



Analysis of Students' Mathematical Problem Solving Skills on Opportunity Material

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ABSTRACT

Problem-solving abilities are an important ability in understanding and applying mathematical concepts, including probability material that requires analysis and logical reasoning. This study aims to describe the mathematical problem-solving abilities of vocational high school students on probability material and to identify the difficulties faced by students in solving related problems. This research uses a descriptive qualitative method with a subject group of 27 students from class XI Yankes 3 at Vocational School Bunga Persada Cianjur for the 2024/2025 academic year who have studied probability material. Data collection techniques were carried out through mathematical problem-solving tests, interviews, and documentation. Data analysis was conducted through the stages of data reduction, data presentation, and conclusion drawing. The research results show that students' mathematical problem-solving ability in probability material is still classified as low. Based on the test results, only 3.7% of students are in the high category, 14.8% in the medium category, and 81.5% in the low category. If reviewed based on its stages, the percentage of student achievement is as follows: understanding the problem at 32,2%, planning the solution at 67,1%, executing the solution at 63,9%, and reviewing at 5,6%. The reviewing stage has the lowest achievement. Students' difficulties primarily lie in understanding problems related to probability material, constructing mathematical models to determine formulas for finding event probabilities, and checking the final results of probabilities found in story problems. These findings highlight the importance of reinforcing the understanding of basic concepts and contextual problem-solving exercises in probability learning to enhance the mathematical problem-solving abilities of vocational high school students.

Keywords: mathematical problem-solving ability; difficulties; opportunities; vocational high school student

INTRODUCTION

Education is a conscious and planned effort to achieve situations or conditions in teaching and learning that are expected according to certain goals (Isnawati & Rosyana, 2021). In the educational environment, one of the lessons that can form a modern Islamic society and there are social resources that are fulfilled is learning mathematics education (Yudha, 2019). Mathematics education plays a very important role in shaping logical, systematic, and critical thinking in students.

Mathematics is the mother or queen of all sciences. Mathematics is also an integral part of the development of technology and information. Some technological inventions are an inseparable part of mathematics, so mathematics is called the queen of science (Sari & Armanto, 2021). According to Sukardjo & Salam (2020) mathematics is also a compulsory subject given in every country because it is part of a person's basic ability, namely counting, and mathematics equips students to have abilities that can ultimately be applied in everyday

life. In line with Permendiknas Number 58 of 2014 that mathematics is a universal that is useful for human life and also underlies the development of modern technology, and has an important role in various disciplines and advances human thinking (Suryani et al., 2020).

According to NCTM (2000), there are five process standards in mathematics, namely problem solving, reasoning and proof, communication, connection, and representation (Rachmawati, 2021). Of the five process standards, it is mentioned that one of them is problem solving ability, an ability that students must have in learning mathematics. As stated by Anggraeni & Kadarisma (2022) that the purpose of learning mathematics according to Permendiknas is that students can solve problems, including understanding problems, planning models, solving, and interpreting solutions.

Problem solving skills are very important for students because by being able to solve a problem students gain experience, use the knowledge and skills already possessed by students to be applied in everyday life (Elita et al., 2019) In line with Fitrianiingsih & Budiman (2022) which states that one of the important skills for learning mathematics is the ability to solve mathematical problems. According to Ahmad & Asmaidah (2018) teaching problem solving skills to students is an activity carried out by a teacher to arouse students to accept and respond to the questions presented and guide students to arrive at problem solving. According to Septian & Rahayu (2021) in learning mathematics, problem solving is not only a learning target, but also a way to carry out the learning process itself.

Mathematical problem-solving skills in Indonesia still need attention. Based on the results of tests conducted by two international studies, namely Trends in International Mathematics and Science Study (TIMSS) and Programming for International Student Assessment (PISA) that mathematical problem-solving skills in Indonesia are still low or below international standards (Hanggara dkk., 2022). Based on the results of TIMSS (Trends in International Mathematics and Science Study) research in 2015, it shows that the average score obtained by Indonesia is 397 and is ranked 44th out of 49 participating countries, while the average standard value set by TIMSS is 500. TIMSS research results show that Indonesian students are ranked very low in the ability to: (1) understanding complex information; (2) theory, analysis and problem solving; (3) use of tools, procedures and problem solving; and (4) conducting investigations. One of the mathematical abilities that are categorized as low is problem solving ability, because in general students still do not understand the problems presented, due to students' habit of working on routine problems (Novitasari & Wilujeng, 2018).

In math lessons there are many materials taught to students, one of which is opportunity material. Chance material is one of the subject matter given to students in grade XI SMA / SMK in even semester. Chance material is an important learning in mathematics because chance material is a mathematical concept needed in everyday life, namely to estimate an event (Noviani et al., 2020). In opportunity material there are many chapters discussed, in this material students learn about experiments, sample points, sample spaces, expected frequencies, opportunities, and much more. In this material, the questions are presented in the form of stories, but students tend to have difficulty in understanding these questions (Muti'ah et al., 2023).

Several studies have revealed problems in mathematical problem-solving ability, this is based on the results of research conducted by Amaliah et al., (2021) showing that

mathematical problem-solving ability on quadrilateral and triangle material concluded that high ability category students were able to solve the problems given, but were less careful in writing units. Students in the medium category have not been able to solve the problems given, because they are only able to understand the problem and plan a solution. Meanwhile, research by Suherlan dkk., (2023) showed that the level of mathematical problem-solving ability of vocational high school students in the subject matter of quadrilateral and triangle.

Based on previous research, there have not been many studies that focus on discussing the stages of mathematical problem solving in detailed probability material. So that this researcher has a goal, namely analyzing the mathematical problem-solving ability of vocational students in solving problems of chance material and identifying the difficulties experienced by vocational students in solving problems of chance material.

RESEARCH METHODS

This research uses a qualitative descriptive method. Which aims to analyze the mathematical problem-solving ability of vocational students on opportunity material. The sampling technique used purposive sampling. The subjects of this study were 11th grade vocational students majoring in Health Services (Yankes) in the 2024/2025 academic year at SMK Bunga Persada Cianjur. The subjects of this study amounted to 27 students.

The data collection technique in this study is to use a mathematical problem-solving ability test in the form of an essay and non-test instruments in the form of interviews, and also documentation as an addition. The data analysis technique in this study is based on the Miles and Huberman model (in Sugiyono, 2016) with three stages of data analysis, namely: Data reduction, data presentation, and conclusion drawing.

Furthermore, to categorize students' mathematical problem-solving ability using the formula according to Hilyani et al., (2020) as in Table 1.

Table 1. Categories of Mathematical Problem-Solving Ability

Value	Achievement of Mathematical Problem-Solving Ability
$x \geq 80$	High
$65 < x < 80$	Medium
$x \leq 65$	Low

The data obtained from the interviews is in the form of oral data which is converted into written data. This interview was conducted to reveal and confirm the difficulties in students' mathematical problem-solving skills.

RESULTS AND DISCUSSION

The mathematical problem-solving ability test was conducted on 27 students of class XI Yankes 3 who were willing to be samples in this study and who had studied the material of chance. The following test results of students' mathematical problem-solving abilities based on high, medium, and low categories can be seen in Table 2.

Table 2. Students Mathematical Problem-Solving Ability Test Results on Chance Material Based on Categories

Category	Value (%)	Number of Student	Percentage
High	$x \geq 80$	1 Person	40
Medium	$65 < x < 80$	4 Person	70
Low	$x \leq 65$	22 Person	50

Furthermore, the results of the student mathematical problem-solving ability test on chance material based on the stages of problem solving can be seen in Table 3.

Tabel 3. Student Test Results on Chance Material Based on Stages of Mathematical Problem-Solving Ability

Stages of Mathematical Problem-Solving Ability	Percentage	Category
Understanding the Problem	32.2%	Low
Developing a Solution Plan	67.1%	Medium
Problem Solving	63.9%	Low
Reassessing	5.6%	Low

Furthermore, the results of student work on the question of students' mathematical problem-solving ability based on the four stages of problem solving on chance material will be presented, as follows:

Stage 1: Understanding the Problem

Problem number 1

Raysa melempar sebuah dadu pada saat bermain monopoli. Dapatkah kamu menentukan ruang sampel, titik sampel dan kejadian pada sebuah dadu tersebut?

Figure 1. Problem Number 1

At the stage of understanding the problem there is 1 indicator, namely students are expected to be able to identify elements that are known, asked, and the sufficiency of elements. Here is one of the answers of students who are able to write at the stage of understanding the problem in the problem of opportunity material number 1 in Figure 2.

1) Dik: Raysa melempar sebuah dadu
 Dit: Ruang sampel, titik sampel, kejadian sebuah dadu.

Figure 2. S7's answer on Problem Number 1 Stages of Understanding the Problem

In Figure 2, the results of the subject's answer show that the subject is able to understand the problem by being able to identify the known and questionable elements in the appropriate opportunity material problem. The subject's answer is one of 8 students whose answers are appropriate. As for the other students, they did not do the stage of understanding the problem at all. Mostly, students do not carry out the stage of understanding

the problem by not identifying known and questionable elements. Students are more likely to write answers directly to the point. In line with the research of Rahmadania et al., (2024) found that some students did not explore the problem at hand, starting from finding the known elements and the elements asked.

Stage 2: Developing a Solution Plan

Problem Number 2

Pada saat bermain ular tangga, Dua dadu setimbang dilempar secara bersamaan. Berapa peluang munculnya mata dadu pertama bilangan prima dan mata dadu kedua bilangan ganjil?

Figure 3. Problem Number 2

In the second stage, namely preparing a solution plan, there is one indicator in it, which is expected that students are able to formulate mathematical problems or develop mathematical models. The following is one of the answers of students who are able to carry out the process of preparing a solution plan in Figure 4.

$$\text{Jawab: } P(A) = \frac{3}{6} = \frac{1}{2}$$
$$P(B) = \frac{3}{6} = \frac{1}{2}$$

Figure 4. Subject S26's Answer to Problem Number 2 Stages of Developing a Completion Plan

The subject calculated the probability of two events, namely the first event of the first dice appearing prime and the second event of the second dice appearing odd. However, the subject did not first memorize the two events. Thus, the lack of clarity of the information $P(A)$ and $P(B)$ in the answer. At this stage, some students do not carry out this stage by not writing a solution plan, not doing mathematical modeling which aims to facilitate students in their work. According to Hadiana et al., (2020) stated that at the stage of preparing a solution plan, the mistake that students often make is not writing the formula and solution steps completely and correctly.

Stage 3: Problem Solving

Problem Number 3

Alif dan teman-temannya sedang bermain kelereng di lapangan. Alif membawa sebuah kantong yang berisi 40 kelereng dengan warna merah 16 buah, hijau 8 buah dan sisanya berwarna biru, kemudian diambil satu buah kelereng secara acak. Bisakah kamu menentukan peluang jika yang terambil adalah kelereng biru?

Figure 5. Problem Number 3 of Opportunity Material

At the problem-solving stage there is one indicator, namely students are expected to be able to apply strategies to solve problems. The following is presented one of the student answers at the problem-solving stage in Figure 6.

$$P(A) = \frac{n(A)}{n(S)}$$

$$P(A) = \frac{16}{40} = \frac{2}{3}$$

Figure 6. Subject S16's Answer on Problem Number 3 Stages of Problem Solving

It can be seen that the subject has carried out the problem-solving stages using the right formula, but the subject made a mistake in the calculation. So as to find the wrong final result. The correct final result is $\frac{2}{5}$, but the subject answered $\frac{2}{3}$. Most students show calculation errors, improper application of formulas, or even skip this stage altogether. According to Saputra (2023) the low problem-solving ability of students on chance problems is closely related to weak mathematical manipulation skills and lack of practice solving contextual problems.

Stage 4: Rechecking

Problem Number 4

Hafiz dan Haikal sedang main suit gajah. Yang dimana jari telunjuk melambangkan manusia, jari kelingking melambangkan semut, dan ibu jari melambangkan gajah. Jika manusia melawan gajah maka yang menang adalah gajah, jika semut melawan manusia maka yang menang adalah manusia, dan jika gajah melawan semut maka yang menang adalah semut. Dapatkah kamu menentukan peluang jika mereka akan seri pada suit gajah tersebut!

Figure 7. Problem Number 3 on Chance Material

In the re-examination stage there is one indicator, which is expected that students are able to explain or interpret the results in accordance with the initial problem. The following are the answers of students who carry out this stage properly and correctly presented in Figure 8.

jadi, peluang seri pada suit gajah adalah $\frac{1}{3}$

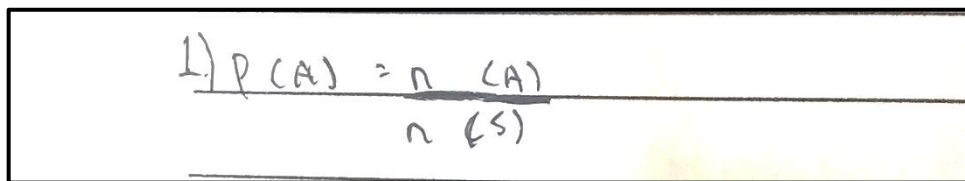
Figure 8. Subject S7's Answer on Problem Number 4 Stages of Problem Solving

It can be seen that the subject carries out the stage of checking back by concluding that the chance of a tie in an elephant suit is $\frac{1}{3}$. Of the 27 students, only the student with subject S7 carried out this stage. Based on the analysis that has been carried out in this study, the checking back stage is the lowest stage owned by students. This is in line with the results of research by Fatkhurrohman et al., (2021) that the checking back stage obtained the lowest percentage among other stages. In his research, it was found that students were not accustomed to checking the answers obtained, in addition to not understanding the material and how to solve problems.

Furthermore, students' difficulties in solving mathematical problem-solving skills questions on probability material will be presented as follows:

Difficulty Understanding the Material

The material given in the problem is opportunity material. In the context of learning mathematics learning, opportunity material not only requires students to understand basic concepts, but also train mathematical problem-solving skills that include critical and analytical thinking skills. Based on the analysis of the test results of students' mathematical problem-solving skills, there are still many students who make calculation errors in the answers they do. This shows that students do not understand the material provided. Here is one of the student answers that shows that students do not understand the problem in solving the problem in Figure 9.



The image shows a handwritten mathematical formula on a piece of paper. The formula is written as:
$$1) P(A) = \frac{n(A)}{n(S)}$$

Figure 9. Subject S4's Answer on Problem Number 1

In Figure 9, it can be seen that the subject answered with an incorrect answer. What is asked in question number 1 is how to determine the sample space, sample points, and events when throwing a dice. The subject should have answered according to the question, but the subject answered outside of the question and the context of the answer was not correct. This was caused by the subject's lack of understanding of the material contained in the problem. The subject's answer can be strengthened by the interview conducted by the researcher with subject S4 which is presented in Figure 10.

P	:"Apakah kamu pernah menyelesaikan soal seperti yang diberikan?"
S4	:"Pernah tapi lupa lagi soalnya udah lama"
P	:"Dari jawaban yang kamu kerjakan belum sesuai dengan jawaban yang seharusnya. Alasannya kenapa?"
S4	:"Alasannya karena aku kurang paham sama soal-soal yang dikasih"
P	:"Menurut kamu ada kesulitan lain ga dari soal yang diberikan?"
S4	:"Ada, tapi secara keseluruhan aku kurang faham sama materi peluang nya."

Figure 10. Excerpt of Researcher's Interview with Subject S4

Based on the results of interviews that have been conducted by researchers with students, stating the reason for answering with incorrect answers is because they do not understand the questions given. This is in line with Adhyan & Sutirna (2022) which found that there are still many students who do not understand the material, which has an impact on students' inability to solve the problems given.

Another cause is due to the lack of students in understanding the concept of the material provided, namely the concept of chance material. Sugiarni et al., (2021) said that some students have difficulty learning mathematics because they tend to memorize rather than really understand the concepts, as a result they have difficulty applying mathematical concepts in everyday life situations. According to Septian et al., (2020) concept

(2022) which states that there are some students who do not write known and questionable elements, which are caused by students' habits of answering the solution directly. As Ramadhani & Hakim (2021) said that students who write problem information into the answer sheet are not used to understanding the problem.

Difficulty Checking Back

The main difficulty in this context is the lack of students' habits to reflect on the steps that have been done. After finding an answer, students tend to immediately consider it correct without evaluating whether the result makes sense and is in the context of the problem or not. The following is presented one of the student answers who had difficulty at the checking back stage in Figure 13.

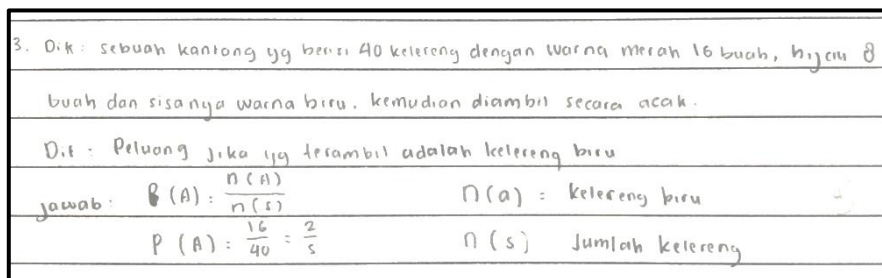


Figure 13. Subject S26's Answer to Problem Number 3

In Figure 13, it can be seen that the subject has answered the question according to the stages of problem-solving ability systematically. However, the answer is incomplete for answers that are in accordance with the stages of mathematical problem-solving ability. The subject did not re-examine the answer he did. The subject's answer is reinforced by the interview conducted by the researcher with subject S26 in Figure 14.

P	: "Apakah kamu pernah mengerjakan soal seperti yang diberikan?"
S26	: "Sebelumnya kaya pernah, tapi lupa lagi"
P	: "Dari jawaban yang kamu kerjakan sudah cukup baik, akan tetapi jawabannya belum lengkap jika berdasarkan tahapan kemampuan pemecahan masalah matematis. Kamu tidak melakukan kesimpulan pada terhadap jawaban yang kamu kerjakan. Alasannya kenapa?"
S26	: "Alasannya karena aku rasa gausah disimpulkan lagi, soalnya aku kan udah dapet jawaban akhirnya yang menurut aku itu benar dan udah cukup jawabannya sampai situ."
P	: "Menurut kamu ada kesulitan lain ga yang kamu temukan pada saat mengerjakan?"
S26	: "Susah susah gampang. Tapi aku suka bingung kalau lagi nentuin rumus yang mau di pake. Takut salah rumus aja."

Figure 14. Excerpt of Researcher's Interview with Subject S26

Based on the results of interviews that have been conducted by researchers with students, it states that students do not recheck the reason is that students have found the final answer and according to them it does not need to be concluded because it is enough. In line with research Damayanti & Kartini (2022) which states that students who do not check the solution obtained are because students think it is necessary to check because they believe that the answer given is correct. It is also because students are not familiar with these stages

due to the lack of direction from the teacher during the learning process. This is reinforced by the results of research by Rahmadania dkk., (2024) which states that students who do not check back are less directed to do so, so that the re-checking of answers is ignored.

Difficulty Understanding Story Problems

In learning mathematics, especially in opportunity material, there are some students who have difficulty when faced with story-shaped problems. This difficulty is one of the main obstacles in improving mathematical problem-solving skills, because understanding the problem as a whole is the first and important step in the solution process. Here is one of the answers of a subject who had difficulty in understanding the story problem in Figure 15.

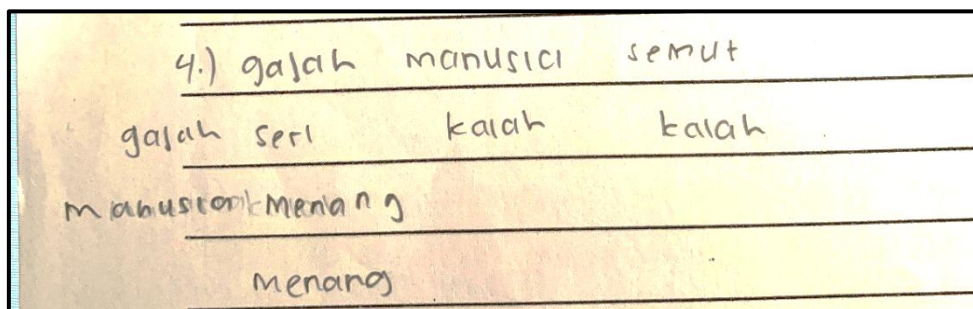


Figure 15. Subject S5's Answer to Problem Number 4

In Figure 15, the subject had difficulty in understanding the information and game rules given in the problem. Problem number 4 asks the subject to determine the chances of a draw, but the student does not arrive at the answer to the odds, but only compiles some of the results of the suit combination incompletely and unsystematically. The subject also did not complete the calculation of the odds, the subject still lacked understanding in linking story information with mathematical representations. The subject's answer can be strengthened by the interview conducted by the researcher with subject S5 in Figure 16.

P	: "Apakah kamu pernah mengerjakan soal seperti yang diberikan?"
S5	: "Pernah, dikelas 10 tapi kayanya udah mulai lupa"
P	: "Dari soal yang diberikan, terlihat kamu sudah berusaha untuk menjawabnya. Akan tetapi secara keseluruhan, jawabannya belum tepat. Salah satu nya untuk soal nomor 4. Alasannya kenapa?"
S5	: "Alasannya karena aku ngerasa susah buat ngerjain soal yang bentuknya cerita gitu. Jadi ya jawab sebisa nya aja."
P	: "Menurut kamu ada kesulitan lain ga dari soal yang diberikan?"
S5	: "Sulitnya di yang tadi aja sih, ngerjain soal yang bentuknya cerita."

Figure 16. Excerpt of Researcher's Interview with Subject S5

Based on the results of tests and interviews, it was found that most students could not accept the information in the questions given in the form of story problems. one of them is a problem that requires modeling situations such as problem number 4. Students do not finish until the final stage, and only write combinations without continuing to calculate the odds. According to research conducted by Nogroho & Astuti (2023) story problems in chance material require understanding the context and students' ability to identify elements of chance such as sample space and events, which is still an obstacle for many students. the

difficulty of solving story problems in chance material is not only related to numerical aspects, but also closely related to the ability to understand context, compile mathematical models, and apply logically. This is in line with the research of Nurmayunita et al., (2024) which states that story problems require students to connect mathematical concepts with concepts of everyday life, which can be complex and require deep student understanding.

This study has several limitations that should be considered. First, the instruments used were only written tests and a few interviews, so they were not able to fully explore students' thinking processes in problem solving. Furthermore, this study only focused on probability, so the results obtained do not reflect students' problem-solving abilities across the material.

CONCLUSION

This study shows that the mathematical problem-solving ability of vocational students on chance material is still relatively low, especially at the stage of re-examining the results. Students tend not to verify their answers, do not write conclusions, and do not reflect on the solution process. Common errors occur in determining the sample space, especially in compound or conditional event problems. In addition, students had difficulty in understanding the problem, constructing mathematical models, and applying the right formula. The lack of reflection skills and concept understanding indicates the need for more structured and contextualized learning so that students can solve chance problems effectively.

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