JPPIPA 9(5) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Analysis of Conceptual, Factual, Principle, and Skill Errors Based on Students' Thinking Ability: How is it Connected to Science Learning?

Mufidah[1*], Niluh Sadiani[1], Akina[1], Nuraini[1], Khairunnisa[1]

[1]Mathematics Department, Universitas Tadulako, Palu, Indonesia.

Received: February 16, 2022
Revised: May 18, 2023
Accepted: May 24, 2023
Published: May 31, 2023

Corresponding Author:
Mufidah
fida.mathc@gmail.com

DOI: 10.29303/jppipa.v9i5.3209

Abstract: This study aims to describe misconceptions about concepts, facts, principles and skills based on thinking skills that were made by fifth grade students at SD Inpres 6 Lolu in solving multiplication fraction problems. This research is descriptive qualitative research which is based on the problem-solving steps put forward by Polya. The research subjects were taken by 6 students based on the level of thinking skills determined using the Standard Deviation (SD) calculation. Data collection methods used are test and interview methods. The study's findings reveal that students make different types of errors based on their thinking ability in the process of solving mathematical problems. These errors can be categorized into four main areas namely: factual errors, conceptual errors, skill errors, principal errors. In summary, the study highlights that students' thinking ability is closely linked to the types of errors they make when solving mathematical problems. These errors primarily involve faulty facts, conceptual misunderstandings, skill-related issues, and principal errors. Understanding these patterns of errors can guide educators in developing targeted interventions to improve students' mathematical problem-solving skills.

Keywords: Analysis of student errors; Multiplication of fractions; Polya steps; Thinking skills

Introduction

Education in Indonesia currently uses the 2013 curriculum which emphasizes a scientific approach in learning Sakti et al. (2021) including mathematics. The process of learning mathematics in elementary schools differs between low and high classes. In the lower grades learning mathematics is taught along with other subjects. Meanwhile, in high school mathematics is taught separately.

Mathematics is a subject taught in schools that is very useful in everyday life (Evendi, 2022; Haeriah & Syarifuddin, 2022), both in general and specifically (Rahmawati et al., 2021). Mathematics is a field of science that has an important position in the development of the world of education (Rahmawati & Supratman, 2022). Learning mathematics is to form the ability to reason in students which is reflected through the ability to think logically, critically, systematically and has an objective, honest, disciplined nature in solving a problem in the field of mathematics and in everyday life (Hidayat & Evendi, 2022). Mathematics has an important role in various fields in solving problems (Aizikovitsh-Udi & Cheng, 2015), which is formed from empirical experience, processed through reasoning in the cognitive structure so that mathematical concepts are formed which are easy to understand (Sudarsih, 2021).

The material studied in mathematics lessons in elementary schools is fractions which is one of the basic materials that students must understand. Mathematics is a subject that is considered difficult by students, causing students to experience difficulties in learning mathematics (Nasruddin et al., 2020; Sartati et al., 2018; Siregar et al., 2020). The learning difficulties experienced by students are shown by a decrease in academic performance or learning achievement as a result of decreased learning motivation (Sudarsih, 2021). The low level of success in learning mathematics is due to several

How to Cite:
Mufidah, M., Sadiani, N., Akina, A., Nuraini, N., & Khairunnisa, K. (2023). Analysis of Conceptual, Factual, Principle, and Skill Errors Based on Students' Thinking Ability: How is it Connected to Science Learning?. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3815–3823. https://doi.org/10.29303/jppipa.v9i5.3209

reasons, including because students have difficulty accepting material and students' inability to solve mathematical problems (Nuralam & Yani, 2019).

The ability of students in solving math problems is different. Students often experience difficulties when given different problems resulting in errors in solving problems related to mathematics (Utami & Wutsqa, 2017). In general, there are several types of errors that often occur in solving math problems, namely (1) fact errors in mathematics, namely errors in using terms, errors in defining terms, errors in giving notations, and errors in using symbols; (2) conceptual errors in mathematics, namely errors in defining concepts, errors in distinguishing examples and non-examples of concepts, giving illustrations that do not match the definition of concepts, errors in presenting two incompatible conceptual relationships; (3) principle errors in mathematics, namely, errors in using concepts, errors in using properties, errors in connecting facts and concepts, and errors in connecting concepts with concepts; and (4) skill errors in mathematics, namely, errors in determining calculation results, errors using definitions or properties, incomplete completion procedures, and data in the calculation process does not match known data (Akina et al., 2021).

Based on the results of the pre-research in class V SD Inpres 6 Lolu, it is known that learning has been carried out optimally but there are still many students making mistakes in solving multiplication fraction problems. These findings indicate that there are still many students who do not understand and master the concept of fractions correctly, so that students experience difficulties in solving multiplication fractions which have an impact on errors in working on the questions. In line with this statement, the results of the study showed that many students were wrong in working on questions on the subject of fractions (Gusti Satria et al., 2022; Saparwadi et al., 2017).

Furthermore, preliminary research conducted through the administration of diagnostic tests showed that there were errors in concepts, facts, principles and skills in the multiplication of fractions material for students of SD Inpres 6 Lolu, East Palu for the 2021/2022 academic year. The test is given to students who have followed the fractional operations material. Analysis of student errors in solving math problems is important to do to find out what mistakes were made and what factors caused students to make mistakes so that they can be used as a basis for improving the learning process. In line with this opinion, Herholdt & Sapire (2014) stated that error analysis is the study of errors in students' work with the intention of looking for possible explanations for these errors. This study seeks to follow up on these descriptions through an error analysis of concepts, facts, principles and skills based on students' thinking skills in solving multiplication of common fractions with natural numbers and mixed fractions with natural numbers in class V SD Inpres 6 Lolu.

Method

The method used in this research is descriptive qualitative method. Descriptive research is research that provides an overview of an existing symptom and answers existing questions related to the status (state) of the research subject at a certain time (Creswell, 2014). The subjects of this study were fifth grade students at SD Inpres 6 Lolu. Selection of class V as a data source is determined randomly. Meanwhile, the interview subjects were taken using a purposive sampling technique, which is a technique for collecting data sources with certain considerations, in this case the research subjects were obtained based on the results of the fractional multiplication test results which were grouped based on the level of students' abilities, namely students with high, medium and low abilities (Table 1).

Table 1. Student Ability Level

Interval	Student ability level
$S > \overline{X} + SD$ $S > 46 + 28$ $S > 74$	High
$\overline{X} - SD \leq S \leq \overline{X} + SD$ $46 - 28 \leq S \leq 46 + 28$ $18 \leq S \leq 74$	Moderate
$S < \overline{X} - SD$ $S < 46 - 28$ $S < 18$	Low

The subjects of this study were fifth grade students at SD Inpres 6 Lolu consisting of 28 students. The data sources selected were 6 students, namely 2 students each from groups with high, medium and low abilities. Data collection techniques using fraction multiplication story questions and interviews. Tests in the form of multiplication of ordinary fractions with natural numbers and mixed fractions with natural numbers consisting of 5 questions were used to collect research data. It is known that the total score of 28 students (s) is 1.297 and $S^2 = 82.537$; so that the average value is 46 and the standard deviation value is 28.

Result and Discussion

Based on the categorization using Table 1, the high ability subjects were obtained, namely TN (score= 88) and NF (score= 84), moderate ability BA (score= 70) and JN (score= 66), and low ability AH (score= 10) and MR (score = 5). The subject name is not mentioned but replaced with the student code. The selection of the subject was based on the mistakes made in solving multiplication fractions. Types of errors made by

students in working on multiplication fractions word problems using polya solving steps based on the level of thinking ability from the results of students' answers in solving multiplication fractions problems, types of errors made by students in working on multiplication fractions word problems using polya solving steps based on level thinking ability, namely (1) the group of students with high abilities made mistakes were facts and skills, (2) the group of students with moderate abilities made mistakes were facts, concepts, principles and skills, and (3) groups of students with low abilities mistakes made are errors in facts, concepts, principles and skills.

Based on the results of the study, it was found that the fifth grade students of SD Inpres 6 Lolu in solving multiplication of ordinary fractions with natural numbers and mixed fractions with natural numbers based on students' thinking abilities, namely factual errors, conceptual errors, principle errors and skill errors. In general, the classification of students' abilities is presented in Figure 1.

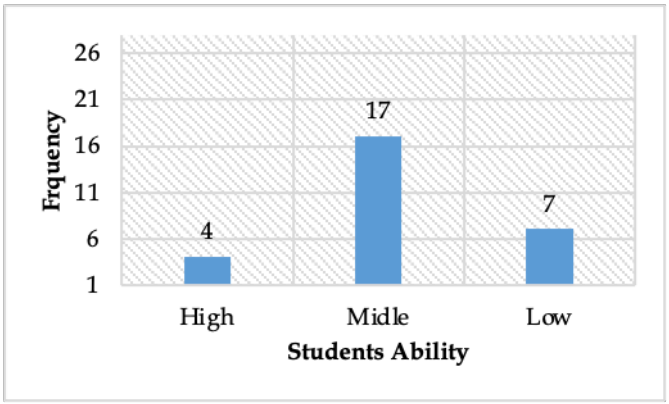

Figure 1. Students Ability Level

High Ability

1. *Factual error*

Based on the analysis of the answers, it was found that fact errors were made by students with high thinking skills, namely in question number 2, TN made a fact error. Fact errors occurred due to mistakes in changing the facts or data in the problem into mathematical form because TN did not understand the concept of fractions. As seen from TN's answer, he changed four and a half liters to 4/5, which should have been 4½. This is supported by the results of interviews with TN. From the interview, information was obtained that TN did not understand how to change sentence form fractional statements into mathematical form correctly because there was a mistake in understanding how to change them.

2. *Skill Error*

Based on the analysis of the answers, it was found that several skill errors were made by students with high thinking skills, namely in question number 3, TN made a skill error. Skill errors occur because they are wrong in determining the result of simplification so that the final result is also wrong. TN after getting a result of 354 then TN simplifies it by dividing 354 by 5 so that the calculation results are wrong. After getting a result of 354, TN shouldn't need to simplify anymore. This was also supported by the results of the interviews. From the interviews, information was obtained that TN made a mistake in calculating when simplifying the answers. The TN error is a skill error because the TN is wrong in calculating or determining the result.

In question number 4, NF made a skill error. Skill errors occurred because they were wrong in determining the result in solving problem number 4. NF was wrong in determining the multiplication result of 5/10 x 4000. This was supported by the results of the interview, from the interview, information was obtained that NF was wrong in calculating the result in solving problem number 4. Error The NF is a skill error because the NF is wrong in calculating or determining results.

In question number 5, NF made a skill error. Skill errors occurred because they were wrong in determining the result in solving problem number 5. It can be seen from the wrong final result of NF because NF was wrong in calculating the multiplication result of 20 x 32. This is supported by the results of the interview, from the interview, information was obtained that NF was wrong in calculating the result in solving problem number 5. The NF error is a skill error because the NF is wrong in calculating or determining the result.

Based on the results of the data analysis above, it can be concluded that students with high ability in solving multiplication of ordinary fractions with natural numbers and mixed fractions with natural numbers using polya solving steps, students in solving complete story problems/according to polya steps. Students write down what is known and asked about the problem, the formula used, the completion steps and conclusions in full. This is supported by research conducted Safrida et al. (2015) that all Polya solving steps can be used by students with high abilities to solve problems. For high-ability students, only one to two mistakes were made. Based on the results of the research the mistakes made were fact errors, namely mistakes in changing what was known in the questions into mathematical sentences, this is in line with the results of research conducted (Fauzi, 2018) that the difficulty in solving mathematical problems is that students experience difficulties in verbal abilities, namely understanding and interpreting questions in mathematical form. In Newman's theory, these errors include transformation errors, students are able to read the questions well and know what is asked in the questions, but cannot convert them into mathematical forms correctly and skill errors that tend to be wrong in calculating and determining the results,

this is in line with Sumadiasa's opinion (2014) that in solving math problems students often solve problems not until the final stage.

Moderate Ability

1. *Factual error*

Based on the analysis of the answers, it was found that several factual errors were made by students with moderate thinking skills, namely in question number 2, BA was wrong in changing the data in the problem into mathematical sentences. It can be seen from the answer sheet that BA changes four and a half liters to 4.5. This is supported by the results of the interviews, from the interviews, information was obtained that BA made a fact error because BA incorrectly changed the data on the problem into mathematical form, it should have been converted into fractional form, but BA changed it into decimal form even though the values were the same. In Newman's theory, these errors include transformation errors, students are able to read the questions well and know what is being asked in the questions, but cannot convert them into mathematical form correctly.

In question number 1, JN made a factual error. Fact errors occur because JN is wrong in writing things that are known, JN writes 2/3 which should be 2/4. This was supported by the results of the interviews. From the interviews, information was obtained that JN was wrong about what was known in question number 1. JN's mistake was a fact error because JN wrote wrong things that were known in the problem due to his lack of thoroughness when reading the questions. In Newman's theory these errors include reading errors, students misread important words in the problem.

In question number 4, JN made a fact error. Fact errors because JN was incomplete in writing the things asked in the questions. This was supported by the results of the interviews. From the interviews, information was obtained that JN was incomplete in writing the things asked in the questions. JN's error is a fact error. Error in fact because JN did not complete the writing asked on the answer sheet.

2. *Conceptual error*

Based on the analysis of answers and interviews, it was found that there were several conceptual errors made by students with moderate thinking skills, namely in question number 1, the BA did not write down the formula to be used in solving question number 1. It can be seen from the answer sheet, the BA immediately wrote 400 : 2 = 200 and 200 : 4 = 50. This is supported by the results of the interview. From the interview, information was obtained that the BA had a conceptual error because the BA did not write down the formula to be used to solve the problem.

In question number 3, BA made a concept error. Conceptual errors occur because BA is wrong in determining the formula to be used in solving problem number 3, BA writes the formula 590: 3/4 but uses the steps for solving multiplication of fractions. This is supported by the results of the interviews. From the interviews, information was obtained that the BA was wrong in determining the formula in solving problem number 3. The BA error was a conceptual error because the BA was wrong in determining the correct formula to solve the problem.

In question number 4, BA made a concept error. The conceptual error occurred because the BA did not write down the formula to be used in solving problem number 4, the BA immediately wrote down 4000 : 10 = 400. This was supported by the results of the interviews. From the interview, information was obtained that the BA did not write down the formula in solving problem number 4. BA's error it is a conceptual error because the BA does not write down the correct formula to solve the problem.

3. *Principle Error*

Based on the analysis of answers and interviews, several principal errors were found by students with moderate thinking skills, namely: In question number 1, BA made a principal error because he was wrong in determining the correct arithmetic operation in solving the problem, BA used division arithmetic operations because according to BA using distribution is easier to solve the problem. This is supported by the results of the interviews. From the interviews, information was obtained that the BA was wrong in determining the arithmetic operations in solving problem number 1. The BA's mistake was a principal error because the BA was wrong in determining the correct arithmetic operations to solve the problem.

4. *Skill error*

Based on the analysis of answers and interviews, it was found that several skill errors were made by students with moderate thinking skills, namely in question number 2, BA was wrong in doing the calculations and incomplete in writing down the steps for solving the questions and BA was wrong in doing the calculations 4.5 x 2 = 63 This was supported by the results of the interviews, from the interviews, information was obtained that the BA made a skill error because the BA made a mistake in doing the calculations and was incomplete in writing down the steps for solving the problem.

In question number 5, BA made a skill error. Skill errors occur because BA is incomplete in solving questions and is wrong in doing calculations, BA after writing the formula 32/5 x 20 directly in the contents of the answer is 1.28 and the answer is inappropriate or wrong, the correct answer is 128. This is supported by interview results, from the interview, information was obtained that the BA made a wrong calculation in

solving problem number 5. The BA error was a skills error because the BA made a mistake in doing the calculations to solve the problem.

In question number 2, JN made a skill error. Skill errors occurred because JN made a mistake in doing the calculations but JN understood the rules for converting mixed fractions into common fractions. This was supported by the results of the interviews. From the interviews, information was obtained that JN made a mistake in calculating when he changed the mixed fraction to an ordinary fraction. JN's error was a skill error because JN incorrectly determined the result of the calculation but JN understood the rules for converting mixed fractions into common fractions.

In question number 4, JN made a skill error, a skill error occurred because JN did not complete the steps for solving the problem. JN only answered until he got 2 tons of results, because he didn't complete the things asked in the question. This was supported by the results of the interviews, from the interviews, information was obtained that JN made a skill error, JN did not complete the solution for the final answer because he was mistaken in determining what was asked in the question. In Newman's theory these errors include reading errors, students misread the important words in the problem so that they are hampered from taking steps to solve them.

In question number 5, JN made a skill error. Skill errors occurred because JN made a mistake in doing the calculations but JN understood the rules for converting mixed fractions into common fractions. This was supported by the results of the interviews. From the interviews, information was obtained that JN made a mistake in calculating when he changed the mixed fraction to an ordinary fraction. The error was a skill error because JN made the wrong calculation result but JN understood the rules for converting mixed fractions into common fractions.

Based on the results of data analysis, it can be concluded that students with moderate abilities in solving multiplication of ordinary fractions with natural numbers and mixed fractions with natural numbers use the steps for solving polya, students in solving word problems not all questions are written down with complete polya solving steps. In some questions students did not write down what was known and were asked about the problem, the formula used, the completion steps and conclusions in full. For students with moderate abilities, two to four mistakes were made. Based on the results of the research, the errors made were factual errors, namely mistakes in writing things that were known in the questions, incomplete writing of the things asked in the questions, mistakes in changing what was known in the questions into mathematical form because students did not understand the meaning of the questions, this was supported by research (Haeriah & Syarifuddin, 2022) that students incorrectly changed the information provided into mathematical expressions because students did not pay attention to the intent of the questions. Conceptual errors made by students, namely errors in not writing formulas and errors in determining the formulas used to solve problems, principal errors made by students, namely errors in using arithmetic operations, and skill errors made by students, namely errors in calculating and determining the results of the settlement.

In line with the research results, Kristofora and Sujadi's research (2017) found that students understand concepts and procedures in the material being studied, but students are often not careful with calculations or computations, causing errors in math problems, errors in entering what is known in the questions into solution, it is not complete to write down the steps for completion. The results of this study are supported by Widodo's statement (2013) that procedural/skill errors occur because students do not write correctly the steps or procedures of a work and algorithm errors. This error occurs because students are not careful and do not understand the questions in working on the problem. Furthermore, Pradini (2019) stated that the factors causing student errors in working on word problems were haste, inaccuracy, not understanding the questions, incomplete writing down what was known and asked, not understanding the material, forgetting the formula used, lack of processing time. Students do not re-check the solutions obtained and obtain final answers that are not in accordance with the initial data provided (re-checking errors).

Low Ability

1. *Factual error*

Based on the analysis of the answers, it was found that several factual errors were made by students with low thinking skills, namely in questions number 1 to 5, AH made factual errors because he did not write down what was known and was asked for answers according to the questions, AH only wrote down the answers. This was supported by the results of the interviews. From the interviews, information was obtained that AH made a factual error because he did not write down what he knew and was asked about the questions on the grounds that AH was used to just writing down the answers right away.

In questions number 1 to 5, the factual errors made by MR because they did not write down were known and asked in the answers according to the questions. It can be seen from MR only writing down the answers. This was supported by the results of the interviews. From the interviews, information was obtained that MR preferred to directly write down the answers and not write down what was known, asked questions. MR error

is a fact error because it does not write down what is known and what is asked in the problem.

2. *Conceptual error*

Based on the analysis of the answers, it was found that there were several conceptual errors made by students with low thinking skills, namely conceptual errors made by AH not writing down the formula, in question numbers 1, 2, 4, and 5 there is no formula to solve this problem, because AH has never worked on questions by writing known, asked, formula and steps of completion. This was supported by the results of the interviews. From the interviews, information was obtained that AH did not write down the formulas used in solving the problems, AH forgot the formulas used to work on the questions.

MR made a conceptual error because he didn't write down the formula. It can be seen from questions number 1 to 5 that there is no formula for solving this problem, MR prefers to write the answer directly. This was supported by the results of the interviews. From the interviews, information was obtained that MR preferred to directly write down the answers and not write down the formula for solving the questions. In Newman's theory these errors include processing skill errors (process skill errors), errors occur because students only immediately write short (incorrect) answers but when interviewed students answer correctly. MR error is a concept because MR does not write formulas in solving problems.

3. *Principle error*

Based on the analysis of the answers, it was found that several principle errors were made by students with low thinking skills, namely in question number 2, AH made a principle error. AH was wrong in using correct arithmetic operations in solving problems, AH used addition arithmetic operations in solving problems, because according to AH using addition was easier to do. This was supported by the results of the interviews. From the interviews, information was obtained that AH was wrong in using arithmetic operations, AH made a principle error because he was wrong in determining the correct arithmetic operation to solve the problem.

4. *Skill error*

Based on the analysis of the answers, it was found that several skill errors were made by students with low thinking skills, namely: 1) in question number 2, AH made a skill error because AH was wrong in entering what was known in the question, it can be seen in question number 2 which is known in the question is Uncle fills his car with gas 4½ every day but AH writes 51/4. This was supported by the results of the interviews. From the interviews, information was obtained that AH was wrong in using arithmetic operations, was wrong in entering what was known in question number 2 into the formula used to solve the problem. Skill error because AH incorrectly entered what was known in question number 2 into the formula used to solve the problem.

Based on the results of data analysis, it can be concluded that students with low ability in solving multiplication of ordinary fractions with natural numbers and mixed fractions with natural numbers use the steps for solving polya, students in solving story problems do not write down the steps for solving polya in working on all questions, students immediately write their answers, students are not used to writing Polya steps in solving problems, this is in line with the opinion of Enlisia et al. (2020) that the most influential factor is students' unfamiliarity with applying the steps according to Polya's theory in solving problems. Only one to two questions are written down the formula and how to solve it. This is supported by research conducted by Raudho et al. (2020) that low ability students still experience difficulties in solving problems based on Polya's steps, because students do not understand the meaning of the problems (questions) given.

For low-ability students, two to four mistakes were made. Based on the results of the research, the most common mistakes made were errors in facts and concepts, these errors were found in all questions. The fact error is not writing down things that are known and things that are asked in questions because they are used to not writing these things when working on math problems, according to Ngilawajan (2013) states that students are said to be able to understand the problem if students are able to express what is known and asked according to the problem which are given. conceptual errors made by students, namely errors in not writing formulas because students preferred to directly write down answers and errors in determining the formula used to solve problems, principal errors made by students, namely errors in using arithmetic operations because students did not understand how to solve them, and skills errors made students, namely errors in entering what is known in the problem into solving. This is supported by the results of research conducted by Komarudin (2016) that the cause of students making this type of error is that students are not used to writing down the information contained in the questions, they do not understand how to interpret the information in the questions in the operational form of mathematics. In the process of making plans, it is because students do not know the completion strategy plans are heard correctly, whereas in carrying out plans, they are caused by the ability to know mathematical operations.

Based on the results of the study it can be stated that there are still many grade V students at SD Inpres 6 Lolu who make mistakes, especially for groups of students with medium and low thinking abilities, in the ability

group making all mistakes (concepts, facts, principles and skills) in solving multiplication problems fractions using the polya solution steps found in the answer results. Research data conducted by researchers also showed that most students made mistakes in concepts, facts, principles and skills in solving multiplication fractions problems.

Connection to the Science Education Context

The research findings have implications for science education as well. In the context of science education, students' writing abilities play a crucial role in their understanding and application of scientific concepts. Students with high writing abilities demonstrate a strong grasp of scientific questions, the appropriate use of formulas, complete solution steps, and accurate conclusions (Muhali, 2019). This indicates their proficiency in scientific reasoning and communication skills (Suryati et al., 2022; Susetyarini et al., 2022). However, even high-ability students may still make occasional mistakes, particularly in facts and skills, which underscores the importance of continuous practice and attention to detail in scientific problem-solving.

On the other hand, students with moderate abilities may encounter challenges in accurately documenting the necessary information, such as known facts, formulas used, and complete solution steps. These errors, spanning across facts, concepts, principles, and skills, indicate a need for targeted support and guidance in science education. Educators should pay close attention to the difficulties faced by moderate-ability students and provide explicit instruction on problem-solving strategies, effective communication of scientific processes, and thorough documentation of their work.

Low-ability students, specifically in the context of solving fraction-related problems, tend to rely on the Polya problem-solving steps. However, they often neglect to document these steps in story problems, opting to immediately write down their answers. Additionally, they may only write down the formula and solution steps for a limited number of questions. This highlights the importance of reinforcing problem-solving strategies and promoting systematic thinking, particularly when dealing with complex scientific scenarios. By encouraging low-ability students to practice more frequently, educators can foster better understanding, develop problem-solving skills, and enhance their overall scientific literacy.

In summary, these research findings emphasize the significance of analyzing students' mistakes in detail to identify specific areas of difficulty and tailor instructional approaches accordingly in science education. By providing targeted support, promoting regular practice, and emphasizing thorough documentation and problem-solving strategies, teachers can enhance students' scientific reasoning, conceptual understanding, and overall learning outcomes (Bilad et al., 2022).

Conclusion

In summary, students with high writing abilities demonstrate proficiency in answering questions, using appropriate formulas, providing complete solution steps, and drawing accurate conclusions. They make only one to two mistakes, primarily in facts and skills. On the other hand, students with moderate abilities may fail to write down essential information and complete solution steps for some questions. They make two to four mistakes, including errors in facts, concepts, principles, and skills. Additionally, low-ability students struggle with solving multiplication problems involving fractions and often skip the Polya problem-solving steps in story problems. They typically write down formulas and solution steps for only one to two questions. Mistakes made by low-ability students encompass errors in facts, concepts, principles, and skills. It is crucial for teachers to analyze students' mistakes in detail to identify their difficulties and enhance learning. Encouraging students to practice more frequently can improve their understanding and problem-solving skills.

Acknowledgements

The researcher would like to thank all the participants who were involved in this research so that it could be carried out.

Author Contribution

Conceptualization, methodology, formal analysis, writing—review and editing by Mufidah; investigation, writing—original draft preparation by Niluh Sadiani; writing—review and editing by Akina, writing—original draft preparation by Nuraini and Khairunnisa.

Funding

No specific grant or funding was given to this educational research from any private institution, public or ganization or nonprofit corporation.

Conflict of Interest

The researchers declare no conflict of interests.

References

Aizikovitsh-Udi, E., & Cheng, D. (2015). Developing Critical Thinking Skills from Dispositions to Abilities: Mathematics Education from Early Childhood to High School. *Creative Education*, *6*(4), 455–462. https://doi.org/10.4236/ce.2015.64045

Akina, A., Mufidah, M., & Tadjila, S. (2021). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Konversi Satuan Panjang. *Jurnal Kreatif Online*, *9*(3), 109-121. Retrieved from

https://jurnal.fkip.untad.ac.id/index.php/jko/article/view/1269

Bilad, M. R., Doyan, A., & Susilawati, S. (2022). Analyzing STEM Students' Critical Thinking Performance: Literacy Study on the Polymer Film Fabrication Process Irradiated with Gamma Rays. *International Journal of Essential Competencies in Education*, *1*(2), 49–60. https://doi.org/10.36312/ijece.v1i2.782

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed). SAGE Publications.

Enlisia, A. P., Rahardjo, S., & Sisworo, S. (2020). Kesulitan Siswa Dalam Menyelesaikan Masalah Matematika Berdasarkan Langkah Polya. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5*(12), 1820. https://doi.org/10.17977/jptpp.v5i12.14347

Evendi, E. (2022). Mathematical Thinking Styles and Its Implications in Science Learning: A Bibliometric Analysis. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1503–1511. https://doi.org/10.29303/jppipa.v8i3.1720

Fauzi, L. M. (2018). Identifikasi Kesulitan Dalam Memecahkan Masalah Matematika. *JIPMat*, *3*(1). https://doi.org/10.26877/jipmat.v3i1.2286

Haeriah, H., & Syarifuddin, S. (2022). Analisis Kemampuan Pemecahan Masalah Matematika Siswa Menggunakan Langkah-langkah IDEAL. *Empiricism Journal*, *3*(1), 42–57. https://doi.org/10.36312/ej.v3i1.734

Herholdt, R., & Sapire, I. (2014). An error analysis in the early grades mathematics –a learning opportunity?. *South African Journal of Childhood Education*, *4*(1), 43-60. https://doi.org/10.4102/sajce.v4i1.46

Hidayat, R., & Evendi, E. (2022). The Intervention of Mathematical Problem-Solving Model on the Systems of Linear Equation Material: Analysing its Impact on Increasing Students' Creative Thinking. *International Journal of Essential Competencies in Education*, *1*(2), 61–68. https://doi.org/10.36312/ijece.v1i2.1069

Komarudin, K. (2016). Analisis Kesalahan Siswa Dalam Pemecahan Masalah Matematika Pada Materi Peluang Berdasarkan High Order Thinking Dan Pemberian Scaffolding. *Jurnal Darussalam: Jurnal Pendidikan, Komunikasi Dan Pemikiran Hukum Islam*, *8*(1), 202–217. https://doi.org/10.30739/darussalam.v8i1.96

Kristofora, M., & Sujadi, A. A. (2017). Analisis Kesalahan Dalam Menyelesaikan Masalah Matematika Dengan Menggunakan Langkah Polya Siswa Kelas VII SMP. *PRISMA*, *6*(1). https://doi.org/10.35194/jp.v6i1.24

Muhali. (2019). Pembelajaran Inovatif Abad Ke-21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *3*(2), 25-50. https://doi.org/10.36312/e-saintika.v3i2.126

Nasruddin, N., Mashuri, S., & Nafiah, U. (2020). Peningkatan Hasil Belajar Matematika pada Materi Segitiga Melalui Pendekatan Penemuan Terbimbing Siswa SMP. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *4*(2), 80-94. https://doi.org/10.36312/e-saintika.v4i2.169

Ngilawajan, D. A. (2013). Proses Berpikir Siswa SMA dalam Memecahkan Masalah Matematika Materi Turunan Ditinjau Dari Gaya Kognitif Field Independent dan Field Dependent. *Pedagogia: Jurnal Pendidikan*, *2*(1), 71–83. https://doi.org/10.21070/pedagogia.v2i1.48

Nuralam, N., & Yani, M. (2019). Tipikal Gender dalam Mengkomunikasikan Penyelesaian Masalah Matematika Sekolah Menengah Pertama. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *7*(2), 100. https://doi.org/10.33394/j-ps.v7i2.1964

Pradini, W. (2019). Analisis kesalahan siswa dalam menyelesaikan soal cerita persamaan linear dua variabel. *Pythagoras: Jurnal Pendidikan Matematika*, *14*(1), 33–45. https://doi.org/10.21831/pg.v14i1.21481

Rahmawati, H., & Supratman, Moh. (2022). Analisis Kemampuan Abstraksi Reflektif Siswa dalam Merekonstruksi Konsep Limit Fungsi ditinjau dari Perbedaan Jenis Kelamin. *Empiricism Journal*, *3*(1), 32–41. https://doi.org/10.36312/ej.v3i1.768

Rahmawati, H., Supratman, Moh., & Aulan, Z. Y. (2021). Pengaruh Model Siklus Belajar Hipotesis-Deduktif terhadap Hasil Belajar Matematika Siswa SMA. *Empiricism Journal*, *2*(2), 85–94. https://doi.org/10.36312/ej.v2i2.599

Raudho, Z., Handayani, T., & Syutaridho, S. (2020). Analisis Kemampuan Pemecahan Masalah Soal Pytagoras Berdasarkan Langkah-Langkah Polya. *Suska Journal of Mathematics Education*, *6*(2), 101-110. https://doi.org/10.24014/sjme.v6i2.9061

Safrida, L. N., Susanto, S., & Kurniati, D. (2015). Analisis Proses Berpikir Siswa dalam Pemecahan Masalah Terbuka Berbasis Polya Sub Pokok Bahasan Tabung Kelas IX SMP Negeri 7 Jember. *Kadikma*, *6*(1). https://doi.org/10.19184/kdma.v6i1.1825

Sakti, N. W. P., Yusuf, R., Suriatno, A., & Irmansyah, J. (2021). Scientific Method in Physical Education Learning: A Cross-Sectional Study. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *5*(3), 212–226. https://doi.org/10.36312/esaintika.v5i3.571

Saparwadi, L., Purnawati, B., & Erlian, B., Puspa. (2017). Kesalahan Siswa Dalam Menyelesaikan Soal Operasi Penjumlahan Pada Bilangan Pecahan Dan Reversibilitas. *JPM: Jurnal Pendidikan Matematika*, *3*(2), 60. https://doi.org/10.33474/jpm.v3i2.715

Sartati, S. B., Subanji, S., & Sisworo, S. (2018). Pemahaman Siswa Tentang Equal Sign dalam Menyelesaikan Tugas Matematika. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *2*(1), 19. https://doi.org/10.36312/e-saintika.v2i1.80

Siregar, S. U., Harahap, A., Milfayetti, S., & Hajar, I. (2020). Peningkatan Kemampuan Komunikasi dan Self-Efficacy Matematis Siswa melalui Pendekatan Pembelajaran Matematika Realistik. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *4*(2), 151. https://doi.org/10.36312/e-saintika.v4i2.207

Satria, T., G., Sari, D., M., Rosalina, E., & Rijal, A. (2022). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Pecahan Pada Siswa Kelas V SD Negeri 43 Lubuklinggau. *Jurnal Paris Langkis*, *2*(2), 23–32. https://doi.org/10.37304/paris.v2i2.4180

Sudarsih, A. (2021). Penerapan Model Pembelajaran Kooperatif Tipe TPS (Think Pair Share) Terhadap Peningkatan Motivasi Dan Hasil Belajar Matematika Siswa Kelas VI B SDN 19 Cakranegara. *Reflection Journal*, *1*(2), 93-99. https://doi.org/10.36312/rj.v1i2.682

Sumadiasa, I. G. (2014). Analisis Kesalahan Siswa Kelas VII SMP Negeri 5 Dolo Dalam Menyelesaikan Soal Luas Permukaan Dan Volume Limas. *Aksioma*, *3*(2), 197-208. https://doi.org/10.22487/aksioma.v3i2.41

Suryati, S., Surningsih, S., & Mashami, R. A. (2022). Pengembangan E-Modul Interaktif Reaksi Redoks Dan Elektrokimia Berbasis Nature Of Science Untuk Penumbuhan Literasi Sains Siswa. *Reflection Journal*, *2*(1), 26-33. https://doi.org/10.36312/rj.v2i1.847

Susetyarini, E., Nurohman, E., & Husamah, H. (2022). Analysis of Students' Collaborative, Communication, Critical Thinking, and Creative Abilities through Problem-Based Learning. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *6*(1), 33–42. https://doi.org/10.36312/esaintika.v6i1.584

Utami, R. W., & Wutsqa, D. U. (2017). Analisis kemampuan pemecahan masalah matematika dan self-efficacy siswa SMP negeri di Kabupaten Ciamis. *Jurnal Riset Pendidikan Matematika*, *4*(2), 166. https://doi.org/10.21831/jrpm.v4i2.14897

Widodo, S. A. (2013). Analisis Kesalahan dalam Pemecahan Masalah Divergensi Tipe Membuktikan pada Mahasiswa Matematika. *Jurnal Pendidikan Dan Pengajaran*, *46*(2). https://doi.org/10.23887/jppundiksha.v46i2