

ERRORS ANALYSIS OF HIGH SCHOOL STUDENTS IN SOLVING MATHEMATICS REASONING OF UTBK BASE ON KASTOLAN STAGES

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ABSTRACT

This study aims to describe student errors and the factors that cause student errors in solving mathematical reasoning topic questions according to Castolan Stages. This research uses a qualitative approach with descriptive methods. The research subjects were 3 class XII high school students consisting of 2 female students and one male student. The research instruments used in the research were written tests and interviews. The results showed that students made three errors in solving the mathematical reasoning questions: conceptual, procedural, and technical. The causes of these three faults differ. As for student errors, (1) conceptual errors because students choose the wrong formula or formulas, so they don't answer questions; (2) procedural errors because students don't work on questions according to the steps requested, so they don't write down what was known and what was asked; and (3) technical errors. The cause of conceptual errors is pupils not understanding the subject and forgetting the formula. Procedure errors occur when kids don't know how to solve problems and aren't used to writing down what they know and what they're asked. Technical errors occur when pupils rush to solve problems and don't check their responses.

Keywords: UTBK model questions, Mathematical reasoning, Kastolan error stages

1. Introduction

State University Entrance Selection (SMPTN) is an issue that has become an exciting topic of conversation in the Indonesian education sector every year. (Sriyati 2022) reveals that college entrance selection is always the hottest issue every year in education. State universities are universities managed by the government, so the quality of State Universities (PTN) is undoubtedly better. Almost all students who will continue their studies at tertiary institutions after completing their high school education will compete to continue their studies at tertiary institutions with state status.

The large number of applicants applying to state universities has resulted in challenging opportunities to qualify for admission to state universities. For prospective students, getting through is certainly not as easy as imagined. Of course, there are several quite strict procedures and entrance tests or selections that prospective students must follow. One of the test routes that prospective students can take is through the Computer Based Test (UTBK). Rismadiyanti stated that the UTBK is a computer-based exam or written test whose results will then be used for selection to enter PTN (Simarmata et al. 2022).

The participants will try to compete with other participants from various places and schools. When taking part in UTBK, due to the large number of participants

If you are ambitious and competing to take part in UTBK, then the UTBK test is tricky because it is done selectively. During the implementation of UTBK every year, only around 20% of participants passed the exam out of the total participants who took the exam (Siahaan et al. 2023; Simarmata and Ahzan 2021). Based on data from the Ministry of Research, Technology and Higher Education, the number of participants who passed the 2019 SBMPTN was 23.61 per cent of the total number of registrants; for this reason, thorough preparation is needed in facing the college entrance exam starting from understanding the material, physically and mentally.

The UTBK material from 2019 to 2022 consists of two parts, namely TPS and TPA, for science and technology and social and social sectors. TPS material consists of general reasoning, quantitative knowledge, general knowledge and abilities, as well as knowledge of reading and writing (Sutarjo 2022). For TKA Soshum UTBK material, including geography,

history, economics, and sociology, as well as TKA Science material, including mathematics, physics, chemistry and biology

Permendikbudristik number 48 of 2022, which regulates the acceptance of new students for diploma programs and undergraduate programs at State Universities, states that there are differences in the UTBK test from the previous year. The significant change in question is that the UTBK test in the coming year, namely 2023, will not use TKA but will only have TPS.

Mathematical reasoning ability is one of the sub-topics of the material tested in UTBK both before the changes regulated by the Minister of Education and Culture, namely since 2019 and after it was stated that there was a change in 2023. Reasoning ability is an important thing that students must have when studying at tertiary institutions and in real life. (Sumartini 2015), his research, stated that reasoning is an activity or thought process to have a learning method as a strategy that can make it easier for students to master the knowledge given or known. A person can think logically, analytically, and theoretically, with good reasoning skills. As a thinking activity, reasoning has two characteristics, namely logical and analytical thinking. Putra in (Syafitri Z, Kamid, and Maison 2021) states that mathematics is understood through reasoning, while reasoning is understood and trained through learning mathematics.

According to (Kurnia Putri, Sulianto, and Azizah 2019; Syafitri Z et al. 2021) the importance of mathematical reasoning abilities greatly influences their mathematics learning process. Students will easily understand mathematics if they have good reasoning abilities; conversely, it will be difficult for them to understand mathematics if they have poor reasoning abilities. Mathematical reasoning is an essential ability every student must possess to solve mathematical problems (Hidayati and Widodo 2015).

Students frequently err in their solutions to content-area questions requiring mathematical reasoning. According to research by Ulfa and Kartini (Ulfa and Kartini 2021), both internal and external factors contribute to pupils' faulty problem-solving. According to studies conducted by Simarmata et al. (Simarmata et al. 2022), students' failure to correctly answer UTBK questions can be attributed to the fact that the questions tested in UTBK are very different from those typically learned and taught in school.

The absence of exposure to UTBK model questions during the learning process in school significantly contributes to students' difficulty in addressing mathematical reasoning questions. It will impact students' failure on the UTBK (Simarmata and Ahzan 2021). As a result of this research, students and teachers will be better prepared for the UTBK by understanding students' common mistakes when solving mathematical reasoning content problems. To identify the causes of student mistakes, an analysis method is required.

The results of previous research show that error analysis needs to be carried out as input for schools, in this case teachers, to adequately prepare students since implementing KBM before students later take UTBK. By knowing the mistakes that students make, at least students will be better prepared to face UTBK.

In carrying out error analysis, one of the theories that can be used as a reference tool in carrying out the research includes the Kastolan stage. Kastolan revealed the types of student errors in solving mathematical problems: conceptual errors, procedural errors and technical errors (Lutfia and Zanthi 2019). Conceptual errors are errors that occur when students do not apply formulas correctly, procedural errors are errors that occur when the steps used by students are inappropriate so that the answers given are incorrect, technical errors are errors that occur when students are not careful in calculations. or students make mistakes in writing.

Previous research, including that conducted by Lutfia, et al (Lutfia and Zanthi 2019), showed that 28.20% of students experienced conceptual errors, 81.50% of students experienced procedural errors and 66.1% of students experienced technical errors. Apart from that, Yulanda and Yarman (2018) stated that there were 3 students' mistakes in solving mathematics problems: conceptual, procedural, and technical.

2. Research Methods

The type of research used in this research is descriptive qualitative research, namely by analyzing the results of the work of students or students regarding UTBK model questions, especially on mathematical reasoning material. Qualitative research is a research procedure that produces descriptive data in the form of written or spoken words from people and observable behavior directed at the background and individuals holistically (Bhangu, Provost, and Caduff 2023; Busetto, Wick, and Gumbinger

2020; Coskun 2021). A total of 28 students who took the test and became the research subjects used in this study were 3 students consisting of 2 female students and 1 male student. Each student was selected to represent an analysis for one error.

The instruments used in the research were written tests and interviews. The interview guide used in the study is unstructured.

Kastolan Error Indicators in Erfan (Lutfia and Zanthi 2019) can be seen in the following Table 1:

Table 1. Kastolan Error Indicators

Kastolan Fault Stages	Error Indicator
Conceptual Errors	- Wrong in determining the formula or theorem - The use of a formula or theorem is not following the prerequisite conditions for the application of the formula - Not writing formulas or theorems to answer problems
Procedural Errors	- Lack of hierarchy of steps in solving problems - Mistakes in manipulating steps in solving problems
Technical Errors	Errors in computing

3. Results and Discussion

The test results showed that students made mistakes at all stages of Kastolan errors. Student errors when solving questions according to the Kastolan error stages in each number are not single but multiple and more than one error.

The test results showed an error at each stage with a different average percentage for each step. The Figure 1 below is a diagram of the average rate of mistakes made by students

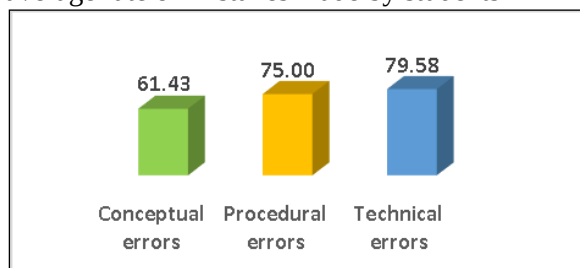


Figure 1. Average percentage error

Based on the test results and shown in Figure 1, the most significant percentage of errors

occurs at the technical stage followed by mistakes at the procedural stage. In contrast, the smallest rate of errors occurs at the conceptual stage.

Conceptual Error

Conceptual errors are errors in choosing or applying formulas, understanding the concepts and rules of a material. Based on the results of this research, it turns out that the most common form of conceptual error is that students choose the wrong formula so that the answer given is incorrect. The following is an analysis of the results of the PNT subject's work on question number 3, which is algebraic material representing errors at the conceptual stage:

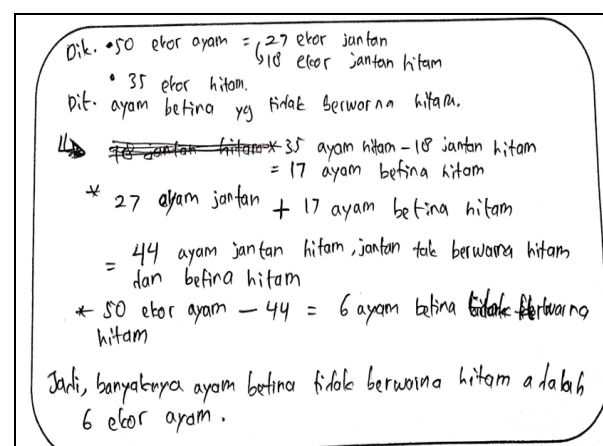


Figure 2. Example of conceptual error

In english of Figure 2:

Known: • 50 chickens = 27 males
 = 18 black males

Asked: A female chicken that is not black?

→ 35 black hens - 18 black males = 17 black hens

→ 27 roosters + 17 black hens = 44 black roosters, black colorless males and black females

→ 50 chickens - 44 = 6 non-black female chickens

So the number of non-black hens is 6 hens.

According to Figure 1, it can be seen that PNT wrote the answer up to the final stage but the definitive answer given was wrong because PNT was wrong in choosing the formula to be used. According to Kastolan's error stages, students are mistaken at the conceptual stage. The conceptual error in the form of an error in choosing the formula made by the subject is also in line with the results of research conducted by Afdila, et al (Fajriyati Afdila 2018) that one form of conceptual error made by the subject is the subject making a mistake in choosing the formula. Based on the results of interviews with PNT, the cause of conceptual errors was because students did not know the procedure to solve the questions. These findings are the basis for researchers to improve mathematical reasoning abilities. One solution is

that interactive learning needs to be developed (Kaplar et al. 2022).

Procedural Errors

Procedural errors are errors in the work steps. The following is the work result of the MBM subject in question number 9 representing errors in the procedural stages.

Wanita Hadir = $40\% \times 50 = 20$
 Pria Hadir = $50\% \times 70 = 35$
 Semua Hadir = $\frac{20 + 35}{50 + 70} \times 100\%$
 $= \frac{55}{120} \times 100\%$

Figure 3. an example of a procedural error

In english of Figure 3:

Women are present = $40\% \times 50 = 20$
 Men Present = $50\% \times 70 = 35$
 All Present = $\frac{(20+35)}{(50+70)} \times 100\%$
 $= \frac{55}{120} \times 100\%$

Based on Figure 3, the subject wrote the answer up to the final stage, but according to the Kastolan error stage, students made errors at the procedural stage. The error that students make is that students do not solve the problem until the final step to get the definitive answer requested by the question. Other research results support the results of research conducted by (Raharti and Yunianta 2020) that procedural errors made by students are students not completing questions until the final stage. The cause of procedural errors made when students were interviewed was that students felt that the time given was insufficient, so they did not have time to complete their answers until the final stage. Another error students make at this procedural error stage is that they do not write down what they know and are asked in the real world question (Wijaya et al. 2014).

Technical Errors

Technical errors are errors in calculating and writing symbols and signs in completion. Based on the results of this study, the form of technical errors made by students was that students made mistakes in calculating. The following is the result of the MP subject's work on question number 4 which is data material and uncertainty represents a technical step error.

$\bar{X} = \frac{X_1 \cdot n_1 + X_2 \cdot n_2}{n_1 + n_2}$
 $23750 = \frac{2500(2) + X_2}{2 + 1}$
 $23750 = \frac{17500 + X_2}{3}$
 $23750(3) = 17500 + X_2$
 $X_2 = 190000 - 175000$
 $= 150000$

Figure 4. example of a technical error

Based on Figure 3, it can be seen that the subject wrote down the completion steps to the final stage but the definitive answer was incorrect. The subject made a mistake at the technical stage because the student made a mistake in doing the calculations. Errors in the calculations made by the subject are also in line with the results of research conducted by (Raharti and Yunianta 2020) that the form of technical errors that occur is that students make mistakes in doing calculations. Based on the results of confirmation with the subject, it turned out that the student made a mistake in carrying out the analyses because the student was in a hurry and was not careful. In addition, students do not look back at the results of their work before submitting it to the teacher (Son, Darhim, and Fatimah 2019).

Based on the description above, the forms of errors made by the subject in solving UTBK model questions on the topic of mathematical reasoning are: (1) Forms of errors in the Conceptual Stage occur because students are wrong in determining the appropriate formula or suitable for solving problems, the causal factors according to the interview results are because students forget the formula that must be used; (2) The form of errors in the Procedural Stages that occur is that the subject does not work on solving the problem until the final stage to get the final answer requested from the question, according to the results of the interview the cause is because the subject feels that the time given is lacking so students seem in a hurry, while another form of error that occurs is that students do not write down what is known and what is asked in the questions and the causal factors according to the results of the interviews are because the subject is not used to writing down what is known and asked when solving problems; (3) Form Technical errors that occur are students doing the calculations incorrectly. The causal factor is that students are not careful when working on questions. Types of errors based on Kastolan stages and influencing

factors show that high school students' mathematical reasoning is still low and closely related to mathematics (Hasanah, Tafrilyanto, and Aini 2019). To obtain a comprehensive and comprehensive view, it is necessary to bring together a lot of literature related to mathematical reasoning in school mathematics (Jeannotte and Kieran 2017).

4. Conclusions

Based on the results of this research, subjects made 3 types of errors in solving questions according to Kastolan's error stages, namely conceptual, procedural, and technical errors. The form of conceptual error made by the subject is that the student makes a mistake in choosing the right formula, the structure of procedural error that occurs is that the student does not work on the question until the final stage. Apart from that, the subject does not write down what is known and what is asked about the question. The form of technical error occurs when students make mistakes when doing calculations. The cause of conceptual errors is that the subject does not know the formula that must be used to solve the problem, the cause of procedural mistakes is because the time given is not enough, in this case the student is not good at managing time when working on the problem, while the cause of technical errors is because the student is in a hurry. and not careful when working on questions.

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6. References

- Bhangu, Shagufta, Fabien Provost, and Carlo Caduff. 2023. "Introduction to Qualitative Research Methods - Part I." *Perspectives in Clinical Research* 14(1). doi: 10.4103/picr.picr_253_22.
- Busetto, Loraine, Wolfgang Wick, and Christoph Gumbinger. 2020. "How to Use and Assess Qualitative Research Methods." *Neurological Research and Practice* 2(1).
- Coskun, Lutfiye. 2021. "Mothers' Views and Home Literacy Practices on Children Literacy Skills Acquisition: A Qualitative Study." *Research in Pedagogy* 11(2):468–82. doi: 10.5937/istrped2102468c.
- Fajriyati Afdila, Nurul. 2018. "Analisis Kesalahan Siswa Dalam Menyelesaikan Masalah Kontekstual Materi Bangun Ruang Sisi Datar Berdasarkan Tahapan Kastolan." *Jurnal LEMMA* 5(1):65–72. doi: 10.22202/jl.2018.v5i1.3383.
- Hasanah, Sri Indriati, Chairul Fajar Tafrilyanto, and Yuniatul Aini. 2019. "Mathematical Reasoning: The Characteristics of Students' Mathematical Abilities in Problem Solving." *Journal of Physics: Conference Series* 1188(1). doi: 10.1088/1742-6596/1188/1/012057.
- Hidayati, Anisatul, and Suryo Widodo. 2015. "Proses Penalaran Matematis Siswa Dalam Memecahkan Masalah Matematika Pada Materi Pokok Dimensi Tiga Berdasarkan Kemampuan Siswa Di SMA Negeri 5 Kediri." *Jurnal Math Educator Nusantara* Vol 1(2).
- Jeannotte, Doris, and Carolyn Kieran. 2017. "A Conceptual Model of Mathematical Reasoning for School Mathematics." *Educational Studies in Mathematics* 96(1):1–16. doi: 10.1007/s10649-017-9761-8.
- Kaplar, Marija, Slaviša Radović, Kristina Veljković, Ksenija Simić-Muller, and Miroslav Marić. 2022. "The Influence of Interactive Learning Materials on Solving Tasks That Require Different Types of Mathematical Reasoning." *International Journal of Science and Mathematics Education* 20(2):411–33. doi: 10.1007/s10763-021-10151-8.
- Kurnia Putri, Dinda, Joko Sulianto, and Mira Azizah. 2019. "Kemampuan Penalaran Matematis Ditinjau Dari Kemampuan Pemecahan Masalah." *International Journal of Elementary Education* 3(3):351. doi: 10.23887/ijee.v3i3.19497.
- Lutfia, Lusi, and Luvy Sylviana Zanthly. 2019. "Analisis Kesalahan Menurut Tahapan Kastolan Dan Pemberian Scaffolding Dalam Menyelesaikan Soal Sistem Persamaan Linear Dua Variabel." *Journal On Education* 1(3).
- Raharti, Antonia Dwi, and Tri Nova Hasti Yuniarta. 2020. "Identifikasi Kesalahan Matematika Siswa Smp Berdasarkan Tahapan Kastolan." *Journal of Honai Math* 3(1):77–100. doi: 10.30862/jhm.v3i1.114.

- Siahaan, Meiva Lestari Marthaulina, Zulkaidah Nur Ahsan, Hermina Disnawati, and Lidwina Felisima Tae. 2023. "Sharing Session Seleksi Penerimaan Mahasiswa Baru (SNPMB) 2023 Untuk Calon Mahasiswa Baru Di SMA Negeri 1 Kefamenanu NTT Sharing Session Of Student Admission Test 2023 For Prospective Student In SMA Negeri 1 Kefamenanu NTT Peralihan Sistem UTBK Dari Yan." 1(4).
- Simarmata, Justin Eduardo, and Zulkaidah Nur Ahzan. 2021. "Bimbingan Dan Pelatihan Penalaran Matematika Jenis Soal UTBK Bagi Siswa SMA Di Masa Pandemi Covid-19." *Jurnal Pengabdian Pada Masyarakat* 6(4):1015. doi: 10.30653/002.202164.853.
- Simarmata, Justin Eduardo, Yosepha Patricia Wua Laja, Cecilia Novianti Salsinha, Yohanes Jefrianus Kehi, Agustinus Giovandi Laki, Margareta Rodrigues Gomes, Jeniana Martha Prima Asa, Elinora Naikteas Bano, Yakoba Yusina Muanley, and Hendrika Yeni Meti. 2022. "Pelatihan Tes Kemampuan Akademik Bagi Siswa Sma Kelas Xii Untuk Persiapan Utbk Sbmnptn 2022." *Jurnal Abdi Insani* 9(2):471–79. doi: 10.29303/abdiinsani.v9i2.557.
- Son, A. L., Darhim, and S. Fatimah. 2019. "An Analysis to Student Error of Algebraic Problem Solving Based on Polya and Newman Theory." *Journal of Physics: Conference Series* 1315(1). doi: 10.1088/1742-6596/1315/1/012069.
- Sriyati, Sriyati. 2022. "Analisis Hasil Tes Potensi Skolastik Sebagai Indikator Kesiapan Siswa Menghadapi Tes UTBK 2022." *Tarbiyah Wa Ta'lim: Jurnal Penelitian Pendidikan Dan Pembelajaran* 9(2):74–83. doi: 10.21093/twt.v9i1.4210.
- Sumartini, Tina Sri. 2015. "Peningkatan Kemampuan Penalaran Matematis Siswa Terhadap." *Jurnal Pendidikan Mosharafa* 5(1):1–10.
- Sutarjo, Sutarjo. 2022. "Meningkatkan Motivasi Belajar Siswa Melalui Pengembangan Tes Bakat Skolastik Dalam Menghadapi Ujian Utbk Dan Sbmnptn Diera New Normal Covid-19." *SECONDARY: Jurnal Inovasi Pendidikan Menengah* 2(1):97–108. doi: 10.51878/secondary.v2i1.878.
- Syafitri Z, Vita Ria, Kamid Kamid, and Maison Maison. 2021. "Analisis Kesalahan Penalaran Analogi Siswa Dalam Menyelesaikan Soal Matematika Dengan Menggunakan Prosedur Newman Ditinjau Dari Gender." *Jurnal Cendekia: Jurnal Pendidikan Matematika* 5(3). doi: 10.31004/cendekia.v5i3.1002.
- Ulfa, Desnani, and Kartini Kartini. 2021. "Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Logaritma Menggunakan Tahapan Kesalahan Kastolan." *Jurnal Cendekia: Jurnal Pendidikan Matematika* 5(1):542–50. doi: 10.31004/cendekia.v5i1.507.
- Wijaya, Ariyadi, Marja van den Heuvel-Panhuizen, Michiel Doorman, and Alexander Robitzsch. 2014. "Difficulties in Solving Context-Based PISA Mathematics Tasks: An Analysis of Students' Errors." *Mathematics Enthusiast* 11(3):555–84. doi: 10.54870/1551-3440.1317.