Students’ mathematical reasoning abilities on number sequence pattern material: viewed from a gender perspective

F E Subekti¹, Zaenuri², and Wardono²

¹Doctoral Students of Graduate School Universitas Negeri Semarang, Indonesia
²Mathematics Department Faculty of Mathematics and Natural Sciences Universitas Negeri Semarang, Indonesia

Corresponding Author: efitrians@students.unnes.ac.id

Abstract. This study aims to describe mathematical reasoning abilities in terms of the gender of grade VIIIA students at MTs Negeri 3 Banjarnegara. The study population was students of MTs Negeri 3 Banjarnegara by taking samples of class VIII A. Sampling using a cluster random sampling technique. Data obtained using tests, interviews, and documentation. The data were analyzed and described quantitatively. The results showed that: 1. The percentage of male students' ability to give assumptions based on the formed pattern was 54.19%, while female students were 64.71%; 2. Students' skills to use a number sequence pattern to draw conclusions about male students were 66.67%, while female students were 76.47%; 3. Male students tend to make guesses by briefly writing down the pattern, while female students describe their tribes first; 4. Male students tend to misunderstand questions so that they are wrong in concluding, and 5. female students draw conclusions based on the results of describing their ethnic groups.

1. Introduction

Reasoning skills play an essential role in mathematics, such as algebra, geometry, relational concepts, or connecting number concepts with spatial representations [1]. Mathematical reasoning skills can use to solve non-routine tasks at all levels of difficulty [2]. Reasoning ability is one of the skills that must be posses in the 21st century to develop critical thinking skills [3]. Mathematics and mathematical reasoning are two interrelated things; mathematics is obtained through reason, while logic applies and enhances mathematics learning [4].

The reasoning is a thought process using reasons, reports to get conclusions [2,5] and trying to solve problems [6] by checking the adequacy of the data and information provided [7]. Mathematical reasoning is a process carried out to get logical conclusions based on facts and relevant sources that are correct [4].

Several steps to solve the problem of reasoning, namely: selecting and interpreting information from the context of the problem, creating and verifying relationships, and draw conclusions based on the information provided, rules, and related processes [3]. Students' mathematical reasoning was measured using a test instrument developed from routine and non-routine problems [2].

Male and female have different learning performances influenced by the goal orientation and mathematical content domain [8]. The ability is influence by various factors, including learning interactions, gender, essential competencies, and self-efficacy [9]. Male and female who have different
orientations can support their intrinsic motivation with a meaningful learning environment. [10]. Female students tend to be more diligent and diligent than male students, while male students tend to have better self-confidence than female students [11]. Males tend to have less anxiety than females [12]. Different characteristics will undoubtedly affect the reasoning abilities of male and female students. Knowing the differences in characteristics between men and women is expected to provide the right strategy to reduce gaps, especially in mathematical reasoning.

One of the materials studied at the intermediate level is number patterns. Students' difficulties in number patterns material are difficulties in identifying number patterns in problem-solving [13]. Based on these problems, we will discuss more how mathematical reasoning abilities in terms of gender. How is the tendency of male and female students’ mathematical reasoning in number pattern material?

2. Methods
This research is descriptive quantitative and qualitative research. Research describes reasoning abilities in terms of gender. The study population was students of MTs Negeri 3 Banjarnegara, and the sample was students of class VIII A MTs Negeri Banjarnegara. Sampling using cluster random sampling technique. The data was collected using tests and interviews with two male students and two female students. The data obtained were then presented using a table of the percentage of mathematical reasoning abilities.

3. Results and Discussion
Indicators of reasoning ability used in this study: giving guesses based on the formed patterns and using patterns to draw. The physical ability test was conducted by 29 students of class VIII A MTs Negeri 3 Banjarnegara. Class VIII A consists of 12 male students and 17 female students.

| No | Indicator                              | T Male (%) | F Male (%) | T Female (%) | F Female (%) |
|----|----------------------------------------|------------|------------|--------------|--------------|
| 1  | Provides a guess based on a pattern    | 54,19      | 45,81      | 64,71        | 35,29        |
| 2  | Use patterns to attract attention      | 66,67      | 33,33      | 76,47        | 23,53        |

Information:
T Men (%) : Male correct answer
F Men (%) : Male uncorrect answer
T Woman (%) : Female correct answer
F Woman (%) : Female uncorrect answer

Table 1 above shows that the percentage of female students' reasoning abilities for the two indicators can be better than male students. Besides, the percentage of students' abilities in using patterns to conclude tends to be better than the indicators of giving conjectures based on the formed patterns. This difference occurs because women tend to learn and practice more regularly. The key to successful mathematics learning is a regular practice [14].

The following will present a description of reasoning abilities based on test results and student interviews from a gender perspective to support this data.

3.1. Female students' reasoning abilities
Figure 1 below shows the results of the work of female respondents (F1). In Figure 1 below, the first step is to take each information contained in the problem. The number of rope pieces gives an "n," and the shortest rope is an "a." The sixth prolonged stress response = 288 cm, without prior permission. It is suspect that the respondent determined the rope's length by using the term formula in the geometric sequence. Using the formula for the 6th term, the respondent determines the value of \( r^5 \). From this value, the ratio value \( r = 2 \). Based on the ratio value, then the entire rope's total length is determined and the difference between the length of the longest rope and the shortest rope. The work results show that the respondent can correctly determine the patterns that arise from the present and interesting problems.
The results are based on interviews, where respondents have no difficulty answering these questions. Respondents used a geometric syllable series formula based on the keywords in the problem, namely: "the length of the second string is twice the length of the first string, the size of the third string is twice the length of the second string, and so on. Respondents are not aware that can the ratio value determine without using the 6th term formula. This problem occurs because the respondent is not careful in understanding the question information to find keywords related to the ratio. This inaccuracy results in problem-solving being longer and more complicated because it has to be. Find the ratio value using the formula Un.

Figure 2 determines the length of the 6th rope by finding the first, second, and so on strings based on the information in question. Respondents use the keyword "twice" to determine the length of the first, second, and so on ropes. After selecting the size of the first, second, and so on strings, the rope's total length determined by adding up each rope's length. The difference between the length of the longest rope and the shortest lines is also determined. The method used is quite effective in getting the right conclusion that the correct statement is the length of the difference between the longest and the shortest rope = 279 m. The results of the interview, the respondents did not have difficulty solving these questions. With the keyword "twice" and the length of the shortest rope 9 cm, the respondent can determine the other rope's size, the length of the entire string, and the difference between the longest and the shortest line.
Figure 3. Results of the work of female respondents (F1)

For the second indicator (Figure 3), female respondent 1 calculates the letters in the numbers. The letter F is an example of 6, H is an 8, K is an 11, and so on. Letters are converted into numeric sequences, namely: 6, 8, 11, 13, 16, 18, 23, 26. Based on this sequence, the respondents suspect that $U_3$ obtained from $U_1 + 5$, $U_5$ is obtained from $U_3 + 5$. So on. Respondents suspect that $U_4$ is obtained from $U_2 + 5$ and $U_7$ from $U_5 + 5$, resulting in $U_4 = 13$ and $U_7 = 21$. Then the numbers are converted back into letters, resulting in $U_4 = M$ and $U_7 = U$. The results of the interview, the respondent said that it would be faster to do when it is in the form of a number sequence. Respondents find it difficult when they are still in the form of a row of letters. Even though it took a long time, changing the number into a sequence convinced the respondent that the answer was correct. Converting letters to numbers makes it easier for respondents to solve these problems appropriately. The patterns that formed are easier to find when in the form of numbers than in letters.

Figure 4. Results of the work of female respondents (F2)

For female respondent 2 (Figure 4), the step taken was to write the pattern under the rows of letters. Respondents reported $U_2$ obtained from $U_1 + 2$ (from the letter F to the H shifted two letters), and $U_3$ received from $U_2 + 3$ (K got from the F went 3 letters). From this pattern, it assumed that the respondent directly determines $U_4$ and $U_7$ from the sequence. The respondent wrote $U_4 = M$ and $U_7 = U$. The results of the interview showed that after deciding the pattern from $U_1$ to $U_2$, $U_2$ to $U_3$, and $U_5$ to $U_6$, the respondent believed that it came from $U_4 = U_3 + 2$ (shifted two letters) and $U_7 = U_6 + 3$ (shift three letters). The use of this method is quite effective in determining the letter in question. The respondents' success in these problems is because respondents feel interested and have a high interest in the number of pattern material. These interests and interests make respondents able to solve problems efficiently.

3.2. Male students' reasoning abilities

Figure 5 below shows the results of the work of male respondents (M1).

Figure 5. Results of the work of male respondents (M1)
In Figure 5 above, the male respondent (M1) misunderstood the information in the questions. Respondents interpreted that twice as the difference. With this error, the respondent is wrong in determining the number sequence formula. Respondents used arithmetic sequence formulas, which should use geometric sequence formulas. Misunderstanding keywords results in incorrectly determining sequence patterns. Likewise, male respondents (M2) made the same mistake, so they were wrong in concluding. During the interview, the respondents realized that they had taken the wrong keywords. Even so, they found it difficult to solve the problem. The difficulty mainly occurs when students understand issues, determine patterns, and make generalizations [15]. This misunderstanding is due to students' incomprehension in distinguishing between arithmetic and geometric sequences. The results in students writing the wrong formula Unused so that the solution given is incorrect.

![Figure 6. Results of the work of male respondents (M1)](image)

The initial steps taken by the two male respondents were the same as the two female respondents (Figure 6). The respondent immediately wrote the shift of letters under the row; the respondent immediately suspected in question. N is the 4th letter, and T is the 7th letter. However, the two respondents' answers were wrong because they were not careful in determining the pattern of shifting the letters. At the time of the interview, both respondents said they had difficulty finding the letter sequence pattern. When asked, "what if it is a number?" Both respondents said that they did not find it difficult. Respondents tried to overcome the inability to understand letter sequence patterns by writing the shifts under the letter sequence pattern. Lack of understanding of the patterns formed and the inaccuracy of writing these patterns causes the letters to be looked for to be wrong.

These results indicate that female respondents tend to have better reasoning abilities than males. However, the methods used by male respondents tended to be more practical than female respondents. Female respondents tend to be more careful in solving problems than male respondents. In terms of the percentage of errors, male respondents outnumbered female respondents. Female students may have higher achievement potential [16] than male students but sometimes attenuated by higher anxiety [17]. Female students are usually more diligent, resilient, and thorough in solving problems [18]. The numerical abilities of male and female students differed significantly [19].

4. Conclusion
The results showed that the percentage of female respondents' abilities was better than that of men. Men tend to be more practical in doing, although sometimes it is wrong. Female respondents tend to do it step by step. Further research is needed to get students' reasoning patterns on number pattern material.

References
[1] Morsanyi K, Prado J, and Richland L E 2018 Think. Reason. 24(2) 129
[2] Jäder J, Sidenvall J, and Sumpter L 2017 Int. J. Sci. Math. Educ. 15(4) 759
[3] Bronkhorst H, Roorda G, Suhre C and Goedhart M 2019 Int. J. Sci. Math. Educ. 18(8) 1673
[4] Hasanah S I, Tafrilyanto C F, and Aini Y 2019 J. Phys.: Conf. Ser. 1188 012057
[5] Fyfe E R and Brown S A. 2018 Think. Reason. 24(2) 157
[6] Olsson J 2018 Int. J. Sci. Math. Educ. 16(4) 715
[7] Saleh M, Prahmana R C I, Isa M, and Murni 2018 J. Math. Educ. 9(1) 41
[8] Leder G C and Forgasz H J 2018 ZDM - Math. Educ 50(4) 687
[9] Alghadari F, Herman T and Prabawanto S 2020 Int. Electron. J. Math. Educ. 15(3) 1
[10] Lazarides R and Rubach C 2017 Math. Educ. Res. J. 29(2) 201
[11] Reilly D, Neumann D L and Andrews G 2019 Res. Sci. Educ. 49(1) 25
[12] Rodríguez S, Regueiro B, Piñeiro I, Estévez I and Valle A 2020 Front. Psychol. 10 3050
[13] Spangenberg E D and Pithmajor A K 2020 Eurasia J. Math. Sci. Technol. Educ. 16(7) 1
[14] Smail L 2017 J. Math. Educ. 8(1) 17
[15] Fauzan A and Diana F 2020 J. Phys.: Conf. Ser. 1470 012019
[16] Van Mier H I, Schleepen T M J and Van den Berg F C G 2019 Front. Psychol. 9 2690
[17] Primi C, Donati M A, Chiesi F, and Morsanyi K 2018 Think. Reason. 24(2) 258
[18] Kusumaningsih W, Darhim, Herman and Turmudi 2018 J. Phys.: Conf. Ser. 1013 012143
[19] Reinhold F, Hofer S, Berkowitz M, Strohmaier A, Scheuerer S, Loch F, Vogel-Heuser B and Reiss K 2020 Math. Educ. Res. J. 32(2) 189