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Submission date: 30-Aug-2018 10:19AM (UTC+0700)

Submission ID: 994814172

File name: IOSR_JOURNAL_JORNAL_OF_MATH_DENGAN_DWI_IVAYANA_1.pdf (353.14K)

Word count: 5668

Character count: 28143

Analyze of Probability Task Completion of Elementary School Students Based on Math Ability and Gender

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Abstract: This study was aimed to analyze probability task completion of elementary school students. In this qualitative research, data was collected by giving probability tasks (probability of an event and probability comparison) and interview. The result showed that students used a numerator strategy in solving probability of an event task, and they used different strategy in solving probability comparison. Boy with high math ability used strategy by considering set with less non target event, boy with low math ability used strategy by considering set with more target event, girl with high math ability used strategy by considering set with greater difference in favor of target event, and girl with low math ability used strategy by considering set with greater quotient in favor of target event. Students' representation to determine probability of an event was difference. Boy with high math ability used fraction representation, while boy with low math ability used verbal and percentage of his estimate representation, girls with high and low math ability used percentage of their estimate representation. Interestingly, there was one strategy of elementary school student in solving comparison probability task, that was greater quotient in favor of target event.

Keywords: Probabilistic Thinking, Elementary Student, Probability Task, Gender

Date of Submission: 31-10-2017

Date of acceptance: 16-11-2017

I. Introduction

In everyday life, humans are not only faced with past and current problems. However, humans are also faced with future problems. Future problems usually related to uncertain situation. There are some questions or problems in everyday life which contain uncertainty element, ranging from simple questions or problems, such as will it rain today?, will my favorite soccer team win?. Questions or problems rather complete, such as can I be accepted in the mathematics department?. Questions or problems very complete, such as will the volcano erupt?.

In solving a problem which contains uncertainty element, one usually uses a measure to represent the quantity of trust degree. For example, often someone says that 80% of his favorite football team will win, 85% of someone will be accepted in the mathematics department, and 90% of volcanoes will erupt. One concept in mathematics which studies about uncertain situation and the quantity of trust degree is probability. This is line with [1] which stated that probability was the study of likelihood and uncertainty. Furthermore [2] stated that probability was the mathematical way to deal with problems of uncertainty. And then [3] stated that probability was an old mathematical discipline deals with calculating probability of various events. Furthermore [4] stated that probability was an assigned value (actually an estimate) given to the likelihood of a particular outcome occurring in a random situation. It was calculated by forming a part-whole fraction; the numerator was the number of times an outcome can occur and the denominator was the total number of possible outcomes.

Due to the essential of probability, it, then, must be introduced to elementary school level, in order elementary school students are accustomed to solve problems which will occur or problems which contain uncertainty elements. Besides, it can also be a provision for students to learn about probabilities at higher levels. This is in accordance with the statement in NCTM [5] which stated that the learning of probability in the early grades would provide students with a stronger foundation for further study of statistics and probability in high school.

Based on the mathematics curriculum in Indonesia, probability was first taught in the middle level, whereas many research results showed that elementary students, even kindergartens succeed in solving probability task. The results of [6] stated that students at the kindergarten school and preschool on probabilities hold and successfully employed in solving problem related with probability concepts. And then result of [3] with 623 students from 6 primary schools and kindergartens in Slovenia was children in the first three grades were able to differentiate among certain, possible and impossible events, and compare probability of various events, while only half of children aged from 4–5 years were able to do so. Similarly, the study conducted by [7] with 404 students from 3 elementary schools in Florina city in Greece, around the age of 7 to 11 years,

consisting of 77 students of second graders, 81 students of third graders, 83 students of fourth graders, 81 students of fifth graders and 82 students of sixth graders. The result of this study was the majority of students from second graders to sixth graders of elementary school could compare the probability of an event.

Based on the explanation above, it is necessary to analyze the probability task completion of elementary school students in Indonesia. It means, it is necessary to analyze students' strategy and students' representations in solving probability tasks. There are two types of probability tasks (probability of an event and probability comparison). [8] had developed probability task indicator; children's understanding of probability of an event was exhibited by their ability to identify and justify, which two or three events were most likely occur and children's understanding of probability comparisons was measured by their ability to determine and justify, which probability situation was more likely generate the target event in a random draw.

² Related to the strategies used by elementary school students, [9] stated that according to Acredolo et al, there were three strategies to solve probability of an event, namely (a) a numerator strategy in which they only examined the part of the set that corresponds to the target event, (b) an incomplete denominator strategy in which they examined the part that corresponds to the complement of the event, and (c) an integrating strategy in which they related the number of target elements with the total number of elements in the set. Furthermore, [9] stated that according to Acredolo et al, there were three strategies to solve probability comparison, namely (a) set with more target event, (b) set with less non target event, and (c) set with greater difference in favor of target event.

In addition to the strategies used by elementary school students, the analysis probability task completion also needs to know representations used by elementary school students in solving probability tasks. This is in line with Fischbein & Steinbring [9] stated that comparing different representations leads to new insights into the relations between a concrete situation and its stochastic modeling. [10] then [10] stated that there were four categories in observing students' probability task completion, that was (a) types of strategies; (b) representation; (c) use of probabilistic language; (d) the nature of cognitive obstacle. Based on [10], use of probabilistic language can be said as a representation. While the fourth category, it related to the conception and misconception. Thus, the discussion for this category is very broad and needs a different discussion.

Probability tasks completion of each students are different. The difference depends on strategy and representation used by students. The strategy and representation differ based on some aspects. One of them is mathematics ability. In addition, probability tasks completion is also influenced by social and cultural relation aspects. Gender is one that distinguishes boy and girl in social and cultural relation aspects. According to the results of [11] and [12] showed that boy had a higher value than girl. However, [13] in his research stated that there was no significant difference between boy and girl. Based on some research results which has been presented, indicates that it is necessary to investigate probability tasks completion of elementary school students based on math ability and gender.

² II. Method

The research design of this study was qualitative design with descriptive approach. This study had characteristics of qualitative research, that is:

1. It was naturalistic because the data sources was real with researchers as primary instrument.
2. The data was descriptive due to its qualitative nature, because data was derived from students' works and students' verbal.
3. It was inductive, which had no intention to test a hypothesis, but merely describing a phenomena [14].

This study involved 30 students of fifth graders in a elementary school in Bangkalan Indonesia with 14 girls and 16 boys as the research subject. Researcher gave mathematics test to make groups based on math ability (high and low). And then researcher took two sample (boy and girl) on each group by using purposive sampling based on interestingly of students' strategy and students' representation. So that, there were four sample, that was boys with high and low math ability and then girls with high and low math ability.

The aimed of study was to analyze of probability task completion of elementary school student. For reaching up the aimed of study, researcher made probability task was related to probability of an event and probability comparison. Probability task has been validated by expert validator. The problem of probability task showed as following.

1. *Probability of an event.* A box contain balls with the same type and size. The balls are 4 red balls, 3 blue balls and 2 green balls. If you are asked to take a ball from inside the box with your eyes closed, what color ball is most likely to be taken? Give your reason!
2. *Probability comparison.* There are 2 boxes containing markers with the same type and size. Box I contains 2 black markers and 6 red markers. Box II contains 1 black markers and 8 red markers. You are asked to take a marker from the box with your eyes closed. If you want to get a red marker, then which box should you take a marker? Give your reason by using numbers!

14 The procedure of data collection was aimed to analyze of probability task completion of elementary school student. Then, researcher conducted in depth interview based on strategy and representation used by subject.

Data analysis conducted within some procedures which are:

1. Data reduction that aims at assert, select, focus, abstract, and transform all raw data into meaningful ones.
2. Data presentation that included classifying and identifying data which transcribed the organized and categorized data that enabled one to make the conclusion
3. Conclusion making.

III. Result

Based on the results of mathematics ability test, obtained by 4 students; 1 boy with high math ability, 1 boy with low math ability, 1 girl with high math ability and 1 girl with low math ability. And then researcher conducted in depth interview.

Interview results are transcribed and coded as follows.

R_i = i^{th} researcher's question
 BH_i = i^{th} the answer of boy with high math ability
 BL_i = i^{th} the answer of boy with low math ability
 GH_i = i^{th} the answer of girl with high math ability
 GL_i = i^{th} the answer of girl with low math ability

2 Probability tasks completion of boy with high math ability. Figure 1 showed the written answer of boy with high math ability in solving probability of an event task.

Figure 1

1 The written answer of boy with high math ability showed that red ball was most likely to be taken, because the number of red ball was the most. While the interview results showed as following.

R_1 : Why is red ball most likely to be taken?
 BH_1 : 1 because the number of red ball is the most.
 R_2 : If the number of ball is the most, why is it most likely 1 taken?
 BH_2 : (Silence while thinking for 10 seconds) because the number of red ball is 4, if the number of blue ball is 3 and green ball is 2. The most is 4, so 4 is more likely.
 R_3 : How much is the possibility of red ball to be taken?
 BH_3 : Emmm ..., 4/9. If I use fraction, I think 4/9.
 R_4 : Why is it 4/9?
 BH_4 : Because if in fractions the number of red balls per total the number of all the balls. 2

Based on the result of written answer and interviewed, boy with high math ability used a numerator strategy because he only examined a part of the set that corresponds to the target event. He explained that the number of red balls are the most, then red ball most likely to be taken (BH_1 , BH_2). He used fraction representation to determine probability of an event (BH_3 , BH_4).

Figure 2 showed the written answer of boy with high math ability in solving probability comparison task.

Figure 2

The written answer of boy with high math ability showed that box I was most likely to get red ball, because probability of black marker in box I less than probability of black marker in box II. In box I, black marker was $2/8$ and red marker was $6/8$. While in box II, black marker was $2/12$ and red marker was $8/12$. So, in box I the number of black marker less than in box II. While the interview results showed as following.

R₁ : Why do you choose box I?

BH₁ : Because probability of black marker in box I less than probability of black marker in box II. In box I, black marker is $2/8$ and red marker is $6/8$. While in box II, black marker is $2/12$ and red marker is $8/12$. So, in box I the number of black marker less than in box II, so that I choose box I.

R₂ : Do you know if the number of black markers is less than the number of red markers in box I?

BH₂ : Yes, in box II, the number of black markers is less than the number of red markers. But the number of red in box II is 4 and the number of red in box I is 2, so probability of black marker in box I less than probability of black marker in box II.

R₃ : Why do you choose the probability of black marker is less?

BH₃ : Because it's more likely to get red markers.

R₄ : How much is the possibility of red marker to be taken in box I?

BH₄ : In box I, the possibility of red marker is $6/8$.

R₅ : Please explain why is $6/8$?

BH₅ : $6/8$, it's the number of red marker per total the number of black and red markers in box I.

Based on the result of written answer and interviewed, boy with high math ability used strategy by considering set with less non target event. He explained that the probability of black marker in box I less than probability of black marker in box II (BH₁, BH₂), so that it was more likely to get red markers (BH₃). He used fraction representation to determine probability of an event (BH₄, BH₅).

Probability tasks completion of boy with low math ability. Figure 3 showed the written answer of boy with low math ability in solving probability of an event task.

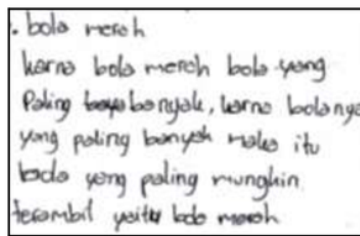


Figure 3

The written answer of boy with low math ability showed that red ball was most likely to be taken, because the number of red ball was the most, so that red ball was most likely to be taken. While the interview results showed as following.

R₁ : Why is red ball which most likely to be taken?

BL₁ : Because the number of red ball is the most. If the number of red ball is the most then red ball is most likely to be taken, because red ball is more secured to be taken.

R₂ : How much is the possibility of red ball to be taken?

BL₂ : Emmm ..., I think, it depends on the amount. I don't know (while smiling). Hmmm ..., (see question) 4 red balls, 3 blue balls, 2 green balls. Difference of the number of balls is one. Green ball is not so taken because the number of green just 2. Suppose the number of red ball is 98 and the number of green ball is 2 then I difficult to get green ball, because I will often get red ball.

R₃ : So, do you think how much is the possibility of red ball to be taken?

BL₃ : I think the possibility of red ball to be taken is very little, because the distance of red and blue balls is not far. If the number of red ball is likely much, then it could be easier to get red ball. I think the possibility of red ball to be taken is very little because there are 4 red balls, 3 blue balls and 2 green balls.

Based on the result of written answer and interviewed, boy with low math ability used a numerator strategy because he only examined a part of set that corresponds to the target event. He explained that the number of red balls was the most, then red ball most likely to be taken (BL₁). He used verbal representation to determine probability of an event by considering the number of each balls (BL₂, BL₃).

Figure 4 showed the written answer of boy with low math ability in solving probability comparison task.

dari kotak ke dua (2)
karna di kotak ke 2 lebih banyak
Spidol merah dari pada kotak 1
karena kita mengambil Spidol merah
inginnya kita ambil dikotak yang banyak
Spidol merahnya itu menyebalkan/memudahkan
kita untuk mendapatkan Spidol merah

Figure 4

The written answer of boy with low math ability showed that box II was most likely to get red marker, cause in box II, the number of red marker in box II more than the number of red marker in box I. If he wanted to get red marker, he took in box which had the number of red marker was more than other box. While the interview results showed as following.

R₁ : Why do you choose box II?

BL₁ : Because the number of red marker in box II more than the number of red marker in box I. So that it easy for us to take red marker. In box I contains 6 red markers. While in box II contains 8 red markers. While in the first box contains 6 red markers.

R₂ : Why is box II easier to get red marker than box I?

BL₂ : Because in box I, the number of red marker is only 6. While in box II, the number of red marker is 8. Well, if we want to get red marker, I think better take in box II because there are more, and it allows us to take a red marker.

R₃ : How much is easier it to get red marker in box II?

BL₃ : (Thinking for 16 seconds) I think about 60% miss.

R₄ : Why is it 60%?

BL₄ : Yeah ..., because here I assume that black marker is 40%, but here the number of red marker is not 6 but it is 8. Let it be 100% then I think red marker is 60%.

Based on the result of written answer and interview, boy with low math ability used strategy by considering set with more target event. He explained that the number of red marker in box II more than the number of red marker in box I so that box II more likely to get red markers (BL₁, BL₂). He used percentage of his estimate representation to determine probability of an event (BL₃, BL₄).

2 Probability tasks completion of girl with high math ability. Figure 5 showed the written answer of girl with high math ability in solving probability of an event task.

merah, karena jumlahnya paling banyak

Figure 5

The written answer of girl with high math ability showed that the red ball was most likely to be taken, because the number of red ball was the most. While the interview results showed as following.

R₁ : Which color balls are most likely to be taken?

GH₁ : Red color. Because the number of red color is the most.

R₂ : Why if the number is the most, why is it most likely taken?

GH₂ : Because the number of red is 4 more than 3 and 2. So, it's easier to take 4.

R₃ : How much is easy to get a red ball?

GH₃ : 70%.

R₄ : Why do you express 70%?

GH₄ : Because if I say 100% then I will always get red. In this case, there are other colors, blue and green, so I will say 70% because 20% blue and 10% green. Because if red is 70%, plus 20% blue, then it equals 90 plus 10% green, so that equal 100%.

Based on the result of written answer and interviewed, girl with high math ability used a numerator strategy because she only examined a part of the set that corresponds to the target event. She explained that the number of red balls was the most, then red ball most likely to be taken (GH₁) so that she easier to get red ball (GH₂). She used percentage of her estimate representation to determine probability of an event (GH₃, GH₄).

Figure 6 showed the written answer of girl with high math ability in solving probability comparison task.

Kotak ke 1, karena dalam kotak 1 angka 2 dengan dan ke 2, karena selisih angkanya sama

Figure 6

The written answer of girl with high math ability showed that to get red marker, she took in box I and II, because difference of the number of red and black markers in box I and in box II were equal. While the interview results showed as following.

R₁ : If you want to get a red marker, then which box should you choose?

GH₁ : My answer is box I and II. Difference of the number of red and black marker in box I and in box II are equal. In box I, the difference of the number of red and black markers is 4, because 6 minus 2 equals 4. In box II, the difference of the number of red and black markers is 4, because 8 minus 4 equals 4.

R₂ : If difference of the number of red and black marker in box I and II are equal, why will two boxes get red marker?

GH₂ : Because if the number of black marker in box I is 2 and the number of red marker is 10, I will take box I because difference of the number of red and black markers in box I are more than difference of the number of red and black markers in box II, automatically in box I is easier to get red marker.

R₃ : How much is easy to get a red ball in box I and box II?

GH₃ : Red marker in box I is 80% and in box II is 60%.

R₄ : Why do you say that in box I is 80% and in box II 60%?

GH₄ : Because the number of black marker in box I is less than box II.

Based on the result of written answer and interview, girl with high math ability used strategy by considering set with greater difference in favor of target event. She explained that difference of the number of red and black marker in box I and in box II were equal (GH₁), furthermore she explained that if in box I the number of black marker was 2 and the number of red marker was 10, she would choose box I to get red marker, because difference of the number of red and black markers in box I was more than difference of the number of red and black markers in box II (GH₂). She used percentage of her estimate representation to determine probability of an event (GH₃, GH₄).

Probability tasks completion of girl with low math ability. Figure 7 showed the written answer of girl with low math ability in solving probability of an event task.

Merah
dialah: karena bola warna merah jumlahnya paling banyak

Figure 7

The written answer of girl with low math ability showed that red ball was most likely to be taken, because the number of red ball was the most. While the interview results showed as following.

R₁ : Why is red ball which most likely to be taken?

GL₁ : Because the number of red ball is the most.

R₂ : If the number of red ball is the most, why is it most likely taken?

GL₂ : Because ..., the red ball is in every corner of the box.

R₃ : How much is the possibility of red ball to be taken?

GL₃ : Emmm ..., 50%.

R₄ : Why is it 50%?

GL₄ : Because the other 50% again is the possibility of other balls can be taken, they are blue and green balls.

Based on the result of written answer and interview, girl with low math ability used a numerator strategy because she only examined a part of the set that corresponds to the target event. She explained that the number of red balls was the most, then red ball most likely to be taken (GL₁) and then she imagined that the red ball was in every corner of the box (GL₂). She used percentage of her estimate representation to determine probability of an event (GL₃, GL₄).

Figure 8 showed the written answer of girl with low math ability in solving probability comparison task.

Dari kotak I
 Alasan: karena pada $6:2=3$ sedangkan $8:4=2$ maka peluang merah pada kotak I lebih banyak daripada kotak II

Figure 8

The written answer of girl with low math ability showed that to get red marker, she took in box I, because quotient of the number of red and black markers in box I was more than in box II. While the interview results showed as following.

R₁ : Why do you choose box I?

GL₁ : Because 6 divided by 2 equals 3 while 8 divided by 4 equals 2 then red marker in box I is more than in box II.

R₂ : Why did you select a box with quotient is bigger?

GL₂ : Because if quotient is bigger then the red marker in box I is most likely to be drawn.

R₃ : Well, now how much is the possibility of red marker in box I?

GL₃ : Hmmm ..., 60%.

R₄ : Why do you say 60%?

GL₄ : Because the other 40% again is the possibility of red marker can be drawn from box II.

Based on the result of written answer and interview, girl with low math ability used strategy by considering set with greater quotient in favor of target event. She explained that quotient of the number of red and black marker in box I was more than in box II (GL₁), so that red marker in box I was most likely to be drawn (GL₂). She used percentage of her estimate representation to determine probability of an event (GL₃, GL₄).

IV. Discussion

The analysis results showed that students used a numerator strategy in solving probability of an event task, while students used different strategy in solving solve probability comparison. Boy with high math ability used strategy by considering set with less non target event, boy with low math ability used strategy by considering set with more target event, girl with high math ability used strategy by considering set with greater difference in favor of target event, and girl with low math ability used strategy by considering set with greater quotient in favor of target event. Students' representation to determine probability of an event was difference. Boy with high math ability used fraction representation, while boy with low math ability used verbal and percentage of his estimate representations, girl with high and low math ability used percentage of their estimate representation.

The results showed that boy higher than girl in solving probability tasks. It was because boy with high math ability used fraction representation in solving probability of an event and probability comparison while girl with high math ability used percentage of her estimate representation in solving probability of an event and probability comparison. This is in line with the results of [11] and [12] showed that boys had a higher value than girls. This result is also in line with the results of [2] [15] study which showed that probabilistic thinking level of boy is higher than girl. In addition, the results indicated that students who have different math ability, also provide different responses in solving probability tasks. The results is in accordance with [16] study which stated that if math ability is different then probabilistic thinking is also different.

The results also found a new strategy used by elementary school students in solving probability comparison task. That was a set with greater quotient in favor of target event. Therefore, the results complete the result of [9] that there are 4 strategies used by elementary students in solving probability comparison task, set with more target event, less non target event and greater difference in favor of target event.

The results can be recommended to elementary school curriculum developer in Indonesia. Specially, elementary school curriculum developer could introduce probability material as part of statistic material. In addition, the result can be also recommended to elementary school teachers to teach probability material by using learning method. One of method is discussion by working in group across math ability and gender, therefore each member in the group can discuss and interact each other in solving probability tasks.

2. Conclusion

Students used a numerator strategy in solving probability of an event task, and used different strategy in solving solve probability comparison. Boy with high math ability used strategy by considering set with less non target event, boy with low math ability used strategy by considering set with more target event, girl with high math ability used strategy by considering set with greater difference in favor of target event, and girl with low math ability used strategy by considering set with greater quotient in favor of target event. Students'

representation to determine probability of an event was difference. Boy with high math ability used fraction representation, while boy with low math ability used verbal and percentage of his estimate representations, girl with high and low math ability used percentage of their estimate representation. The results can be recommended to elementary school curriculum developer in Indonesia. It means elementary school curriculum developer could introduce probability material as part of statistic material. In addition, the result can be recommended elementary school teachers to teach probability material by using learning method. One of method is discussion by working in group across math ability and gender, therefore each member in the group can discuss and interact each other in solving probability tasks.

1

Acknowledgements

The authors would like to thank to the Director of Research and Community Service, Directorate General for Strengthening Research and Development, Ministry of Research, Technology and Higher Education that has provided research costs. Indeed, the Chairman of the institute of Research and Chairman of the Mathematics Education STKIP PGRI Bangkalan who have given permission for research.

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Dwi Ivayana Sari Analyze of Probability Task Completion of Elementary School Students Based on Math Ability and Gender. IOSR Journal of Mathematics (IOSR-JM) , vol. 13, no. 6, 2017, pp. 25-32.

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