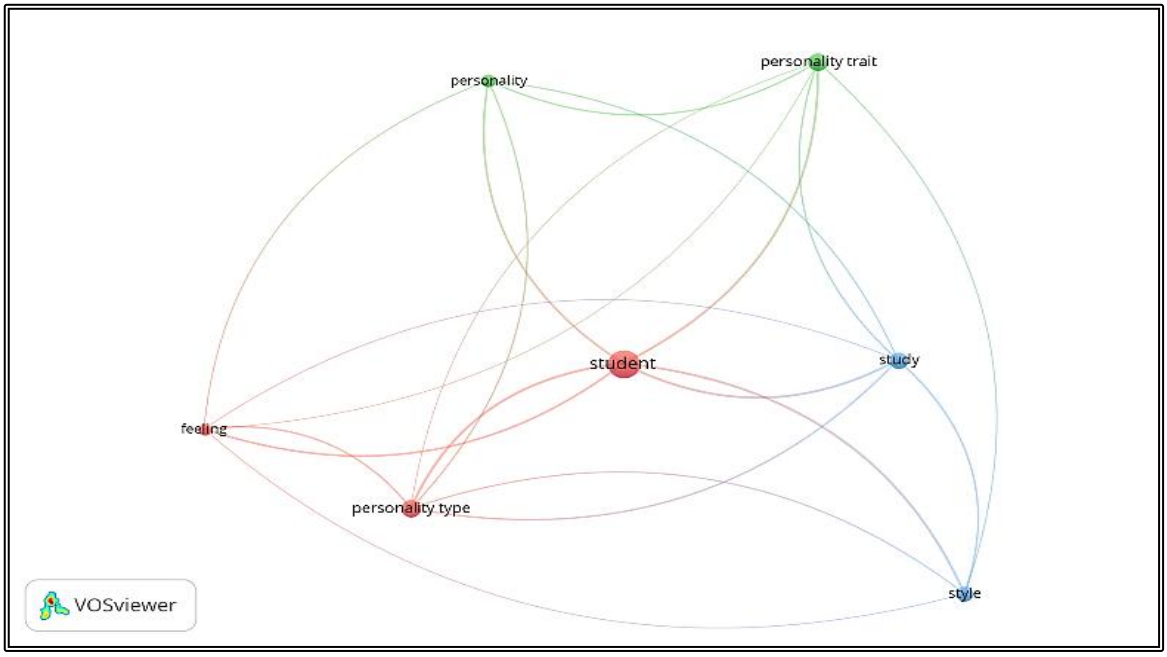


Figure 1. VOSviewer Results

Based on the VOSviewer mapping analysis, the novelty of this study lies in identifying a research gap between MBTI personality types and mathematical error analysis in statistical learning. Unlike most prior studies that focus on isolated clusters, this study connects all three: personality types, error patterns, and statistical learning. It also highlights the lack of research on the Sensing – Intuiting dimension's role in error patterns among Indonesian university students. The findings suggest that integrating cognitive traits with error analysis remains underexplored, offering new insights for more personalized learning strategies.

This research is based on several fundamental study questions: (1) How do the error patterns exhibited by students with a Sensing personality category when addressing mathematical statistics questions? (2) What are the error patterns exhibited by students with an Intuiting personality type when working on mathematical statistics problems? (3) How do the distinguishing characteristics of errors differ between these two personality types?

## 2. METHOD

This research utilizes a qualitative methodology combined with a case study framework to conduct an in-depth exploration of learners' patterns in solving mathematical statistics issues related to the Sensing and Intuiting personality types. According to Muhajirin et al. (2024),

a qualitative approach is highly suitable for exploring and understanding phenomena in depth, particularly when the research aims to uncover individual thought processes and experiences.

The study population includes 36 students registered in the Mathematical Statistics course within the Mathematics Study Program at IAIN Kerinci. The subjects of the study were students enrolled in the Mathematical Statistics course, with a total population of 36 students. This study employs the validated MBTI (Myers-Briggs Type Indicator) test, as established by (Mukhlis et al., 2021), with a Cronbach' s Alpha reliability of 0.87. The choice of research respondents was conducted employing purposive sampling, considering students with comparable academic abilities based on their GPA and prerequisite course grades. Consequently, two learners possessing the Sensing personality category and two learners exhibiting the Intuiting personality category were selected based on their MBTI test results (Vrasetya & Nasution, 2024). Purposive sampling is a non-random sampling technique where researchers select subjects according to particular traits pertinent to the study goals, ensuring that the selected participants provide precise information related to the studied case (Faradilla et al., 2024).

This study analyzes students' errors in solving mathematical statistics problems based on the Sensing-Intuiting personality types, referring to Newman's Error Taxonomy. The version of Newman's Error Taxonomy used in this research is an adaptation developed by (Dewi & Kartini, 2021), which categorizes mathematical errors into five indicators: reading errors, comprehension errors, transformation errors, process skills errors, and encoding errors. These indicators are presented in Table 1 below:

Table 1. Indicators of Mathematical Errors Based on Newman's Error Taxonomy

| Newman's Error | Error Indicators |
|---|---|
| Reading Error (RE) | • Lack of accuracy<br>• Students have difficulty interpreting or identifying symbols within the problem<br>• Students are unable to understand the meaning of words, terms, or symbols presented in the problem. |
| Comprehension Error (CE) | • Learners are incapable to fully understand the given information<br>• Students are unable to fully understand what is being asked |
| Transformation Error (TE) | • Students fail to construct a mathematical model based on the given information<br>• Students incorrectly transform the given information into a mathematical model |

| Newman's Error | Error Indicators |
|---|---|
| Process Skills Error (PSE) | • Calculation mistakes<br>• Students fail to execute the necessary procedures or steps to solve the problems<br>• Carelessness in calculation processes |
| Encoding Error (ER) | • Writing notations (negative signs, symbols, equal signs, etc.) incorrectly<br>• Failing to include variables/units<br>• Incorrect use of units<br>• Failing to write conclusions |

The characteristics of the Sensing-Intuiting personality types are based on the MBTI theory developed by the Myers & Briggs Foundation and have been validated in the context of mathematics learning by (Suwarno et al., 2024). The indicators of the Sensing and Intuiting personality types are presented in Table 2 below:

Table 2. Indicators of Sensing and Intuiting Personality Types

| Personality Type | Indicator |
|---|---|
| Sensing | 1. Focus on concrete facts |
| | 2. Preference for standard procedures |
| | 3. Attention to detail |
| | 4. Sequential approach |
| Intuiting | 1. Focus on patterns and relationships |
| | 2. Preference for innovation |
| | 3. Attention to the big picture |
| | 4. Holistic approach |

The research instruments in this qualitative study consist of core instruments and supporting instruments. The primary tool in this research is the researcher themselves, serving simultaneously as both the instrument and the data collector, aligning with the nature of qualitative research (Nasution, 2018). Meanwhile, the supporting instruments in this study include the MBTI questionnaire, a mathematical statistics competency test, a semi-structured interview guide, and an observation sheet. The test consists of five mathematical statistics problems that have been validated by three experts in mathematics education, with an average content validity score of 0.85 (highly valid) using Aiken' s V formula, and an inter-rater reliability score of 0.83 using Fleiss' Kappa. The interview guide, which consists of 15 main questions, has been validated by two experts in qualitative research methodology, with a validity score of 0.88 using the Content Validity Ratio (CVR). The observation sheet, covering 20 observation aspects, has been validated with a score of 0.82 and an inter-observer reliability score of 0.85 using Cohen' s Kappa.

Data analysis follows the interactive model proposed by (Sukmawati et al., 2020), which consists onsisting of three phases: data reduction, data presentation, and drawing conclusions. At the stage of condensing the data, interview results are transcribed, observation data are categorized, and test responses are analyzed to identify error patterns. This process produces initial coding, which is then organized into broader categories. During the data display stage, findings are presented in the form of matrices, diagrams, and descriptive narratives to facilitate the analysis of patterns and relationships. The conclusion drawing stage involves an in-depth interpretation of the identified patterns and verification through data triangulation from multiple sources. To ensure research credibility, method triangulation (comparing data from tests, interviews, and observations), source triangulation (comparing perspectives from different respondents), and member checking (confirming interpretations with respondents) are conducted. Research dependability is maintained through an audit trail that documents the entire data collection and analysis process, while confirmability is ensured through researcher reflexivity and peer debriefing with other research team members. Each error category is assigned a score ranging from 0 to 4, then converted into a percentage to determine its category.

Table 3. Categories of Errors in Solving Mathematical Problems

| Error Percentage | Category |
|---|---|
| 81%-100% | Very Low |
| 61%-80% | Low |
| 41%-60% | Moderate |
| 21%-40% | High |
| 0%-20% | Very High |

## 3. RESULT AND DISCUSSION

### a. Research Results

1) MBTI Personality Test Results

The first stage of data collection involved administering the MBTI personality test to 36 students to identify research subjects with Sensing and Intuiting personality types. The test consisted of 26 objective questions, each with two answer choices (a and b), and 24 word-selection questions, where participants chose the most appealing word from two available options. These word-selection questions were specifically designed to correspond to the traits of students with Sensing and Intuiting personality types.

According to the findings of the personality assessment conducted on 36 students, the data are shown in Table 4.

Table 4. Student Personality Test Results

| Personality | Total | Percentage |
|---|---|---|
| Sensing | 28 | 77,78% |

| Personality | Total | Percentage |
|---|---|---|
| Intuiting | 8 | 22,22% |
| Total | 36 | 100% |

The MBTI questionnaire was coded and conducted using purposive sampling. The analysis results indicated that among the 36 students who participated in the questionnaire, the majority had the Sensing personality type compared to the Intuiting. Based on these results, four students were selected as research subjects for further study, consisting of two learners exhibiting the Sensing personality category and two learners exhibiting the Intuiting personality category.

2) The test outcomes on students' error evaluation in mathematical statistics.

Table 5. Recapitulation of Student Error Scores Based on Newman's Theory

| Personality Type | Quest No. | RE | CE | TE | PSE | ER |
|---|---|---|---|---|---|---|
| Sensing | 1 | 4 | 2 | 2 | 1 | 1 |
| | 2 | 3 | 3 | 3 | 3 | 2 |
| Average | | 3.50 | 2.50 | 2.50 | 2.00 | 1.50 |
| Category | | Low (87.5%) | Moderate (62.5%) | Moderate (62.5%) | Moderate (50%) | High (37.5%) |
| Intuiting | 1 | 3 | 2 | 2 | 1 | 1 |
| | 2 | 4 | 3 | 3 | 2 | 2 |
| Average | | 3.50 | 2.50 | 2.50 | 1.50 | 1.50 |
| Category | | Low (87.5%) | Moderate (62.5%) | Moderate (62.5%) | High (37.5%) | High (37.5%) |
| Combined | | 3.50 | 2.50 | 2.50 | 1.75 | 1.50 |
| Category | | Low (87.5%) | Moderate (62.5%) | Moderate (62.5%) | High (43.75%) | High (37.5%) |

Based on Table 5, in terms of reading errors, both Sensing and Intuiting students demonstrated strong performance with an identical average score of 3.50 (87.5%), categorized as low error. This suggests that students from both personality types were generally capable of identifying and understanding the given information, though not at a perfect level. For comprehension errors, both groups also achieved an equal average score of 2.50 (62.5%), falling into the moderate error category. These results indicate that Sensing and Intuiting students encountered a similar level of difficulty in interpreting the meaning of questions and grasping essential information, despite their different cognitive orientations.

In transformation errors, the performance was once again equal, with both personality types scoring an average of 2.50 (62.5%), indicating moderate levels of difficulty in converting verbal problems into appropriate mathematical models. However, differences

emerged in the process skill component: Sensing students had a slightly higher average (2.00 or 50%, moderate error), while Intuiting students scored lower (1.50 or 37.5%, high error), suggesting better procedural consistency among Sensing individuals. In encoding errors, both types recorded the same score of 1.50 (37.5%), categorized as high error, which reflects challenges in expressing final answers clearly and accurately. Overall, both personality types exhibited similar error patterns, but Sensing students showed a slight advantage in executing procedures.

## b. Discussion

The outcomes of the error evaluation of students in solving mathematical statistics problems can be seen below:

1) Sensing Student (SS)

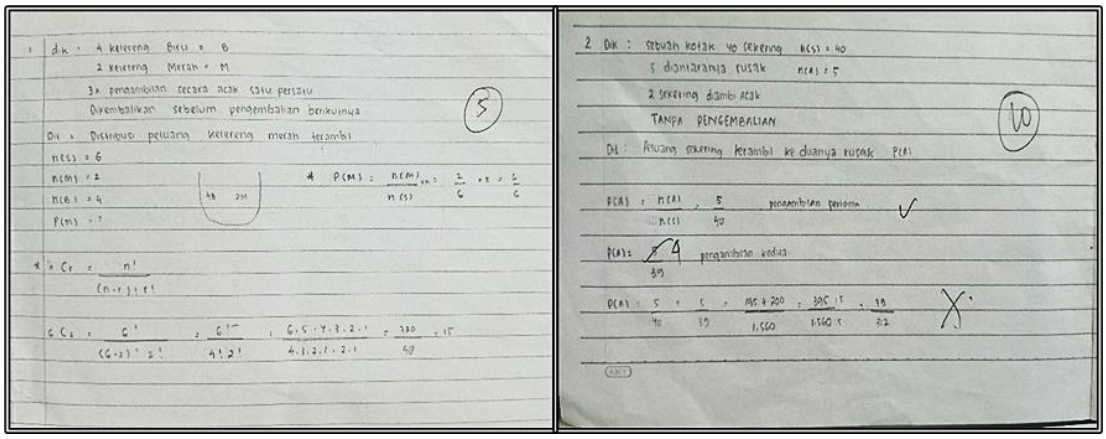

Figure 2. Answers to Questions 1 and 2 by SS

Based on SS' s responses, no reading errors were found. The student was able to identify and understand the information presented in the problems accurately, such as the total number of marbles or fuses and the applicable selection rules (with or without replacement). This is consistent with the characteristics of Sensing-type individuals who tend to be detail-oriented and careful in processing factual information (Purwanto & Putra, 2024; Suwarno et al., 2024).

SS understood that the probability of an event is calculated by comparing the number of successful outcomes to the total possible outcomes. In the first problem, the student correctly identified the number of red and blue marbles and calculated their probabilities. Similarly, in the second problem, the student recognized that the total number of fuses decreases after the first draw. However, a slight misunderstanding occurred in determining when to add or multiply probabilities for combined events. These findings align with those of (Afnenda et al., 2023), who found that students frequently experience misconceptions regarding compound probabilities, especially in determining the appropriate rules based on

event dependency. Similar misconceptions were also reported by (Haerudin & Nur, 2020), who observed that students often confuse the use of basic probability rules when faced with multi-step problems.

A transformation error occurs when a student fails to convert problem information into a correct mathematical model. In SS' s responses, such errors were evident in both problems. In the first problem, although SS correctly applied the probability formula, a mistake was made in combining the probabilities across three draws, which indicates a misunderstanding of how to model the sequence of events mathematically. In the second problem, SS accurately calculated the probability of drawing a defective fuse on the first draw $\frac{5}{40}$, but inconsistently applied the concept of conditional probability when calculating the probability for the second draw. This difficulty in converting verbal problems into correct mathematical models is in line with the findings of (Nainggolan et al., 2022), who reported that Sensing students tend to struggle with abstract generalizations and often face challenges when constructing appropriate mathematical representations of verbal or contextual information.

SS made mistakes in applying mathematical operations during the final calculations, such as in the first problem, SS incorrectly added the probabilities for the three draws of red marbles when they should have been multiplied since the events are independent. In the second problem, the student correctly identified the probability of drawing defective fuses but failed to apply the multiplication rule for sequential events correctly. These types of errors have been noted by (Feronika et al., 2023), who emphasized that inaccuracies in process skills often stem from weak conceptual foundations and limited experience with problem-solving strategies.

SS' s final answers were not aligned with the correct calculations. This error resulted from mistakes in previous steps rather than carelessness in writing the final answer. This is consistent with the conclusion of (Juliana et al., 2025), who argued that encoding errors often arise as the culmination of misunderstandings occurring in earlier stages of problem-solving. (Feronika et al., 2023) also observed that the clarity and accuracy of students' final answers are closely tied to their ability to correctly execute prior stages, especially transformation and process skills.

2) Intuiting Student (IS)

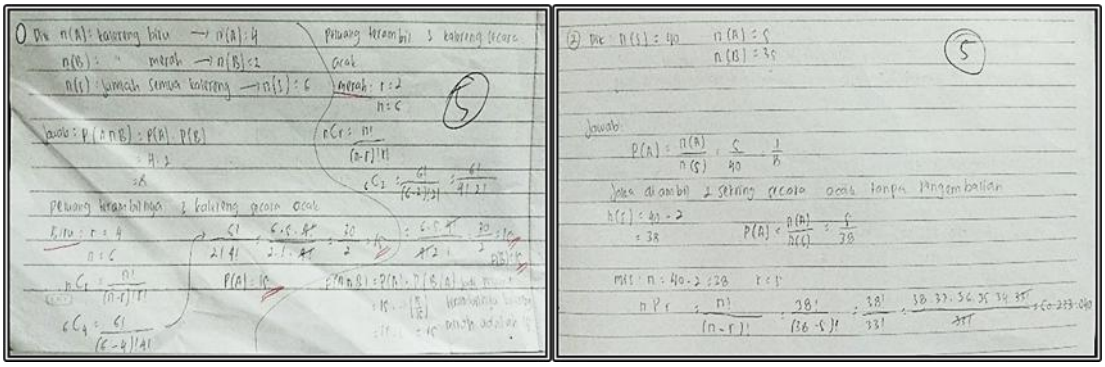

Figure 3. Answers to Questions 1 and 2 by IS

No reading errors were found in the student's answers. The student correctly understood the information provided in the problem, including the total number of objects used in probability calculations. There was no indication of miscopying or misinterpreting the given numerical data. This supports the general view that Intuiting-type students, while more abstract in their reasoning, are still capable of recognizing and utilizing surface-level information when clearly presented (Suwarno et al., 2024).

The student demonstrated a lack of understanding of probability concepts in cases of selection without replacement. In some calculation steps, the student did not adjust the total number of elements after one was drawn, leading to inaccurate results. This indicates that the student has not fully grasped that in sampling without replacement, the probability of the second event depends on the change in population size. (Afnenda et al., 2023) identified similar difficulties among students who did not differentiate between independent and dependent events when solving probability problems. Furthermore, (Haerudin & Nur, 2020) found that errors in this area often stem from misconceptions regarding how event sequences affect probability outcomes.

These errors occurred when the student incorrectly selected and applied formulas to solve the problem. In the provided answer, the student assumed that each event was independent, whereas conditional probability should have been applied in this case. The incorrect choice of formula resulted in errors in the final calculations. This type of transformation error is consistent with research by (Nainggolan et al., 2022), which found that Intuiting students often struggle with translating verbal information into accurate mathematical representations. (Feronika et al., 2023) also noted that such students tend to overlook procedural structures, leading to model-building inconsistencies.

During calculations, the student was not systematic in using combination and factorial operations. Some calculation steps were too lengthy and inefficient, increasing the likelihood of computational errors. Additionally, in certain parts of the calculations, the

student did not simplify factorials properly, making the solution process more complex than necessary. If approached more systematically and efficiently, the solution could be obtained more easily and accurately. These findings are similar to those of (Juliana et al., 2025), who emphasized that unsystematic working procedures often result in miscalculations. (Feronika et al., 2023) also concluded that lack of procedural fluency contributes significantly to student error rates in solving statistical problems.

The presentation of the answer was unclear and lacked systematic organization, potentially confusing the reader or examiner. Some calculation steps were not sufficiently explained, making it difficult to follow the student's thought process. Additionally, some parts of the answer were untidy and did not follow an ideal problem-solving structure. This issue can be addressed by providing more detailed explanations for each step and organizing the answer in a clearer and more structured manner. This supports the conclusion of (Feronika et al., 2023), who found that unclear solution presentation is often a direct result of earlier transformation and procedural errors. (Juliana et al., 2025) further emphasized that encoding problems typically stem from conceptual and process misunderstandings, rather than mere writing issues.

## 4. CONCLUSION

This study concludes that students with Sensing and Intuiting personality types exhibit distinct error patterns in solving mathematical statistics problems. Sensing students excel in reading and executing procedures due to their attention to detail and structured thinking but often struggle with abstract understanding, model transformation, and answer clarity. In contrast, intuiting students show better conceptual understanding and pattern recognition but are more prone to procedural errors, particularly in conditional probability and complex calculations, often leading to disorganized final answers. These differences highlight the significant role of personality types in influencing mathematical error tendencies, from interpreting information to executing solutions. Based on these findings, mathematics instructors are encouraged to adopt differentiated teaching strategies aligned with students' personality traits. Instruction for Sensing-type students should enhance conceptual understanding and generalization, while for Intuiting-type students, it should strengthen procedural accuracy and structured problem-solving. Incorporating personality-based approaches into curriculum design can help reduce common errors and improve learning outcomes. This research provides empirical insights into the impact of personality on statistical problem-solving and offers practical implications for educators, curriculum developers, and researchers in higher education.

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## AUTHOR BIOGRAPHY


**Syarifa Anggraini**

Born in Sungai Penuh, on 14 December 2005. Tadris Mathematics Undergraduate Study Program student at Institut Agama Islam Negeri Kerinci (IAIN) Kerinci.

**Eline Yanty Putri Nasution, M. Pd.**

Born in Padangsidimpuan on September 27, 1988, the researcher is a lecturer at Institut Agama Islam Negeri (IAIN) Kerinci. The researcher completed a Bachelor's degree in Mathematics Education at Universitas Negeri Medan in 2011 and a Master's degree in Mathematics Education at Universitas Pendidikan Indonesia (UPI) Bandung in 2014.