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Number Sense of High School Students on Real Numbers Based on Gender

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ABSTRACT

This research aims to describe number sense of high school students on real numbers based on gender. This type of research is descriptive qualitative. The research was conducted in class XI (consists of 36 students) of SMA Negeri 3 Malang in the even semester of the 2023/2024 academic year. The subjects are one student with male gender and one student with female gender. The subjects were selected using purposive sampling technique. The research instruments consisted of number sense tests and interview guidelines. The number sense test used consisted of five questions with each question representing the number sense indicator used. Data analysis was carried out by examining students' answers on the number sense test given and then conducting interviews with selected subjects. The result showed that the male student is able to recognize relative number size, understand the meaning of numbers, recognize the relative effect of operations on numbers, compose or decompose numbers, and judge the reasonableness of estimates of computed results. Meanwhile, the female student is only able to recognize relative number size and the relative effect of operations on numbers.

Keywords: gender; number sense; real numbers

INTRODUCTION

Numbers as one of the scopes of mathematics learning must be well mastered by students because understanding the concept of number serves as the basis for learning mathematical concepts and skills (Sood & Mackey, 2015) According to Musser et al. (2008)**,** number is an abstract idea and is used to represent quantity. According to Sood and Mackey (2015), understanding number concepts is an important part of all areas of life. In addition, Sood dan Mackey (2015) also added that understanding the concept of number in students is very important because it will make it easier for students to follow the next educational process, especially in mathematics. Thus, an understanding of number is important for all students to have as a foundation for understanding further mathematical concepts.

According to Mcintosh et al. (1995), understanding number concepts is one component of number sense ability. Number sense is a person's general understanding of numbers and their operations and the ability and inclusion to use that understanding flexibly to make mathematical judgments and develop useful strategies for organizing numbers and their operations (Mcintosh et al., 1995). For example, with this ability students can answer the question "Is 83×0.83 more than 83?" or the question "Is there a fractional number whose value is between $\frac{42}{7}$ and $\frac{43}{7}$? If so, name it!" without using conventional calculations. Thus, number sense can be said to be an intuition about numbers and their operations, and their application in a mathematical problem without having to involve a certain calculation or algorithm.

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There are several experts who put forward indicators of number sense. Mcintosh et al. (1995) stated that there are eleven indicators derived from three components of number sense, namely 1) knowledge of numbers which contains four indicators, 2) knowledge of operations on numbers which contains three indicators, and 3) application of knowledge about numbers and their operations in calculations which contains three indicators. Yang and Lin (2015) also described five indicators of number sense. In addition, Yang et al. (2004) and Yang et al. (2008) developed the indicators of number sense. The indicators by Yang and Lin (2015) and Yang et al. (2004) & Yang et al. (2008) just slightly different.

According to Mohamed and Johnny (2010), number sense is very important because number sense is part of meaningful learning and understanding of mathematics. It is because number sense is an ability that builds mathematical abilities (Murniasih et al., 2018) and the basis for understanding mathematics more deeply (Aminah & Sa'dijah, 2015). Number sense ability is the key for students to be able to understand mathematical concepts (Salim et al., 2020; Wahyuni & Duryati, 2019; Wulandari et al., 2020). Thus, number sense is an ability needed for the success of students' mathematics (Koleza & Koleli, 2014; Mcintosh et al. 1995). Number sense is also one way to build student resilience (Sumaji et al., 2022). Students with good number sense tend to have good self-confidence in terms of their mentality and thoughts (As'ari, 2008). In addition, number sense is very important and must be mastered by every student to enable them to handle everyday numerical problems, solve problems without using conventional algorithms, and can develop mental math (Mohamed & Johnny, 2010). Number sense instruction in the learning process is also considered a key ingredient in the mathematics curriculum (Nickerson & Whitacre, 2010; D. C. Yang et al., 2008).

Number sense is a basic skill for a good numeracy (Fahlevi, 2022). This is because number sense is part of numeracy (Ameer & Singh, 2013). This is also in line with the statement (Kemendikbudristek, 2021) that numeracy is the application of number concepts and arithmetic operation skills in solving everyday problems. In addition, research shows that the numeracy of Indonesian students is low and requires special support. This is often presented in several ministry of education reports (Basri et al., 2021; Perdana & Suswandari, 2021). Thus, efforts to improve numeracy results need support from essential abilities such as number sense, especially now that numeracy is one of the abilities that is evaluated nationally in Indonesia through the AKM program (Fahlevi, 2022).

Over the past ten years, many studies have focused on the topic of number sense (Mohamed & Johnny, 2010). Hastuti and Setyaningrum (2023) found that the number sense ability of junior high school students in solving numeracy problems of reasoning-based AKM model is generally low. Asyfaini and Sari (2023) revealed that students with field dependent cognitive style on fractional number material did not fulfill all indicators of number sense. Wulandari dan Triutami (2022) revealed the low number sense ability of junior high school students based on gender, namely the percentage of correct answers from students with female gender was 32.50% and the percentage of correct answers from students with male gender was 27.00%. Safitri et al. (2017) found that junior high school students do not have good enough sensitivity regarding numbers and its operations, and its poperties. Ekawati (2013) also found that students were not flexible in using their understanding of the concept of integers and their operations and focused on using the

procedural calculations they received at school when solving problems. Other research results also show that although students have high competence in mathematics subjects as well as high scores in school exams, they are generally weak in number sense (Illahi & Darmawan, 2022; Mohamed & Johnny, 2010; Singh et al., 2019).

Based on all the research related to the topic of number sense that has been described, there has been no research related to the topic of number sense conducted on high school students in terms of gender. This is important because high school is the highest level of school before students enter the world of lectures. So, the number sense of high school students should be mature to support the success of the lectures they will face. In addition, based on preliminary studies that have been conducted by researchers, the results obtained that the number sense of male and female high school students is still relatively low. The majority of these students are still weak in using basic sensitivity in general related to numbers and their operations, one of which is in assessing the reasonableness of the calculation results. Almost all male and female high school students answered questions with indicators of assessing the reasonableness of calculation results as shown in Figure 1 below.

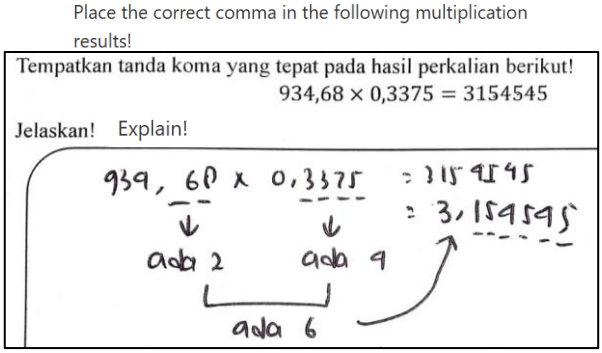


Figure 1. Respondent's answer result

Based on Figure 1, it can be seen that students fail to assess the reasonableness of the calculation results of the multiplication operation given. This is because students are only fixated on applying conventional rules that are not appropriate for the multiplication of decimal numbers that contain numbers behind the comma. Students tend to directly calculate the total number behind the comma in the two decimal numbers being multiplied, i.e. students get a total of six numbers behind the comma, then conclude that the result of the multiplication will also contain six numbers behind the comma without paying attention to the two zero digits that have been omitted in the result value.

Based on the whole explanation, it can be concluded that there is no research related to the topic of number sense conducted to high school students based on gender. Thus, it is important to conduct research on the number sense of high school students in terms of gender.

RESEARCH METHODS

This study uses descriptive research and a qualitative approach. Descriptive qualitative research was chosen for this study because it is in accordance with the final results desired by the researcher, namely in the form of a qualitative description or description of the number sense of grade XI high school students in terms of gender. This research was conducted in class XI (consists of 36 students) of SMA Negeri 3 Malang in the even semester of the 2023/2024 academic year. The research steps taken by the researcher are the first to

review the theory of number sense in terms of gender. The theory obtained by researchers is that there is no significant difference between the number sense of male students and female students. The second step is to conduct a preliminary study. Based on the preliminary study that has been conducted, the researcher obtained the results that the number sense of the majority of male and female students is still very low. They only managed to fulfill a few of the number sense indicators tested. The third step was to formulate the problem. The formulation of this research problem is how is the number sense of high school students in terms of gender? The fourth step was to compile the research instruments. The research instruments consisted of a number sense test consisting of five questions and interview guidelines. Each test question represents one number sense indicator. The researcher used the number sense indicator which consists of five indicators. The number sense indicators and the list of number sense test questions used in this study are shown in Table 1.

Table 1. Number sense's indicator and test questions

No.	Indicator	Test questions
1.	*Understanding the meaning of numbers*	Are there any decimal numbers whose values are between 3/7 and 4/7? If so, how many decimal numbers are there and explain how you found them!
2.	*Recognizing relative number size*	Which of the fractions $\frac{12}{13}$ and $\frac{15}{16}$ is closest to 1 without using calculations? Explain the method you used!
3.	*Compose or decompose numbers*	Is there an alternative way to calculate the result of 39×4 without using stacking down multiplication? If so, explain the method you used!
4.	*Recognizing the relative effect of operations on numbers*	Observe the following number line!  Determine the position of the value of A×B on the number line above! Explain your reasoning!
5.	*Judging the reasonableness of estimates of computed results*	Place the correct comma in the following multiplication! And explain! $934{,}68 \times 0{,}3375 = 3154545$

The reason for selecting these indicators is that they are the most concise and core form of the eleven number sense parent indicators. The parent indicator of number sense is an indicator stated by Mcintosh et al in 1995 which consists of three components and one indicator of number sense. Furthermore, the fifth step is to validate the research instrument to experts. After obtaining a valid instrument, the sixth step is that the researcher tests the instrument to class XI high school students. The first instrument tested to students was the number sense test question. After the students finished working on the test, the researcher examined the students' answers to select the research subjects. Researchers also dug up information from mathematics teachers related to students' communication skills. Researchers chose subjects with certain criteria, namely having appeared sensitivity in all answers to the number sense test and having good communication skills. This good

communication ability is to facilitate the interview process that will be carried out. Then, proceed with conducting interviews with the selected subjects. The interview was conducted to explore in depth about the subject's answers on the answer sheet. The seventh step, the researcher analyzed the data obtained. The analysis of number sense data was carried out by referring to the five indicators of number sense which have been displayed in Table 1. The last step was to draw conclusions and present them in the form of an article.

RESULT AND DISCUSSION

The selected subjects were one male student, namely MS and one female student, namely FS from 36 students in the class. The reasons for their selection were that their answers were the most representative of the answers from other students, their writing was the easiest to read, and they had excellent communication skills that supported the interview process. Next, number sense obtained from number sense tests and interviews will be presented in the form of descriptions accompanied by pictures of the results of each subject's number sense test work. The researcher chose two students as research subjects consisting of one subject with male gender, namely the subject with the code MS and one subject with female gender, namely the subject with the code FS. The explanation of the number sense of the two subjects is based on the five indicators of number sense previously described. The explanation will be described in this section.

Understanding the meaning of numbers

MS and FS's answers to the questions with the indicator of understanding the meaning of numbers are shown in Figure 2 and Figure 3 below.

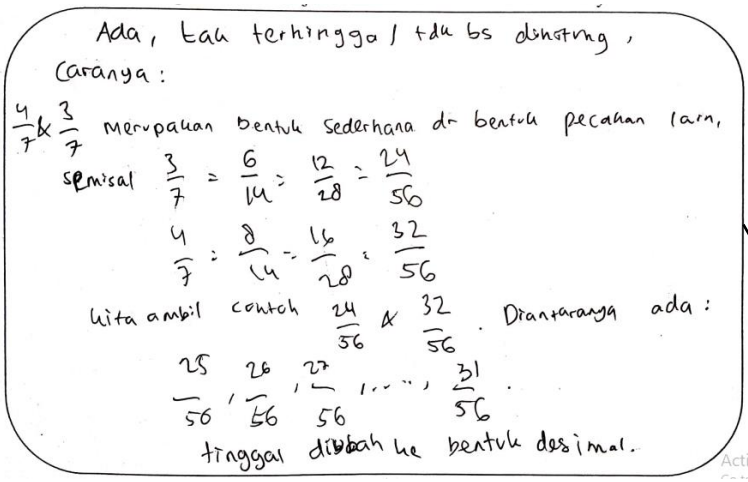


Figure 2. MS's answer in understanding the meaning of real numbers

- The male subject was able to understand the meaning of real numbers correctly.
- The female subject failed to understand the meaning of real numbers.

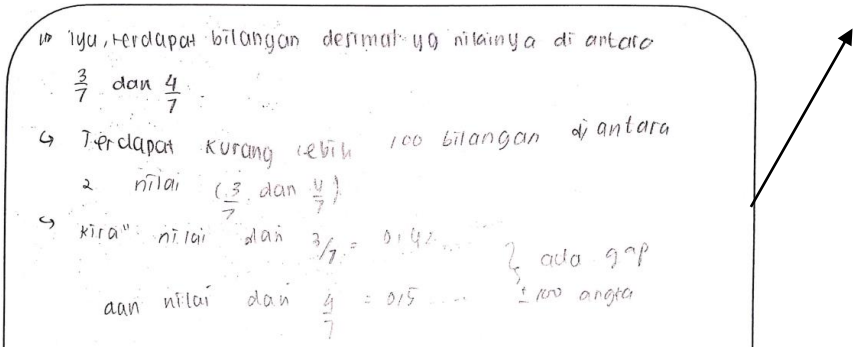


Figure 3. FS's answer in understanding the meaning of real numbers

Based on Figure 2, it is revealed that MS knows there are infinite decimal numbers whose values are between 3/7 and 4/7. The method used by KN in finding those decimal numbers is by taking some other fraction numbers that are equal to 3/7 and 4/7 such that they have the same denominator. KN decomposes the numbers, then takes the numbers 24/56 and 32/56. Furthermore, KN explains that between the two fractions there are fractions 25/56, 26/56, ...,31/56, each of which can be converted into decimal form.

Furthermore, based on Figure 3, it was revealed that FS only knew 100 decimal numbers whose values were between 3/7 and 4/7. The method FS used to find these numbers was by estimating the values of 3/7 and 4/7 in decimal form. FS estimated $3/7 \approx 0.42$ and $4/7 \approx 0.5$. Furthermore, during the interview, FS explained that FS considered 3/7 close to 0.4 and 4/7 close to 0.5. Then, FS concluded that there were approximately 100 decimal numbers whose values were between 0.4 and 0.5. FS revealed that the decimal numbers she understood were only decimal numbers with a maximum of 3 digits behind the comma. So, FS concluded that there are 100 decimal numbers whose values are between 3/7 and 4/7.

Based on the answers of MS and FS, it is revealed that MS understands the basic concept of real numbers. This is shown by MS being able to realize that there are infinite decimal numbers whose values are between the two given fractions. In addition, MS also succeeded in explaining how to obtain the decimal number correctly. This shows that MS understands the meaning of real numbers. Meanwhile, FS did not understand the basic concept of real numbers. This is shown by FS only knowing some decimal numbers whose values are between the two given fractions. FS does not realize that there are infinite decimal numbers like that. This shows that FS does not understand the meaning of real numbers.

Recognizing relative number size

MS and FS's answers to the questions with the indicator of recognizing the relative size of numbers are shown in Figure 4 and Figure 5 below.

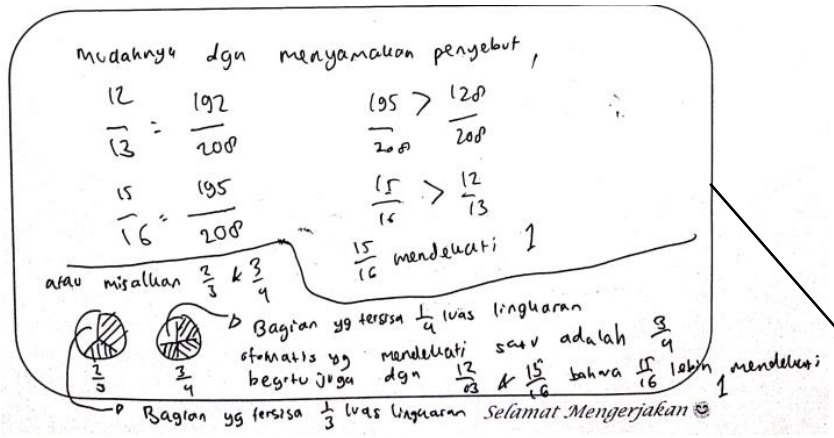


Figure 4. MS's answer in recognizing relative number size

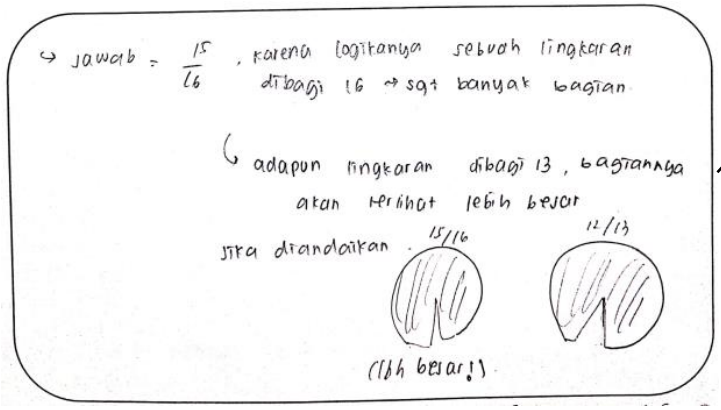


Figure 5. FS's answer in recognizing relative number size

- The male subject was able to recognize the relative size of numbers.
- The female subject is also able to recognize the relative size of numbers.

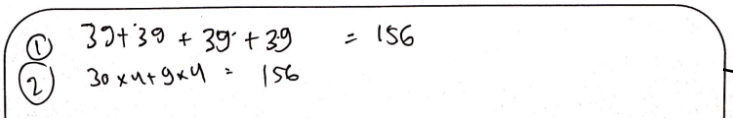
Based on Figure 4, it is revealed that MS is able to recognize the relative size of numbers. This can be seen from MS being able to make analogies through simpler fractions, namely 2/3 and 3/4. MS drew two pie charts to illustrate the two fractions, then MS explained that the remaining part in the first chart is 1/3 and the remaining part in the second chart is 1/4, with 1/3 being bigger than 1/4. In this case, 1/3 and 1/4 are the relative sizes of the numbers 2/3 and 3/4 to 1. Furthermore, MS concluded that 3/4 is closer to 1 than 2/3. Thus, MS concludes that 15/16 is closer to 1 than 12/13.

Furthermore, based on Figure 5, it is revealed that FS is able to recognize the relative size of numbers. FS gave the answer that 15/16 is closer to 1. FS explained his reasoning logically by using two circle drawings. FS used the first circle to represent 12/13 and the second circle to represent 15/16. FS explained that the first circle started from a full circle of which 1/13 part was taken, while the second circle started from a full circle of which 1/16 part was taken. In this case, FS recognized the numbers 1/13 and 1/16 as relative quantities that he needed to compare. Furthermore, it appears that 15/16 is bigger so it is at most 1.

Based on MS and FS' answers, it was revealed that MS and FS were successful in recognizing the relative size associated with the two fractions. Furthermore, MS succeeded in comparing the relative sizes she obtained and used them to conclude the final answer correctly.

Compose or decompose numbers

MS and FS's answers to the questions with the indicator of composing or decomposing numbers are shown in Figure 6 and Figure 7 below.



- The male subject was able to arrange or decompose the numbers correctly.
- The female subject failed to arrange or decompose the numbers.

Figure 6. MS's answer in composing or decomposing numbers

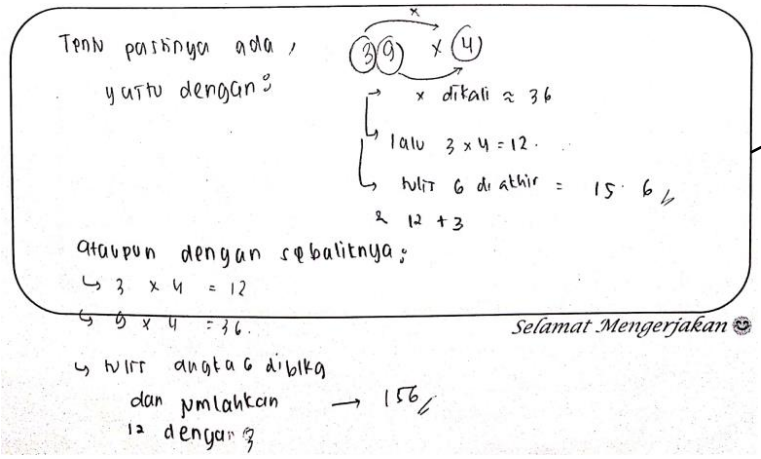


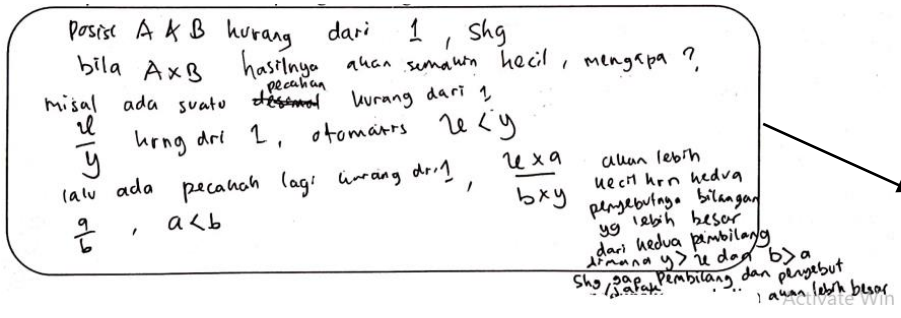
Figure 7. FS's answer in composing or decomposing numbers

Based on Figure 6, it is revealed that MS is able to decompose the numbers in the given operation to facilitate the calculation of the operation result. MS gave two alternative ways to calculate 39×4 as shown in Figure 6. The second way that MS wrote down showed that MS was able to decompose 39 into 30+9 to facilitate the calculation. Furthermore, based on Figure 7, it was revealed that FS failed to decompose the numbers in the given operation to facilitate the calculation of the operation result. FS provided an alternative way to calculate 39×4 by explaining how to calculate stacking multiplication down.

Based on the answers of MS and FS, it was revealed that MS was able to arrange or decompose the numbers. This is shown by MS being able to decompose the numbers in the given operation in order to facilitate the calculation correctly. Meanwhile, FS failed in composing or decomposing numbers. This is shown by FS not decomposing the numbers in the given operation in order to facilitate the calculation correctly.

Recognizing the relative effect of operations on numbers

MS and FS's answers to the questions with the indicator of recognizing the relative effect of number operations are shown in Figure 8 and Figure 9 below.



- The male subject was able to recognize the relative effect of number operations correctly.
- The female subject was also able to recognize the relative effect of number operations correctly.

Figure 8. MS's answer in recognizing the relative effect of number operations

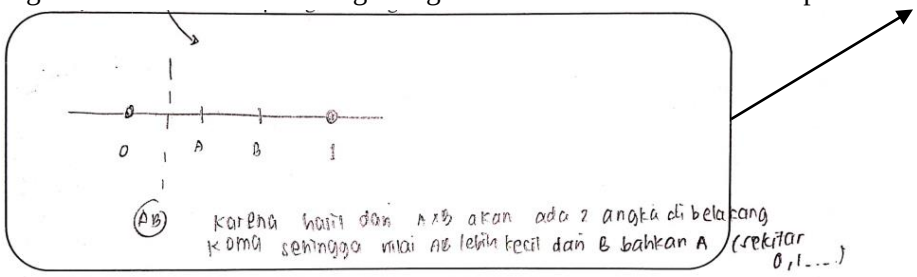


Figure 9. FS's answer in recognizing the relative effect of number operations

Based on Figure 8, it is revealed that MS is able to recognize the relative effect of the multiplication operation of numbers whose values are between 0 and 1. MS explains her answer by supposing the two numbers being multiplied are $A = \frac{x}{y}$ and $B = \frac{a}{b}$ with x<y and a<b. Furthermore, MS explained that when x/y and a/b are multiplied, it will result in $\frac{x \times a}{y \times b}$ which is less than both A and B because it has a denominator that is more than y and b.

Furthermore, based on Figure 9, it is revealed that FS is able to recognize the relative effect of the multiplication operation of numbers whose values are between 0 and 1. MS answered that if A and B are multiplied, the result will be smaller than both A and B. This is because A and B are more than 0 and less than 1. This is because A and B are more than 0 and less than 1. Thus, FS explained that A and B will be in the form of decimal numbers 0, ... This results in the product will also be in the form of 0, ... with a value that is less than A and B. FS concluded that the position of A×B on the number line is between point 0 and point 1.

Based on FS and MS's answers, it is revealed that FS and MS are able to recognize the relative effect of operations on numbers. This is shown by FS being able to recognize the effect of the multiplication operation on the given number and being able to explain it correctly.

Judging the reasonableness of estimates of computed results

MS and FS's answers to the questions with the indicator of assessing the reasonableness of the calculation results are shown in Figure 10 and Figure 11 below.

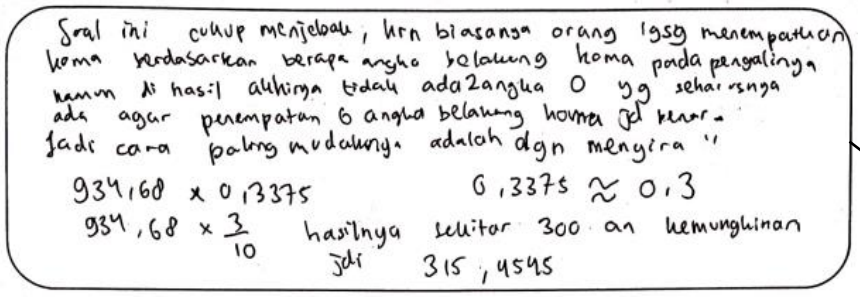


Figure 10. MS's answer in judging the reasonableness of estimates of computed results

- The male subject was able to assess the reasonableness of the calculation results correctly.
- The female subject failed to assess the reasonableness of the calculation results.

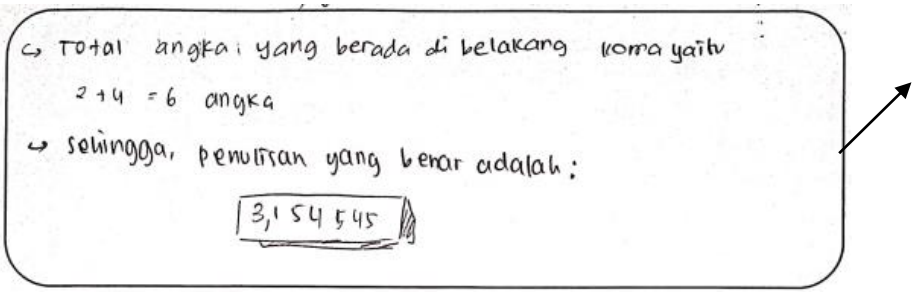


Figure 11. FS's answer in judging the reasonableness of estimates of computed results

Based on Figure 10, it was revealed that MS was able to assess the reasonableness of the multiplication calculation result given. The method MS used to put the comma correctly in the multiplication result was by estimating. MS estimated the number 0.3375 as a number close to 0.3. Next, MS estimated the multiplication result of $934.68 \times 0.3375 \approx 934.68 \times 0.3 = 934.68 \times 3/10$. Thus, the multiplication result would be close to 300s. So, MS concluded that the right comma is after the number 315, which is 315.4545.

Furthermore, based on Figure 11. it was revealed that FS failed to place the right comma sign in the given multiplication result. This is because FS did not use the appropriate estimation method. Instead, MFS2 used the conventional method by counting the number of digits behind the comma of the two numbers being multiplied. Then, FS added up the digits behind the comma and adjusted it to the digits behind the comma of the multiplied numbers. Thus, FS obtained six digits behind the comma. So, FS put a comma sign behind the number 3. So, the multiplication result is 3.154545.

Based on the MS and FS answers, it was revealed that MS was able to assess the reasonableness of the calculation results. This is shown by MS being able to estimate one of the numbers to be multiplied to a certain number in such a way as to facilitate the estimation of the multiplication result. Furthermore, MS managed to conclude a reasonable result correctly based on the estimation. Meanwhile, FS failed in assessing the reasonableness of the calculation result. This was because FS did not use the estimation method but instead used an invalid conventional method.

Based on the research results presented, it shows that male subjects were able to understand the meaning of real numbers very well. Meanwhile, female subjects failed to understand the meaning of real numbers. It is in accordance with the results of research conducted by Patricia and Zamzam (2019). Patricia and Zamzam (2019) revealed that male students' ability to understand the meaning of numbers is better than female students.

Furthermore, both male and female subjects were able to recognize the relative size of numbers very well. However, in the indicator of composing or decomposing numbers to facilitate calculations, male students managed to fulfill it well, while female students failed to fulfill it. It is in accordance with the results of research conducted by Patricia and Zamzam (2019). Patricia and Zamzam (2019) stated that the percentage of female students' math learning difficulties was higher than male students. In addition, the percentage of wrong answers of female students is also higher than male students.

Furthermore, both male and female subjects were able to recognize the relative effect on number operations very well. However, in the indicator of assessing the reasonableness of the calculation results, it was revealed that male students were able to fulfill it very well,

while female students failed to fulfill it. This is in line with the results of research by Mulyani and Muhtadi (2019). Mulyani and Muhtadi (2019) stated that female students made more mistakes in terms of computation or calculation compared to male students.

Thus, overall, male students were able to meet all the number sense indicators tested. Meanwhile, female subjects were only able to meet two of the five indicators, namely recognizing the relative size of numbers and recognizing the relative effect of number operations. Therefore, the number sense of male subjects is better or superior to the number sense of female subjects. This is contrary to the results of research conducted by Wulandari and Triutami (2022), Wahyuni and Duryati (2019), and Salim et al. (2020) which state that there is no difference in number sense between the two genders. The absence of differences between the number sense test results based on gender can be caused by several factors, namely student unpreparedness (Sitriani et al., 2019), biological (Alimuddin & Trisnowali, 2019), cultural, cognitive, psychological, and sociological (Dehaene, 2011). The research results contradict the previous theory because male students prioritize rationality and intuition when completing the number sense test, compared to female students.

CONCLUSION

The result showed that the male student is able to recognize relative number size, understand the meaning of numbers, recognize the relative effect of operations on numbers, compose or decompose numbers, and judge the reasonableness of estimates of computed results. Meanwhile, the female student is only able to recognize relative number size and the relative effect of operations on numbers. So that, the male student fulfilling all the number sense indicators tested, while the female student only fulfills two of the five number sense indicators. This is because male student prioritizes rationality and intuition more than female student. Furthermore, the suggestion for further research is to develop teaching modules or make learning innovations with the aim of developing the number sense of high school students. This is important to do because the number sense of students, especially women at the high school level is low.

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