The Students' Ability in The Mathematical Literacy for Uncertainty Problems on The PISA Adaptation Test

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Abstract. One of purposes of this study was to describe the solution profile of the junior high school students for the PISA adaptation test. The procedures conducted by researchers to achieve this objective were (1) adapting the PISA test, (2) validating the adapting PISA test, (3) asking junior high school students to do the adapting PISA test, and (4) making the students' solution profile. The PISA problems for mathematics could be classified into four areas, namely quantity, space and shape, change and relationship, and uncertainty. The research results that would be presented in this paper were the result test for uncertainty problems. In the adapting PISA test, there were fifteen questions. Subjects in this study were 18 students from 11 junior high schools in Yogyakarta, Central Java, and Banten. The type of research that used by the researchers was a qualitative research. For the first uncertainty problem in the adapting test, 66.67% of students reached level 3. For the second uncertainty problem in the adapting test, 44.44% of students achieved level 4, and 33.33% of students reached level 3. For the third uncertainty problem in the adapting test n, 38.89% of students achieved level 5, 11.11% of students reached level 4, and 5.56% of students achieved level 3. For the part a of the fourth uncertainty problem in the adapting test, 72.22% of students reached level 4 and for the part b of the fourth uncertainty problem in the adapting test, 83.33% students achieved level 4.

INTRODUCTION

Program for International Student Assessment (PISA) was an international program sponsored by the OECD, which was a membership of 30 countries, to assess the literacy skills in reading, mathematics, and science of students aged about 15 years. The purpose of the mathematical literacy test in the PISA test was to measure how students apply mathematical knowledge that they have to solve a set of problems in a variety of real context. PISA defines mathematics literacy was an individual's ability to identify and understand the role of mathematics in the world, to make an accurate assessment, to use and involve mathematics in various ways to meet the needs of individuals as reflective, constructive and filial citizens [8].

From several studies reported that in a modern society in the 21st century that humans not only required a content knowledge, but they also required skills that called as 21st century skills that include critical thinking and problem solving, creativity and Innovation, communication and collaboration, flexibility and adaptability, initiative and self-direction, social and cross-cultural, productivity and accountability, leadership and responsibility, and information literacy [2, 8]. Mathematical literacy became one of the components necessary to build 21st century skills.

In 2015, Indonesia followed the PISA test for the fifth time. In the 2015, ranking Indonesia for PISA tests were 62 for science, 63 for mathematics, and 64 for reading from 70 countries. These results generally improved, especially for scientific literacy and mathematics. In the PISA test at 2012, ranking literacy in science and mathematics was 64 and 65, while the areas of reading literacy in 61 of 65 countries. The average score on the PISA tests at 2015 were as follows 403 for science, 386 for math, and 397 for reading. The average score on the PISA tests at 2012 were as follows 382 for science, 375 for math, and 396 for reading (source: www.oecd .org / pisa). The material of the PISA

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tests in mathematical literacy can be grouped into four group, namely (1) the quantity, (2) space and shape, (3) change and relationship, and (4) uncertainty [1]. One of the research questions that would be answered by researchers in this paper was how were the solution profiles of junior high school students for the adapting PISA test for uncertainty problems.

THE PISA TEST

PISA was an international program sponsored by the OECD, which was a membership of 30 countries, to determine the ability of reading literacy, mathematical literacy, and science literacy of students aged about 15 years. According to Jan de Lange, mathematical literacy was an individual's ability to identify and understand the role of mathematics in the world, to make an accurate assessment, use and involves mathematics in various ways to fulfill the individual needs as a reflective, constructive and filial citizen [3].

According to Jan De Lange, the following competencies would form the mathematical literacy skills, namely: (1) the thinking and reasoning mathematically competence, (2) the argumenting logically competence, (3) the communicating mathematically competence, (4) the problem modelling competence, (5) the proposing and solving problem competence, (6) the representing idea competence, and (7) the using symbol and formal language competence [3].

There are six levels in the PISA questions related to mathematical literacy of students. Below is a description of each level of matter [6]:

1. First level, namely: (a) students could answer questions involving familiar contexts where all relevant information was present and the questions were clearly defined, (b) they were able to identify information and to carry out routine procedures according to direct instructions in explicit situations, and (c) they could perform actions that were obvious and follow immediately from the given stimuli.
2. Second level, namely: (a) students could interpret and recognize situations in contexts that require no more than direct inference, (b) they could extract relevant information from a single source and make use of a single representational mode, (c) they could use basic algorithms, formulae, procedures, or conventions, and (d) they are capable of direct reasoning and making literal interpretations of the results.
3. Third level, namely: (a) students could execute clearly described procedures, including those that required sequential decisions, (b) they could select and apply simple problem solving strategies, (c) they could interpret and use representations based on different information sources and reason directly from them, and (d) they could develop short communications reporting their interpretations, results and reasoning.
4. Fourth level, namely: (a) students could work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions, (b) they could select and integrate different representations, including symbolic ones, linking them directly to aspects of real-world situations, (c) they could utilize well-developed skills and reason flexibly, with some insight, in these contexts, and (d) they could construct and communicate explanations and arguments based on their interpretations, arguments, and actions.
5. Fifth level, namely: (a) students could develop and work with models for complex situations, identifying constraints and specifying assumptions, (b) they could select, compare, and evaluate appropriate problem solving strategies for dealing with complex problems related to these models, (c) they could work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations, and (d) they could reflect on their actions and formulate and communicate their interpretations and reasoning.
6. Sixth level, namely: (a) students could conceptualise, generalise, and utilise information based on their investigations and modelling of complex problem situations, (b) they could link different information sources and representations and flexibly translate among them, (c) they were capable of advanced mathematical thinking and reasoning, (d) they could apply this insight and understandings along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations, and (e) they could formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations.

METHOD

In a qualitative study, the researcher sought to describe a phenomenon that occurred in a natural situation and not make a quantification of the phenomenon [4, 5]. This research was classified in the qualitative research, because in this study the researchers sought to describe a phenomenon that occurred in a natural situation and did not make a quantification of the phenomenon. A natural phenomenon that was described in this study was how the junior high school students solved the adapting PISA test.

One of purposes of this study was to describe the solution profile of junior high school students for the adapting PISA test. The process conducted by researchers to achieve this objective was as follows:

1. Adapting the PISA test;
2. Validating the adapting PISA test;
3. Asking junior high school students to solve the adapting PISA test.
4. Describing the junior high school student solution profiles for the adapting PISA test.

In the adapting PISA test, there were fifteen questions that consist of two questions for quantity, six questions for space and shape, three questions for change and relationship, and four questions for uncertainty. The time given to students to take the test was 90 minutes.

There were 18 junior high school students who had 14-15 years old as the subject of this study. The were came from 11 junior high schools in Yogyakarta, Central Java, and Banten. The steps to choose these subjects were the researchers chose the schools proportional randomly and then the researchers chose the best students in those schools to become our research subjects.

RESULTS AND DISCUSSION

The research results that would be presented in this paper were the result test for uncertainty problems. In the following section, researchers would present the solution profile of the junior high school students for the uncertainty problems.

1. The first problem:
   Adi had a drawer full of socks that contain white, brown, red, and black sock. How many minimum socks that Adi should be taken out of the drawer, so Adi could get at least a couple of the same color sock.
   The solution profiles of students for the first problem were as follows:
   a. Nine of 18 students answered 5 times. Their reasoning was as follows: suppose that Adi took four socks from the drawer and he got four different color socks. So, if Adi take a sock from the drawer for the fifth time, then he would have to get a pair of the same color sock. So, Adi would get at least a pair of the same color sock if Adi has taken at least 5 times. The students' answer for this problem could be incorporated into level 3, because students could explain how the procedures were used to solve the problems mentioned above. (the example of the student's answer could be seen in figure 1).
   b. Three of 18 students answered four times. Students thought that there were only three different color socks in the drawer. Students thought that Adi had already taken three times and got three different color socks. So, if Adi took one sock from the drawer, then he would get at least a pair of the same color sock. So, students thought that Adi only required 4 times. The students' answer for this problem could be incorporated into level 3, because students could explain how the procedures were used to solve the problems mentioned above.
   c. One of 18 students answered $\frac{1}{4}$. Student thought that there were three different colour socks in the the drawer. Student thought that Adi had already taken three times and got three different color socks. So, if Adi took one sock from the drawer, he would get at least a pair of the same color sock. So, student thought that Adi only required 4 times, then student think about the probability of this event was $\frac{1}{4}$.
   d. Five students did not answer this problem.

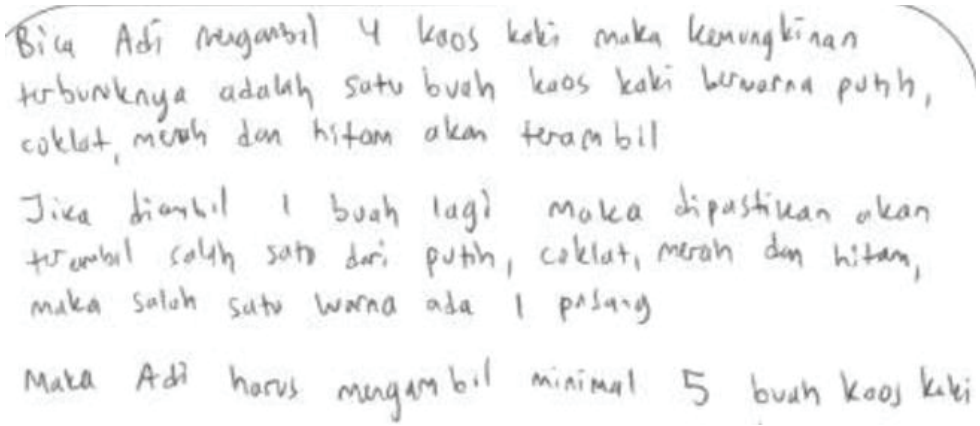


FIGURE 1. The example of student's answer to the first question

2. The Second problem :

   A terkali number was a natural number in which the first and second digit of the number was a natural number and the next digit was the product of two numbers that occupy the first and second digits. For example, 7856, 236, and 200 was the terkali number because the first two digits were a natural number and the next digits were the multiplication result for the first and the second digit. For the note, the first digit must not be 0. How many the terkali number was possible?

   The students' solution profiles for the second problem were as follows:

   a. There were four students who did not answer the question.
   b. In general, there were three methods that students use to solve this problem.
      1) Filling slot method.
         a) This method was used by six students (the example of the student's answer could be seen in figure 2).
         b) The students knew that the number of the terkali number only influenced by the first two digits only.
         c) The students knew that the first digit could be charged with 9 possibilities and the second digit could be filled with 10 possibilities.
         d) The student stated that the number of the terkali number was $9 \times 10 = 90$ numbers.
         e) The students' answer for this problem could be put in level 4 because these students were able to interpret the information in the question and were able to create relationships between the information so that they could solve the problem.
      2) Finding the pattern and calculating the number of the possibility.
         a) This method was used by two students (the example of the student's answer could be seen in figure 3).
         b) The students knew that the number of the terkali number only influenced by the first two digits only.
         c) Students wrote the whole possibility of the first two digits and write it in the form of {10, 11, 12, 13, ..., 98. 99}. He had calculated that the number of the possibility was $99 - 10 + 1 = 90$.
         d) The students' answer for this problem could be put in level 4 because these students were able to interpret the information in the question and were able to create relationships between the information so that they could solve the problem.
      3) Recording and calculating the number of the possibility.
         a) This method was used by six students.
         b) Students wrote all of the terkali number systematically, and counting them systematically.
         c) The students' answer for this problem could be incorporated into level 4 because these students were able to interpret the information in the question and were able to create relationships between the information so that they could solve the problem.

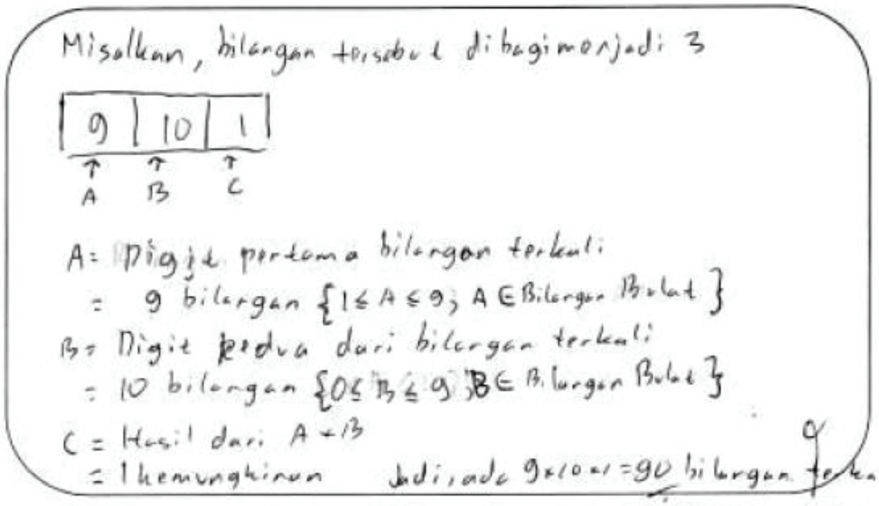


FIGURE 2. The example of the student's answer using filling slot method to solve the second problem

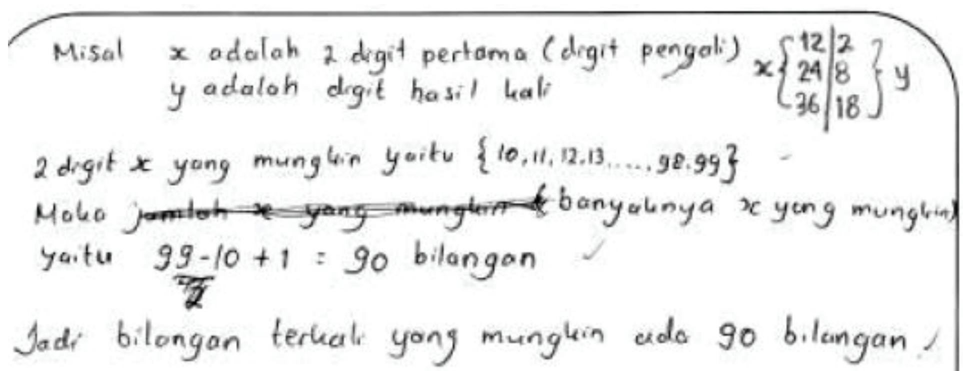
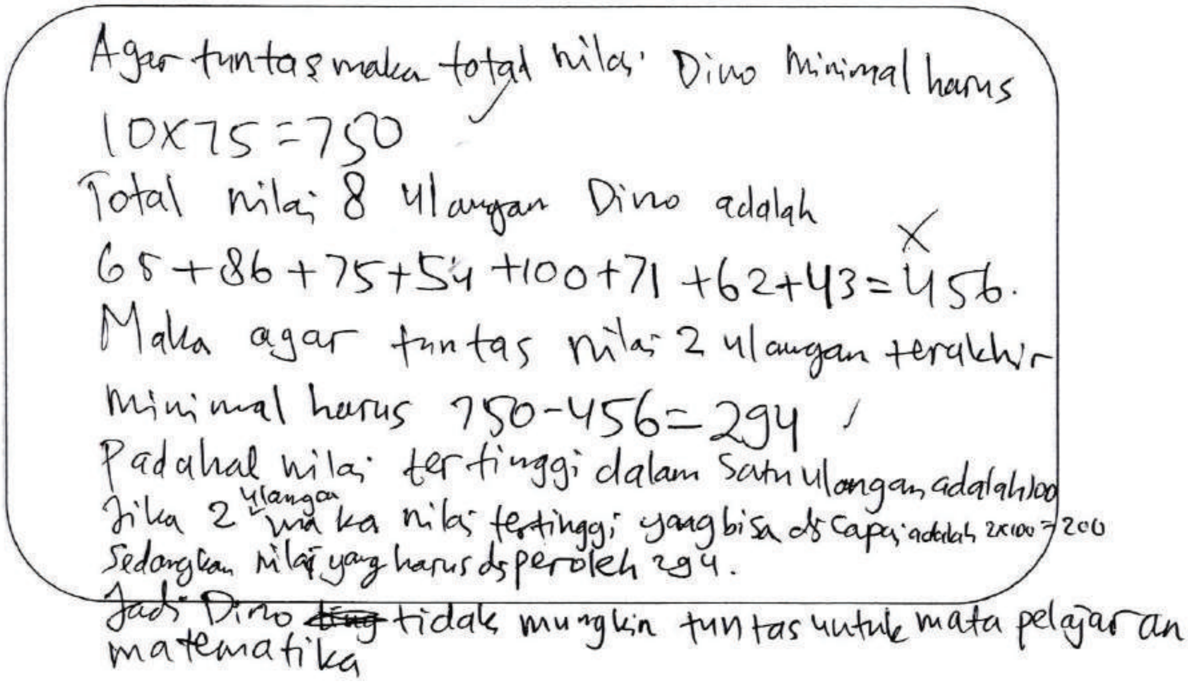


FIGURE 3. The example of the student's answer using second method to solve the second problem

3. The third problem:
   There were 10 math test held this semester. For 8 math test, the scores of Dino were as follows: 65, 86, 75, 54, 100, 71, 62, and 43. The student passed for mathematics if they got the average of the mathematics score test more than or equal 75. Did Dino possible to pass for mathematics? Please, write down your reasons!
   The students' solution profiles for the third problem were as follows:
   a. Generally, there were five methods used by students to solve the third problem.
   b. In the first method, students connected the passing requisite and average, but they did not make the right conclusion. Students did not read the problem carefully, because they only used 8 mathematics test scores to make a decision. Though there were two possibilities of data that needs to be seen. Consequently, the students' conclusion was not right. There were 8 students from 18 students who did this strategy.
   c. In the second method, students connected the passing requisite and average, they could make the right conclusion, but they made a mistake in a calculation. Students connected the passing requisite and average of the mathematics score test, students realized that the maximum mathematics score test was 100, students were able to reformulate the average formula, students were able to understand that there were two data that needs to be unlikely, and the students have been able to draw the right conclusion for this problem, but they made a mistake in calculating (the example of student's answer could be seen in Figure 4). There were three students from 18 students who done this strategy. The students' answer for this problem could be incorporated into level 5 because the students were able to reformulate a average formula and were able to explain why they did that solution steps to solve this problem, even though they did mistake in a calculation.


Agar tuntas maka total nilai Dino minimal harus

$10 \times 75 = 750$

Total nilai 8 ulangan Dino adalah

$65+86+75+54+100+71+62+43=456.$

Maka agar tuntas nilai 2 ulangan terakhir

minimal harus $750-456=294$

Padahal nilai tertinggi dalam satu ulangan adalah 100

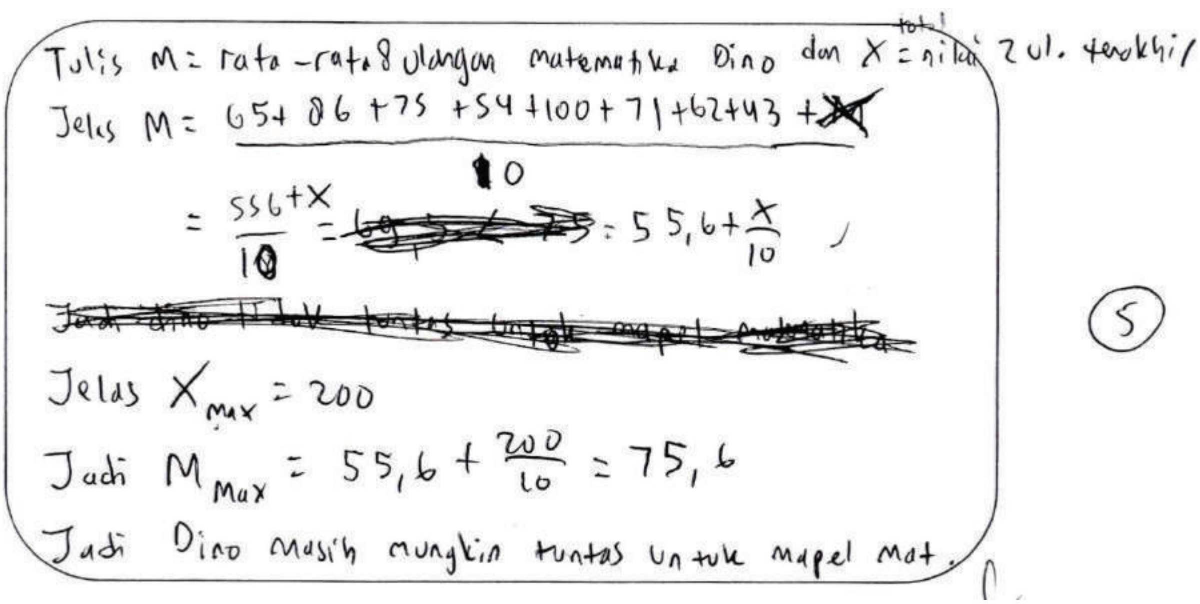
Jika 2 ulangan maka nilai tertinggi yang bisa di capai adalah $2 \times 100 = 200$

Sedangkan nilai yang harus di peroleh 294.

Jadi Dino ~~dng~~ tidak mungkin tuntas untuk mata pelajaran matematika

FIGURE 4. The example of student' answer who used the second method to solve the third problem

d. In the third method, students connected the passing requisite and average, they could make the right conclusion. Students connected the passing requisite and average of the mathematics score test, students realized that the maximum mathematics score test was 100, students were able to use the average formula, students were able to understand that there were two data that needs to be unlikely, and the students have been able to draw the right conclusion for this problem (examples of student work can be seen in Figure 5). There were two students from 18 students who did this strategy. The students' answer for this problem could be put in level 4 because students did not reformulate the average formula, but only used the formula and they were able to explain why they did that solution steps to solve this problem.


Tulis M = rata-rata 8 ulangan matematika Dino dan X = nilai total 2 ul. terakhir

Jelas $M = \dfrac{65+86+75+54+100+71+62+43+X}{10}$

$= \dfrac{556+X}{10} = 55,6 + \dfrac{X}{10}$

~~Jadi dino tidak tuntas untuk mapel matematika~~

Jelas $X_{max} = 200$

Jadi $M_{Max} = 55,6 + \dfrac{200}{10} = 75,6$

Jadi Dino masih mungkin tuntas untuk mapel mat.

5

FIGURE 5. The example of student' answer who used the third method to solve the third problem

e. In the fourth method, students connected the passing requisite and average, they could make the right conclusion. Students connected the passing requisite and average of the mathematics score test, students realized that the maximum mathematics score test was 100, students were able to reformulate the average formula, students were able to understand that there were two data that needs to be unlikely, and the students have been able to draw the right conclusion for this problem (examples of student work can be seen in Figure 6). There were four students from 18 students who did this strategy. The students' answer for this problem could be incorporated into level 5 because the students were able to reformulate a average formula and were able to explain why they did that solution steps to solve this problem.

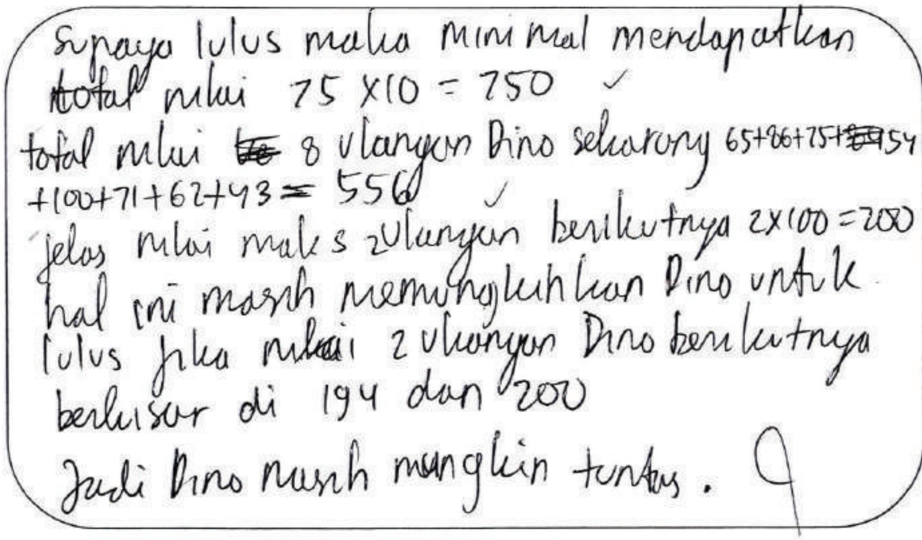


FIGURE 6. The example of student' answer who used the fourth method to solve the third problem

f. In the fifth method, students connected the passing requisite and average, they could make the right conclusion, but he did not write the solution completely. Students connected the passing requisite and average of the mathematics score test, students realized that the maximum mathematics score test was 100, students were able to reformulate the average formula, students were able to understand that there were two data that needs to be unlikely, and the students have been able to draw the right conclusion for this problem, but he did not write the solution completely. There was one student of 18 students who did this strategy. The students' answer for this problem could be incorporated into Level 3, because the student could explain briefly about his problem interpretation and his reason why he did solution steps.

4. The fourth problem:

Four soccer players did penalty kick exercises. The results were presented in the following table:

Name	The number of penalty kicks	The number of success penalty kicks
Arif	12	10
Bambang	10	8
Candra	20	15
Dedi	15	12
Gimin	14	12

a. Who did have the greatest chance of success in performing the penalty kick?
b. If Bambang conducted penalty kicks for 65 times, then how many successful penalty kick was done by Bambang?

The students' solution profiles for the part a of the fourth problem were as follows:

a. Six of 18 students did as follows:
The probability of Arif was $\frac{10}{12} \times 100\ \% = 83{,}33\ \%$. The probability of Bambang was $\frac{8}{10} \times 100\ \% = 80\ \%$. The probability of Candra was $\frac{15}{20} \times 100\ \% = 75\ \%$. The probability of Dedi was $\frac{12}{15} \times 100\ \% = 80\ \%$. The

probability of Gimin was $\frac{12}{14} \times 100\ \% = 85{,}71\ \%$. So, the player who had the greatest chance of success in making a penalty kick was Gimin, because he had the greatest chance (the example of students' answers could be seen in Figure 7).

The students' answer for this problem could be categorized into level 4, because students could connect the information about the number of penalty kicks and the number of success penalty kicks with the probability concept. Students were able to use appropriate strategies to compare the probability for all of penalty kickers.

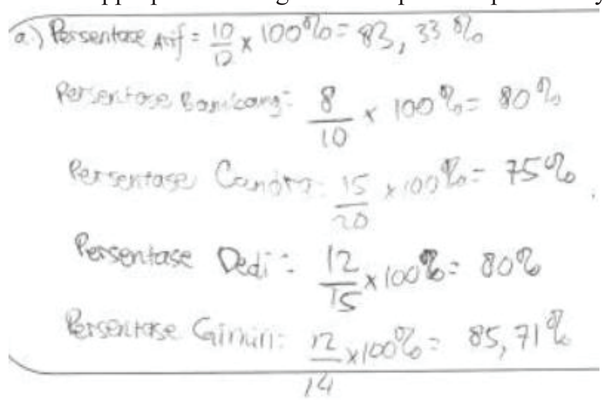


FIGURE 7. Examples of student work using the strategy percent to answer the fourth part of a group of uncertainty

b. Seven of 18 students responded as follows:
   The probability of Arif was $\frac{10}{12} = \frac{5}{6} = \frac{350}{420}$. The probability of Bambang was $\frac{8}{10} = \frac{4}{5} = \frac{336}{420}$. The probability of Candra was $\frac{15}{20} = \frac{3}{4} = \frac{315}{420}$. The probability of Dedi was $\frac{12}{15} = \frac{4}{5} = \frac{336}{420}$. The probability of Gimin was $\frac{12}{14} = \frac{6}{7} = \frac{360}{420}$. So, the player who had the greatest chance of success in making a penalty kick was Gimin, because he had the greatest chance.
   The students' answer for this problem could be categorized into level 4, because students could connect the information about the number of penalty kicks and the number of success penalty kicks with the probability concept. Students were able to use appropriate strategies to compare the probability for all of penalty kickers.
c. Three out of 18 students responded as follows:
   The probability of Arif was $\frac{12}{10} = 1{,}2$. The probability of Bambang was $\frac{10}{8} = 1{,}25$. The probability of Candra was $\frac{20}{15} = 1{,}33$. The probability of Dedi was $\frac{15}{12} = 1{,}25$. The probability of Gimin was $\frac{14}{12} = 1{,}16$.
   So, the player who had the greatest chance of success in making a penalty kick was Candra, because he had the greatest chance. These students had a misconception about the probability concept. They failed to make a connection between the information about the proportional of the number of penalty kicks with the number of success penalty kicks and the probability concept.
d. Two of the 18 students did not answer the question.
   Discussion of student work to part b above matter:

The students' solution profiles for the part a of the fourth problem were as follows:

a. Eleven of 18 students answered the number of Bambang's successful penalty kick from 65 kicks was $\frac{8}{10} \times 65 = \frac{4}{5} \times 65 = 52$ times. The students' answer for this problem could be categorized into level 4 because they could connected the information about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang with the probability concept. Students could think proportionately about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang.
b. Two of 18 students answered the number of Bambang's successful penalty kick from 65 kicks was $80\ \% \times 65 = \frac{4}{5} \times 65 = 52$ times. The students' answer for this problem could be categorized into level 4 because they could connected the information about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang with the probability concept. Students could think proportionately about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang.
c. Two of 18 students answered as follows:

If the number of kicks that would be done by Bambang was 60 times, then the number of the successful penalty kicks was $8 \times 6 = 48$ times.
If the number of kicks that would be done by Bambang was 5 times, then the number of the successful penalty kicks was $\frac{1}{2} \times 8 = 4$ times.
So, the number of the successful penalty kicks was 48 + 4 = 52 times (the example of the student's answer could be see in figure 8).
The students' answer for this problem could be categorized into level 4 because they could connected the information about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang with the probability concept. They could think proportionately about the number of the successful penalty kicks, and the number of kicks that would be done by Bambang.

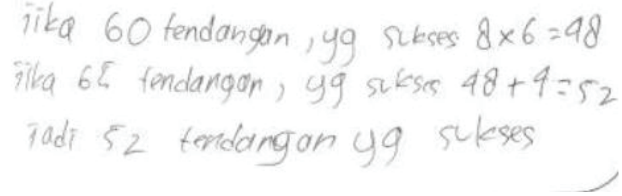


FIGURE 8. Examples of student work that uses proportional thinking to answer the fourth part b uncertainties group

d. One of 18 students answered as follows:
   10 times to kick penalty = 8 times successful penalty kick.
   11 times to kick penalty = 9 times successful penalty kick.
   12 times to kick penalty = 10 times successful penalty kick.
   13 times to kick penalty = 11 times successful penalty kick.
   etc. in order to obtain 65 times to kick penalty = 63 times successful penalty kick.
   In this case, the student assumed that no matter how many kicks performed Bambang, the number of the fail penalty kicks was always two times. It means that student has not been able to think proportionately.
e. Two of 18 students did not answer this problem.

CONCLUSIONS

For the first question, there were 12 of 18 students who achieved level 3. For the second question, there were 8 of 18 students who achieved level 4, and 6 of 18 students who achieved level 3. For the third question, there were 7 of 18 students who reached level 5, two of 18 students who achieved level 4, and one of 18 students who achieved level 3. For the part a of the fourth problem, there were 13 of 18 students who achieved level 4. For the part b of the fourth problem, there were 15 of 18 students who achieved level 4.

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