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Mathematical Connection Ability of Junior High School Students in Solving Story Problems on Probability

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Abstract

This study aims to describe the mathematical connection abilities of ninth-grade junior high school students in solving story problems on probability. The aspects examined include connections among mathematical concepts, links to other disciplines, and relevance to daily life. A descriptive qualitative approach was applied to 22 students at a junior high school located in Tapung Hilir District. Data were collected through essay-based tests and semi-structured interviews, with three students selected to represent high, medium, and low levels of mathematical connection ability. Results showed that 9 students were categorized as high, 9 students as medium, and 4 students as low. Students in the high category demonstrated a strong conceptual understanding, although they lacked systematic problem-solving strategies. Medium-level students showed comprehension yet required guidance. Low-level students struggled to interpret story problems and relate them to probability concepts. These findings emphasize the need for contextual learning and structured practice to enhance students' mathematical connection abilities.

Keywords: Mathematical Connection, Probability, Story Problems, Student Ability

INTRODUCTION

Mathematics is a science taught at all levels of education, from kindergarten to university. This knowledge is also an important foundation in human life (Lan et al., 2021; Sharma, 2021; Skovsmose, 2021). Since it was first discovered, mathematics has continued to develop in line with the changing times (Borba, 2021; Steen, 1989). Its development never stops because mathematics is always needed in various fields. Mathematics education is essential to instill the various concepts that exist in this field. In addition, students are expected to develop their own ways of reasoning to apply mathematics in daily life (Andini et al, 2020; Abassian et al., 2020). Therefore, mathematics learning should be focused not only on mastering procedures, but also on the ability to connect various concepts thoroughly, known as mathematical connection skills.

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A connection is defined as a relationship. In this context, mathematical connections mean the relationship between various mathematical concepts, both with mathematics itself and related to other fields and contextual. Mathematical connection skills enable students to relate concepts to one another, to other disciplines, and to real-world contexts (Jawad, 2022; Ziliwu et al., 2022; Baiduri, 2020; Rohmah et al., 2020). According to Suherman in Putri et al. (2020) stated that the ability to connect mathematical ideas or principles with others, both in different fields and by relating them in everyday life. This means that the ability to connect math supports students in understanding how various mathematical concepts are interrelated with other topics. Mathematical connection skills are very important for students because each concept is related to another concept or in other words, the entire field is related to mathematics. Through mathematical connections, it is hoped that students can expand their horizons and thoughts on mathematics, so that a positive attitude towards the subject arises.

According to Riyanto et al. (2024) indicators of mathematical connection ability can be grouped into three, namely 1) Connections between mathematical concepts, this indicator reflects students' ability to relate and connect mathematical concepts; 2). Connection with other disciplines, this indicator reflects students' ability to connect mathematics with other disciplines; and 3) Connection with daily life, this indicator shows that learners can understand the relationship between mathematics and daily life. In the context of learning, story problems or contextual problems are an effective means to cultivate mathematical connection skills. Story problems present problems in the form of narratives that contain real-life elements, thus encouraging students to connect information from the text with relevant mathematical concepts in order to solve them. Through story problems, students are not only tested on their understanding of the material, but also their skills in transferring knowledge into more complex and meaningful situations (Aini et al., 2024; Kaminski & Sloutsky, 2020). Therefore, it is important to further research how story problems can serve as a means to assess and improve students' mathematical connections, especially at the junior high level on probability material.

The topic of probability is one of the most relevant parts of mathematics to combine with real situations in narrative problems. Probability is closely related to assessing uncertainty in daily life, such as the probability of winning in a game, weather forecasts, or the results of an experiment (Batanero & Álvarez-Arroyo, 2024; Beltrami, 2020; Prihartini et al., 2020). Integrating story problems into probability learning is an effective way to enhance students' mathematical connection skills.

However, based on the results of various research findings by Fatunnisa & Fitri (2021), it was found that students face challenges in understanding ideas about probabilities and often incorrectly use the right formula when working on story problems on the topic of probabilities. This indicates that students' mathematical connection abilities are still relatively weak in relating the material that has been learned to the context of the given question. The mathematical connection ability of Indonesian students is still relatively low. This shows the need for systematic efforts to identify

and describe students' mathematical connection skills, especially in solving story problems based on probability material. Therefore, this study aims to describe the mathematical connection ability of junior high school grade IX students in solving story problems in probability material.

METHOD

This study employed a qualitative research design with a descriptive approach. The participants were 22 ninth-grade students from a junior high school in Tapung Hilir District during the 2024/2025 academic year. The data collection methods used in this study are interviews and measurement methods, which are in the form of written tests from indicators of students' mathematical connection ability, namely below.

1. Testing students' skills in relating mathematical concepts, namely probability material, to other mathematical concepts, namely ratio material.
2. Testing students' skills in relating mathematical concepts, namely probability materials, to concepts from other disciplines, namely sports.
3. Testing students' skills in relating mathematical concepts, namely probability materials with daily activities.

The written test used to test the ability of mathematical connections for grade IX junior high school students is in the form of story problems against probability materials. The instrument is in the form of four (4) descriptive test items based on 3 mathematical connection indicators, where the first indicator is tested with one description test question, the second indicator is tested with one description test question, and the third indicator is tested with two descriptive test items, the following test questions in Table 1 are based on the indicator of mathematical connection ability.

Table 1. Students' mathematical connection ability test questions.

No	Mathematical Connection Ability Indicator	Description Questions
1	Connecting mathematical concepts with other mathematical concepts	In a drawer there are green, yellow, and black pencils. Ratio of the number of green pencils: yellow: black = $5:2:3$. A student takes one pencil at random from the drawer. 1. Determine the probability of taking a green pencil. If the sum of the entire pencil is 200, how many pencils of each color?
2	Connecting mathematical concepts with concepts in other fields of	In a class sports activity, there were 30 students who took part in a draw to determine their turn to play in a futsal match, consisting of: 18 male students 12 female students

	science	The committee randomly selects 1 student to be the team captain. 1. Determine the probability of female students being elected as captains. 2. If the committee chooses 1 more student after the captain to be a assistant referee, determine the probability of the student being male.
3	Connecting mathematical concepts to everyday life	In Andi's closet there are 10 clothes of different colors, namely: 4 pink shirts 3 brown shirts 3 purple shirts Andi will pick up one shirt at random without looking at the color of the shirt. After seeing the results, he said: "The *color of the shirt I took was the color that was least likely to appear."* Specify: 3. What color is most likely to be taken by Andi? Explain your reasons using the concept of probability. 4. Sort the color of the shirt from the smallest to the most likely to be taken. A mother has 8 shopping bags each containing fruits: 3 bags filled with oranges 2 bags of mango 3 bags of kiwifruit Without looking at the contents, the mother asked her child to take 1 bag at random. Determine the probability of the child taking a bag of kiwi.

The method to collect data was carried out by means of tests and interviews. From the 22 participants, three students were purposively selected for further analysis and interviews, representing high, medium, and low levels of mathematical connection ability. Purposive sampling is a non-random sampling technique, where the researcher selects participants according to predetermined criteria relevant to the research objectives, so that it is expected to provide a response to the case being studied (Lenaini, 2021).

The data analysis stage consists of (1) collecting information from written tests and interview sessions, (2) carrying out analysis based on information obtained from written tests and interview sessions, (3) providing a description of the results of data processing, (4) designing research documents, and (5) specific conclusions to answer research questions (Zainudin et al., 2021).

The mathematical connection ability of students is then grouped into three categories, namely high, medium, and low (Widiyawati et al., 2020). Here are the categories of students' mathematical connection abilities.

Table 2. Criteria for grouping mathematical connection ability.

Category	Achievement of Mathematical Connection Ability
Low	$0\% \leq x < 50\%$
Medium	$50\% \leq x < 70\%$
High	$70\% \leq x < 100\%$

To obtain information related to the results of questions that assess the ability of mathematical connections, an assessment guide is needed as a guideline in assigning a score to each statement indicator and the following scoring guidelines criteria are used according to Fajriani in (Wismayani et al., 2023) as follows in Table 3.

Table 3. Test scoring guidelines.

Score	Information
0	Not answering questions
1	Imprecise in making mathematical connections and incorrect answers
2	Not right in making connections but the right answer
3	Can make a good connection, but there are errors in the calculation process and incorrect answers
4	Can make good connections, good calculation and workmanship processes and right answers

The analysis of exam results is used to measure students' mathematical connectedness abilities and identify mistakes that often occur by them and provide explanations (Zainudin et al., 2021).

RESULTS AND DISCUSSION

Results

Based on the results of the descriptive test questions that have been worked on by 22 students that have been provided and compiled as in Table 1, the following are presented the results of the mathematical connection ability test conducted by 22 grade IX junior high school students attempted to solve the four descriptive test items that have been given.

Table 4. Results of the mathematical connection ability test for grade ix students.

No	Student Name Code	Category Scores Based on Questions				Total Score	Percentage of Achievement of Mathematical Connection Ability	Category
		No.1	No.2	No.3	No.4			
1	S1	1	3	3	3	10	65%	Medium

2	S2	2	3	3	2	10	62.5%	Medium
3	S3	1	3	1	3	8	52.5%	Medium
4	S4	1	3	3	3	10	65%	Medium
5	S5	1	3	3	3	10	65%	Medium
6	S6	1	3	2	3	9	58.75%	Medium
7	S7	4	3	1	3	11	67.5%	Medium
8	S8	1	3	3	3	10	65%	Medium
9	S9	4	3	1	3	11	67.5%	Medium
10	S10	1	3	1	1	6	31.25%	Low
11	S11	1	1	1	3	6	46.25%	Low
12	S12	1	2	3	0	6	36.25%	Low
13	S13	1	1	0	0	2	11.25%	Low
14	S14	4	3	3	4	14	87.5%	High
15	S15	1	3	3	4	11	72.5%	High
16	S16	4	3	3	4	14	87.5%	High
17	S17	4	3	4	4	15	93.75%	High
18	S18	2	3	3	4	12	77.5%	High
19	S19	4	3	1	4	12	75%	High
20	S20	4	3	1	4	12	75%	High
21	S21	1	3	4	3	11	71.25%	High
22	S22	4	3	3	4	14	87.5%	High

Based on Table 4, the results of the test were presented by 22 students. Each student was given a score for each question, which was then summed and converted to the percentage of achievement of mathematical connection ability, which was then qualified and categorized into three categories, namely low, medium, and high based on the criteria for grouping mathematical connection ability.

Table 5. Qualification of students' mathematical connection ability.

No.	Categories Mathematical Connections	Percentage	Sum
1	Low	$0\% \leq x < 50\%$	4
2	Medium	$50\% \leq x < 70\%$	9
3	High	$70\% \leq x < 100\%$	9

After conducting assessments and grouping based on the scoring guidelines of mathematical connection ability, the researcher then determined 3 students as selected respondents for further analysis. This selection is based on 3 categories, namely one student with a low category of mathematical connection ability, one student with a medium category level of mathematical connection ability, and one student with a high category of mathematical connection ability. The information on the selection of 3 students as respondents for further analysis, is coded as in Table 6, as follows.

Table 6. Coding three student representatives.

No.	Student Code	Subject Description
1	S17	Students with a high category of mathematical

		connection ability level
2	S5	Students with a moderate level of mathematical connection ability
3	S10	Students with a low category level of mathematical connection ability

Based on Table 6, the code is presented by three students who are representatives of the respondents. The selection of these three students aims to obtain a more comprehensive picture of the characteristics of mathematical connection abilities in solving story problems in probability materials based on academic level.

Discussion

Based on the previous findings, this study aimed to describe and explain the mathematical connection ability of grade IX junior high school students in solving story problems in probability material. The researcher did this by giving students a description of four questions arranged based on indicators of their mathematical connection ability. The results of the students' mathematical connection ability test are shown below in Table 7, according to (Putri & Suripah, 2022).

High Mathematical Connection Ability

Table 7. S17 test results in the high academic category.

Mathematical Connection Ability Indicator	Question Number	Description
Ability to connect mathematical concepts with other topics	1	S17 was able to solve the problem at number 1, and can connect the concept of probability with the ratio and was able to solve the problem with the right calculation. However, attempted to solve the problem, S17 did not solve the problem systematically by writing down the known and the asked information, but writing down the solution to the question directly.
Ability to connect mathematical concepts with other fields	2	S17 can solve the problem at number 2, and can relate the concept of probability to other fields, such as sports. However, attempted to solve the problem, S17 has not worked on the problem systematically by writing down what is known and what is asked instead of directly writing down the solution. S17 got an unsatisfactory score on question number 2 point b because it only answered part of the question from point b.
Ability to connect	3	S17 has the ability to solve problems at

mathematical concepts with everyday life	4	number 3, has the ability to relate the concept of probability to daily life, and has the ability to solve problems with precise calculations. However, attempted to solve the problem, S17 has not worked on the problem systematically by writing down what is known and asked, but directly writes the solution to the problem. S17 has the ability to solve problems at number 4, has the ability to relate the concept of probability to daily life, and has the ability to solve problems with proper calculations. However, attempted to solve the problem, S17 has not worked on the problem systematically by writing down what is known and asked, but directly writes the solution to the problem.

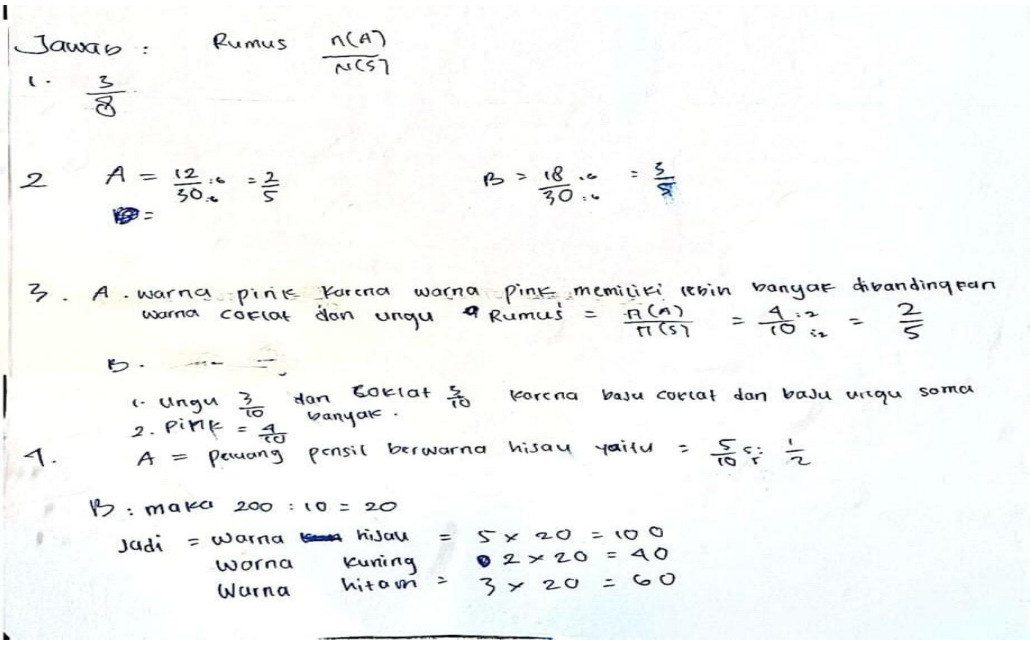

Figure 1. Answer S17 in the high academic category.

The following are the results of the interview on students' mathematical connection skills according to (Julaeha & Fathani, 2020).

Table 8. Results of S17 interviews in the high academic category

Student Name Code	Interview Results

S17	S17 has studied probability material in grade 8 semester 2. According to him, this material is quite difficult, especially in terms of application in the matter of stories. He had difficulty turning story problems into proper mathematical forms. S17 states that he used the fractional form when solving the first question. The step that S17 does is to add all the fruits first, then put the number of kiwifruit in the counter and the total number of fruits in the denominator. But in solving math problems, S17 sometimes always forgets to make it known and asked. Regarding the application of probabilities in daily life, S17 admitted that he was not sure how the concept could be applied in daily life.

Based on the data presented in Table 7 and Figure 1, S17 has been able to do all four questions well by using the concept of probability and precise calculation operations. However, even though the concept of probabilities and calculation operations are correct, S17 tends to answer with steps that are not yet systematic. S17 has not been able to work on the questions given by writing "known", "asked" first, but directly to the solving section. In addition, in question number 2b, S17 failed to provide a complete answer because it did not carefully examine the questions asked.

Overall, S17 demonstrated strong mathematical connection skills in probability. This is in line with the opinion of (Wildaniati et al., 2021) that the ability of mathematical connections is the ability of a person to relate mathematical ideas to things in daily life or to ideas from other fields of science.

Based on the results of the interviews that have been explained, S17 already understands the concept of probability, but when given a story question, he is sometimes still confused about understanding and relating the story problem and making his mathematical model. This is in line with the research conducted by (Putridayani & Chotimah, 2020) which concluded that students still have difficulty understanding mathematics material, especially when probability material is given in the form of story problems. Probability materials allow students to understand the problem in a more direct way than reading it through a story.

Medium Mathematical Connection Ability

Table 9. S5 test results in the medium academic category.

Mathematical Connection Ability Indicator	Question Number	Description
Ability to connect mathematical concepts with other topics	1	S5 attempted to solve question number 1, S5 has not worked on the problem systematically by writing down what is known and asked, as well as the formula used but directly writes down the solution or calculation on the

		problem, even though the answer he writes is correct.
Ability to connect mathematical concepts with other fields	2	S5 was able to solve the problem at number 2, and can connect the concept of probability with another field, namely the field of sports. However, attempted to solve the problem, S5 has not worked on the problem systematically by writing down what is known and asked, but directly writes the solution to the problem. In question number 2b, S5 only answered part of the question from point b, therefore S5 got a score that was not optimal.
Ability to connect mathematical concepts with everyday life	3	S5 was able to solve question number 3 at point a, but at point b, S5 does not answer the core of what is asked in the question, but in the calculation process that S5 makes is correct and it results in S5 not getting the maximum score on question number 2. Then, S5 is also still working on the problem not systematically by writing down what is known and asked, but directly writes the solution to the problem.
	4	S5 was able to solve the problem at number 4, but at point b in the question work on the steps there is an error in the calculation steps/operations that caused ambiguity for the researcher in understanding what S5 is doing. Furthermore, S5 does not work on questions systematically by writing down what is known and what is asked. Instead, he wrote down the solution of the problem directly.

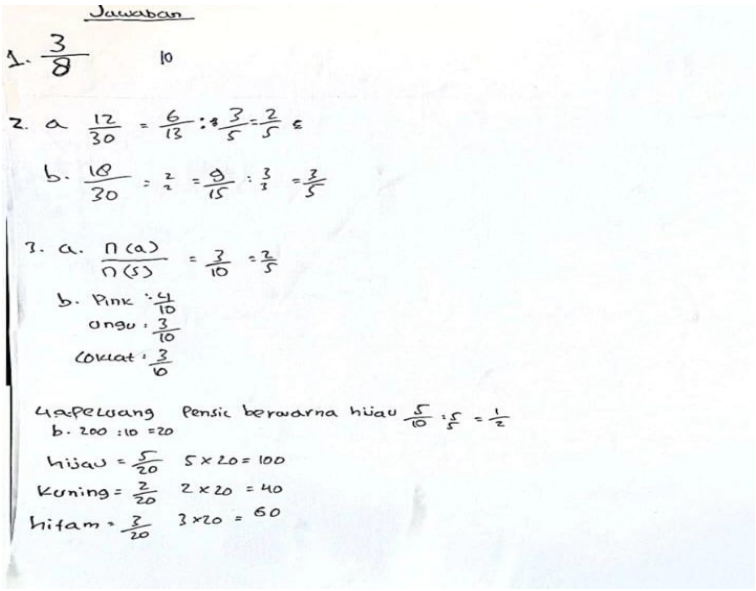

Figure 2. S5 answers in the medium academic category.

Table 10. S5 interview results in the medium academic category.

Student Code	Name	Interview Results
S5		The S5 said that S5 had studied probability material in grade 8 and considered this material quite easy. When working on the questions, S5 also had time to be helped by his friend. However, S5 has difficulty in answering question number 4, especially in part b. Nonetheless, S5 argues that probability materials can be used in everyday life.

Based on the data presented in Table 9 and Figure 2, S5 has been able to do the four questions well by using the concept of probability and precise calculation operations. However, even though the concept of probabilities and calculation operations is correct, S5 tends to answer with steps that are not yet systematic. S5 is not able to work on the questions given by writing "known", "asked" first, but directly to the solution section. In question number 1, S5 worked on the question by directly writing the answer without writing down the formula and the steps to work on it, thus creating an ambiguous understanding of the researcher, whether S5 really understood the question well, or S5 saw his friend's answer. In addition, in question number 2b, S5 failed to provide a complete answer because he did not pay attention to the questions asked, as seen in the answer S17. And in question number 4b, the completion steps written by S5 tend to be confusing, so that the presentation of the answer becomes difficult for researchers to understand. This is in line with the research conducted by Wati and Ningtyas in (Widiyawati et al., 2020) where students' carelessness caused them to make mistakes in calculation operations or errors in their computing skills because they did not understand the concepts or steps of the calculation operations that should be used, and they were also not very thorough when solving problems. Nevertheless, S5 clearly has a pretty good ability in relation to mathematical connections with probability material.

Based on the results of interviews with S5 students, it shows that S5 has studied probability material in grade 8 and considers it easy to understand. However, S5 showed that his understanding of the material was not completely independent, because S5 admitted that he had asked his friend for help when working on the questions. In question number 4, S5 admitted that it was quite difficult, especially part b, where S5 was not sure of the answer choice he took, therefore, when working on the question S5 made an ambiguous step. However, S5 states that the concept of probability can be used in real-world situations, showing that students have a basic understanding of how mathematical concepts relate to real-world situations.

However, they need to get help and expand their understanding of how the concept of probability relates to everyday life, as shown by research conducted by (Izasmi et al., 2025) that several factors cause students to still have difficulty associating mathematical concepts with daily life, such as learning methods that do not fit into daily life and lack of practice to apply mathematics in everyday life. Real-life situations, as mathematics is only

given as a theory or formula without telling students how to use it in everyday life.

Low Mathematical Connection Ability

Table 11. S10 test results in the low academic category.

Mathematical Connection Ability Indicator	Question Number	Description
Ability to connect mathematical concepts with other topics	1	S10 attempted to solve question number 1, S10 did not solve the problem systematically by writing down the known and the asked information, as well as the formula used but directly writing the solution or calculation on the problem, even though the answer that S10 writes or gives is correct.
Ability to connect mathematical concepts with other fields	2	S10 attempted to solve question number 2 points a and b, S10 has not worked on the problem systematically by writing down what is known and asked, as well as the formula used but directly writes the solution or calculation on the problem, even though the answer that S10 writes or gives is quite correct, but when S10 wants to make an answer with simpler fractions, S10 makes a mistake in simplifying the fraction.
Ability to connect mathematical concepts with everyday life	3	S10 cannot answer the question in question number 3a correctly; in the case of 3b, S10 just rewrites what he already knows, and doesn't solve the problem to the end well.
	4	S10 can do problem number 4 at point a well, but at point b in the question work step, S10 does not understand well what the problem means, or it can also be said that S10 is still confused in solving the problem.

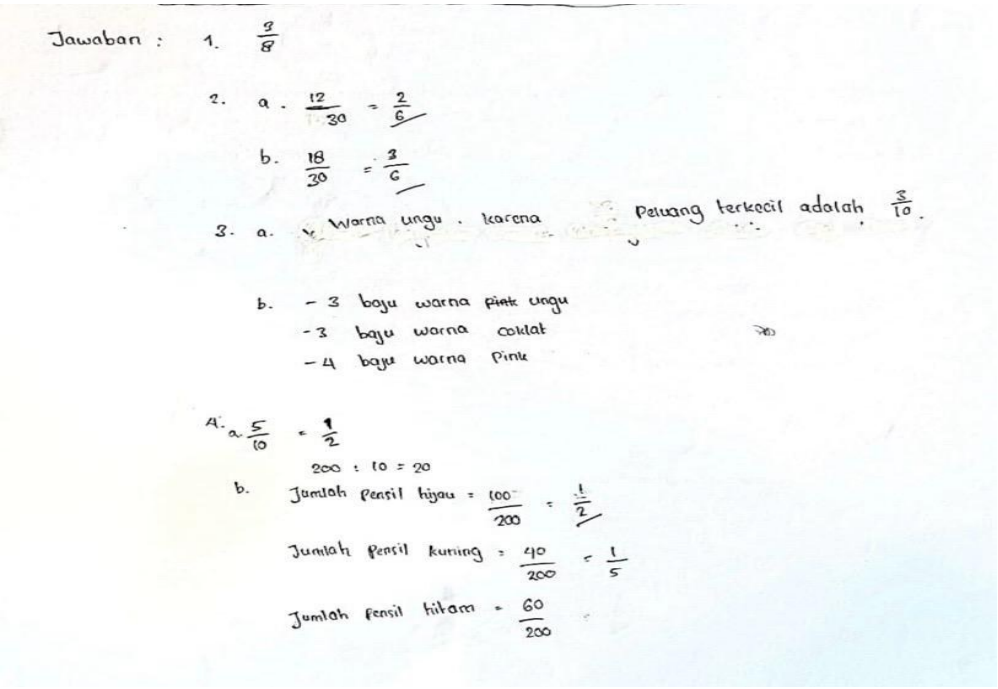

Figure 3. S10 answers in the low academic category.

Table 12. S10 interview results in the low academic category.

Student Name Code	Interview Results
S10	S10 said that S10 had studied probability material in grade 8 and returned to study it in grade 9. Therefore, S10 feels that this material is quite familiar and relatively easy. According to him, the story problems in the probability material are actually not difficult, but it requires precision in understanding the content of the questions so that they can be converted into mathematical forms. S10 explained that in the first question, because the number of kiwifruit is known and the total number of all fruits is 8, S10 can directly state the probability in the form of fractions, namely $^3/_8$. This is possible because S10 already understands the formula used and the numbers in the questions are already available. S10 also argues that material probabilities are important in everyday life, because often in mathematics questions related to real situations in life are encountered.

Based on the data presented in Table 11 and Figure 3, S10 has not been able to do the four questions well in using the concept of probability and proper calculation operations, S10 also does not do the problem with a systematic step by writing down first known and asked. Although based on the results of the interviews that have been presented in table 12, that S10 admits that this question is quite easy, but in practice S10 is not thorough and careful in understanding the problem and in the calculation operations that he does. S10 made a computational error when it wanted to simplify the

fraction in question number 2, which resulted in a final answer that didn't match what it should have been. Furthermore, in question number 4b, S10 does not understand how to solve the question asked, as shown in Figure 3. This is in line with research conducted by (Kraeng, Yosef Fredrik Lagadoni Meran., Rahaju., Murniasih, 2021) that students do not have the ability to understand problems and create basic mathematical models. As a result, they face problems choosing the right formula, implementing the data in the problem to the formula, and finding solutions to the problems in the problems.

Furthermore, students with low-level mathematical connection abilities face the challenge of understanding and connecting the concept of probability to ratio material, other fields of science, especially sports, and everyday life. This study is in line with the findings of research conducted by (Izasmi et al., 2025), which showed that students with low-level mathematical connection abilities showed that they did not have enough understanding of the questions given, lacking.

CONCLUSIONS

The mathematical connection ability studied includes the relationship between mathematical concepts, their connection with other fields of science, and their relationship with daily life. Of the 22 students, 9 demonstrated high mathematical connection ability, 9 moderate ability, and 4 low ability. Further analysis of three representative students showed that those in the high category could relate probability concepts effectively, although their solutions were not always systematic. Students in the medium category displayed partial understanding but required assistance and occasionally made errors in structuring their solutions. Meanwhile, students in the low category struggled to interpret story problems and to connect probability concepts with the given contexts. It is therefore recommended that students practice solving story problems in a systematic manner, enabling them to strengthen their mathematical connection skills and apply mathematical concepts not only in academic settings but also in everyday life.

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