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Mathematical exploration ability and students' habits of mind based on gender: a study in junior high school level

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ABSTRACT

In learning mathematics, students tend to only be directed to get good results, without paying attention to how the exploration process of the problems given. In fact, the exploration process that students go through is different from one another and influenced by certain factors. The objective of this study is to describe the mathematical exploration ability on number pattern topic studied from the students' habits of mind based on gender at the junior high school level. This study used mixed methods with sequential-explanatory model, and involved 27 students of grade VIII (second year). The instruments used include a test of mathematical exploration ability, habits of mind questionnaire, and an interview guidelines. The results revealed that there are differences in mathematical exploration ability between male and female students where some of the differences are caused by their habits of mind. Female students tended to be more able to explore mathematical problems than male students, because they applied more habits of mind than male students when trying to solve the problem. This also shows that habits of mind affect students' mathematical exploration ability.

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1. INTRODUCTION

During the mathematics learning process, students were not only required to get good grades, but they must be stimulated to be able to discover, investigate or explore on their own, as well as prove a conjecture that they make themselves, and find out the answers to questions that arise [1]–[3]. These activities are known as exploration. The purpose of exploration activities is for students to get the opportunity to be widely involved in the problem solving process [4].

In the classroom, mathematical exploration activities are important in the learning process because they provide opportunities for students to improve their mathematical thinking skills [5], [6]. In exploring mathematical problems, students will be faced with basic concepts that they need to master so that later they can be developed again when they find more complex problems related to the previous concepts. This will then lead to the formation of mathematical exploration skills when students are trained continuously in exploring various concepts or rules, solving problems, thinking creatively and explaining their findings [7]–[10].

In fact, the mathematical exploration ability of the students are still indicated to be low. This can be reflected in the students' mathematical problem solving skills which are still relatively low [4], [11], [12].

The results of the Program for International Student Assessment (PISA), carried out by the Organization for Economic Co-operation and Development (OECD) explained that Indonesia obtained an average mathematics score of 379 from the OECD average score of 487 and placed Indonesia 74th out of 79 countries in the mathematics category [13]. This phenomenon is also aligned with the pre-research results that has been carried out by giving initial ability test questions to students in grade VIII (second year) at SMP Negeri 10 Pontianak (public middle school) on number pattern material. As a result, only 20.4% of the students' answers were correct, while the rest were indicated to be wrong. Based on the answers given by students, they had difficulty in solving the problems given. This is reflected in the answers of students who are identified as not fulfilling the indicators of mathematical exploration ability. The indicators of mathematical exploration [5] are include: i) understanding the problem; ii) examining patterns; iii) searching informally; iv) clarifying the solution effort; and v) symbolization and generalization. They indicated that they were unable to properly understand the problem contained in the question, determine the number pattern that must be used, solve the pattern using the number pattern formula and use or write the symbols used in the number pattern. Furthermore, from a gender perspective, there are generally differences in mathematical abilities among male and female students in exploring and solving mathematical problems, although not significant. Some studies mention that male students' ability to explore is lower than female students and some studies mention the opposite [14]–[18].

The low mathematical exploration ability can be influenced by the affective aspects of students. This is because students attitudes and characters affect their ability to capture and understand mathematics learning [19]–[22]. In learning mathematics, one of the affective aspects of students who are trained is to have habits of mind [23]–[25]. Habits of mind were first developed by Costa and Kallick in 1985 and consist of 16 habits, namely: i) persisting; ii) managing impulsivity; iii) listening to others-with understanding and empathy; iv) thinking flexibly; v) thinking about thinking; vi) striving for accuracy and precision; vii) questioning and posing problems; viii) applying past knowledge to new situations; ix) thinking and communicating with clarity and precision; x) gathering data through all senses; xi) creating, imagining, and innovating; xii) responding with wonderment and awe; xiii) taking responsible risks; xiv) finding humor; xv) thinking interdependently; and xvi) learning continuously.

The habit of intelligent thinking is one of the positive habits possessed by humans [26]. Habits of mind positively influence students' mathematical ability and can shape their thinking skills, which are important for them in solving mathematical problems [25], [27]. It is mean, habits of mind can motivate students to connect mathematical ideas and help them in overcoming or resolving the problems they face with productive actions and ways. These productive ways can be in the form of exploration of given mathematical problems. Students who apply these habits will know how to start solving the problem and what steps to take. In addition, they also realize what data needs to be collected and generated to solve the problem. They will explore by trying to find other alternative solutions and assessing whether the solution is appropriate or not [28], [29].

The contribution of habits of mind to mathematical ability has been investigated by several researchers previously. As a result, habits of mind positively affect on students' mathematics ability [30]–[33]. Based on the explanations and the opinions of the research results that has been presented, it is important to know how the differences between male and female students' mathematical exploration ability and to see whether the influence of habits of mind on the differences that may appear in order to design an effective learning process, because some relevant research only studies each variable separately either mathematical exploration ability or habits of mind. Therefore, the objective of this study is to analyze and describe how the differences in mathematical exploration ability between male and female students which is then studied from their habits of mind while learning or solving mathematics problems in junior high school level.

2. METHOD

2.1. Research design

This study used combination or mixed research. This is a combination of two research methods, namely quantitative and qualitative methods which are then used in together in a research to acquire data that is more complete, valid, reliable, and objective [34]. This mixed research method uses a sequential explanatory model. The sequential explanatory model is a combination between quantitative and qualitative methods sequentially (serially), where researchers start by conducting a quantitative analysis and then continue with a qualitative analysis to help explain the previous quantitative phase [34], [35]. In this study, the research design began with collecting data and analyzing quantitatively, then continued with collecting data and analyzing qualitatively, which is presented in Figure 1.

2.2. Participants

This study was conducted at SMP Negeri 10 Pontianak (public middle school) during 12 May-12 June 2023. The study data was collected from 27 students in grade VIII (second year), 12 were male students and

15 were female students who had learned the number pattern material. The subject was chosen as a result of a discussion by the researcher and the mathematics teacher of SMP Negeri 10 Pontianak based on the highest average mathematics score. This number was also based on an adequate sample size of 20-30 samples according to previous studies [35], [36]. A total of 27 students were given an exploratory ability test, then two students each were selected consisting of male and female students to represent the high, moderate and low categories to be given a habits of mind questionnaire followed by conducting interviews with them. This selection was based on students test results that were not significantly different in each category.

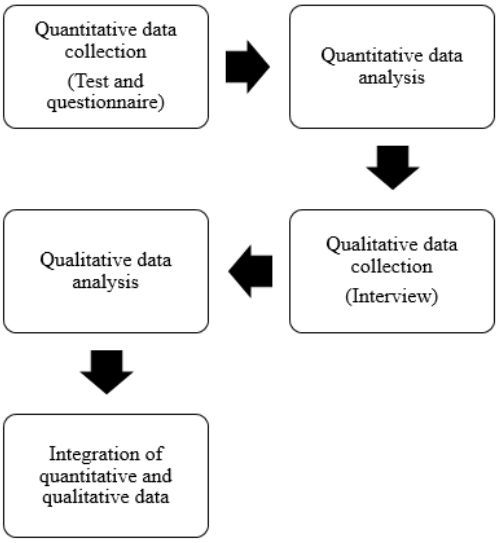

Figure 1. Sequential explanatory phase

2.3. Instruments

The instruments used consisted of a test of mathematical exploration, questionnaire of habits of mind, and interview guidelines. The test used was a test of number pattern material with a description type of question. The test questions consisted of two questions with each question consisting of five items. The test questions were validated first by one of the Mathematics Education Study Program lecturers. After the test questions were deemed good, a test was conducted on 30 students to measure validity and reliability. The results of the two questions were indicated valid with r_{xy} (0.866 and 0.874) $> r_{table}(0.361)$ at a significant level of 5% and in a very high category ($0.800 < r_{xy} \leq 1.000$). Both questions were also indicated reliable with r_{11} (0.723) $> r_{table}(0.361)$ at a significant level of 5% and in the high category ($0.700 < r_{11} \leq 0.900$).

The questionnaire for this study is a closed questionnaire consisting of 32 statements according to the 16 habits of mind indicators. Each indicator consists of two statements consisting of positive and negative statements. This questionnaire aims to find out how students' habits of mind are in solving mathematics problems. Guttman Scale is the scale used in this instrument. The questionnaire was validated first by one of the Guidance and Counselling Study Program lecturers. After the questionnaire was deemed good, it was tested on 30 students to measure validity and reliability. The 32 statements were indicated valid with r_{xy} ($0.362 - 0.769$) $> r_{table}$ (0.361) at a significant level of 5% and were in categories that varied from low to high. The questionnaire was also indicated reliable with $r_{11}(0.875) > r_{table}(0.361)$ at a significant level of 5% and in the high category ($0.700 < r_{11} \leq 0.900$).

The interview used in this study was a semi-structured interview. In its implementation, semi-structured interviews are freer than structured interviews. This is because semi-structured interviews aim to find problems more openly by providing opportunities for respondents to argue [37]. The interview guidelines were also validated by one of the Mathematics Education Study Program lecturers. The interview guidelines consist of several questions that were used to clarify and explore more deeply how students' exploration ability when solving problems, so its prepared by adjusting the indicators of mathematical exploration ability and the questions given also developed according to the students' test results. The interview guidelines presented in Table 1.

Table 1. Interview guidelines

Indicators of mathematical exploration ability	Question guidelines description
Understanding the problem	Provide explanations regarding source of the information provided
	Provide reasons related to the accuracy of the information provided
Examining patterns	Explains how to identify the pattern formed in the problem
	Explains the actions taken to ensure the suitability of the pattern that has been identified
Searching informally	Explaining how the solution of the given problem
	Explaining the sequence of actions taken in solving the problem.
Clarifying the solution effort	Provide information related to confidence in the solution given
	Provide reasons related to factors that influence confidence in the given solution.
Symbolization and generalization	Explaining the obstacles in concluding the solution of the given problem
	Provide reasons that can strengthen the truth of the conclusion given

2.4. Data analysis

Data analysis techniques used in this study, were adjusted to the formulation of problems and mixed research methods so that valid data were obtained. Data analysis began with quantitative data analysis of the mathematical exploration ability test and habits of mind questionnaire results, then continued with qualitative data analysis of the interview results.

Quantitative analysis used in this research is descriptive statistical analysis type. The data analyzed with descriptive statistics which are the test results of the mathematical exploration ability and habits of mind questionnaire presented through diagrams and tables. The categorization of the mathematical exploration ability test results takes into account the average value ($\bar{x}$) and standard deviation (SD) as seen in Table 2.

The qualitative data analysis process follows the previous quantitative data. Based on the quantitative data that has been reduced previously, data analysis continues with data presentation by connecting habits of mind and exploration skills in each category. Through this stage, an explanation about how the students' habits of mind in the high, moderate and low categories of mathematics exploration ability is obtained. The analysis process is also followed by further data collection conducted by semi-structured interviews with students. Interview data was obtained from representatives of students at each level of their mathematical exploration ability. The interview data was analyzed with the aim of revealing in depth their mathematical exploration ability that was not directly observed.

Table 2. Classification criteria for mathematical exploration ability

Criteria	Students' category
$S \geq (\bar{x} + SD)$	High
$(\bar{x} - SD) \leq S < (\bar{x} + SD)$	Moderate
$S < (\bar{x} - SD)$	Low

3. RESULTS AND DISCUSSION

3.1. Students' mathematical exploration ability based on gender

The test given aims to classifying the level of mathematical exploration ability. Based on the test results of the mathematical exploration ability, the following data were obtained in Table 3. Furthermore, based on the classification criteria in Table 3, the classification of students' mathematical exploration ability scores is presented through a frequency graph in the form of a bar chart as Figure 2.

Based on Figure 2, it revealed that the frequency of mathematical exploration ability in the high category is 14.8% or as many as 4 students. Furthermore, the frequency of mathematical exploration ability in the moderate category, which is 74.1% or as many as 20 students. The frequency of mathematical exploration ability in the low category, which is 11.1% or as many as 3 students. This result has shown that most students have moderate mathematical exploration abilities. However, if viewed based on gender, the student ability test results average are as presented in Table 4. Based on Table 4, it revealed that female students have higher average achievement test scores than males. This shows that the test scores obtained by female students are mostly higher than the scores of male students.

Table 3. Students' mathematical exploration ability test results

Information	Mathematical exploration ability test result
$\bar{x}$ (average)	49.63
SD (standard deviation)	16.81
$X\ min$ (lowest score)	5
$X\ max$ (highest score)	25

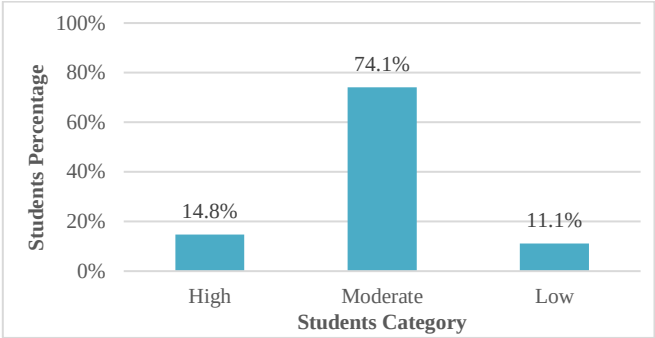

Figure 2. Category bar diagram of students' mathematical exploration ability

Table 4. Average of mathematical exploration ability test results based on gender

Students	Average of mathematical exploration ability test result
Male students	48.22
Female students	51.05

3.2. Students' habits of mind based on gender

After being given the mathematical exploration ability test, 2 students consisting male students and female students selected from each category of mathematical exploration ability were asked to fill out the questionnaire. On each category from high to low, male students coded as M-1 to M-3 and female students coded F-1 to F-3. The purpose of the questionnaire is to find out about the habits of mind in each category of mathematical exploration ability. The score of the students' habits of mind questionnaire results are presented through a frequency graph in the form of a bar chart as Figure 3.

Based on Figure 3, it revealed that in the high mathematical exploration ability category, male and female students both obtained the same questionnaire score percentage, which means in learning mathematics, they tend to show the same number of habits of mind out of the total. In the moderate and low mathematical exploration ability category, the percentage of habits of mind shown by female students is higher than male students. Although the difference shown is not too significant, but his reflects that female students show more habits of mind during the learning process or applied them on problem solving process. In general, female students tend to apply more habits of mind either in learning or when solving problems than male students.

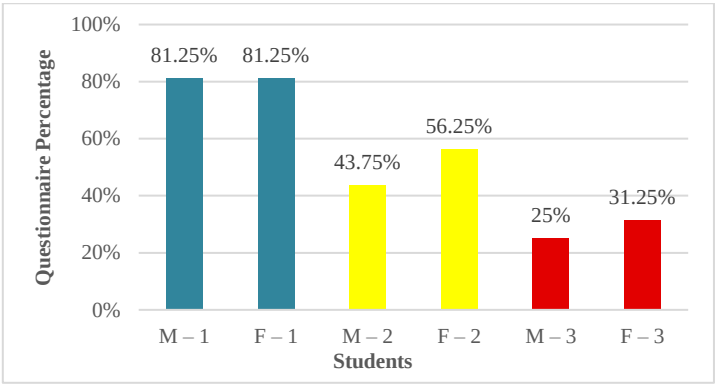

Figure 3. Bar diagram of students' habits of mind questionnaire based on gender

3.3. Students' interview results

Interviews were conducted with representatives of each category of mathematical exploration ability that had been previously selected to reveal in depth their mathematical exploration abilities that might not be observed. In the high category, female students gave more precise and complete answers than male student. They provide answers to all questions completely in accordance with the problem to be solved. The answers of male student (M-1) and female student (F-1) are presented in Figures 4 and 5 followed by excerpts of their interviews.

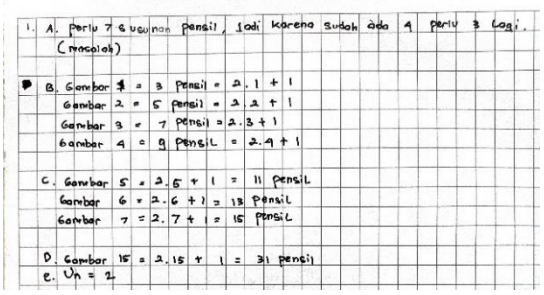

Figure 4. Answer of subject M-1

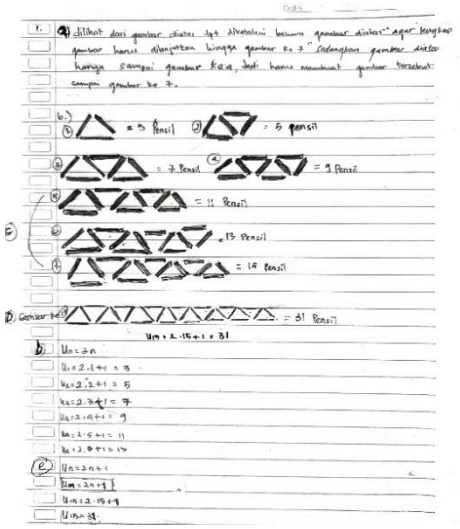

Figure 5. Answer of subject F-1

Researcher : *Are you sure you have written down the information and the problem to be solved correctly?*
Subject M-1 : *Sure, because what I wrote was as known in the problem.*
Researcher : *How do you know the pattern formed in the given problem?*
Subject M-1 : *I tried, Sir.*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject M-1 : *When I entered the value, it turned out to be correct.*
Researcher : *How can you think of problem solving in the problem?*
Subject M-1 : *I just used the pattern earlier.*
Researcher : *Tell me what you have to do first in solving the problem in the problem?*
Subject M-1 : *I want to determine the pictures 5, 6, 7. So the pattern just changed the numbers to 5, 6, 7.*
Researcher : *What makes you sure of the solution you gave?*
Subject M-1 : *For picture 15, it's the same method as c.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving that you have given?*
Subject M-1 : *No.*
Researcher : *Then what is the conclusion?*
Subject M-1 : *It should be 2n+1 (while pointing to the wrong answer 1e).*
*this conversation is translated from Indonesian

Researcher : *Are you sure you have written down the information and the problem to be solved correctly?*
Subject F-1 : *Sure, because it is the same as the question asked*
Researcher : *How do you know the pattern formed in the given problem?*
Subject F-1 : *Because the difference in the number of pencils is 2, I started with a 2n pattern. After checking it turns out need to add 1 to make it fit.*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject F-1 : *Just see the result of the number of pencils, Sir.*
Researcher : *How can you think of problem solving in the problem?*
Subject F-1 : *Just continue from the previous pattern, Sir.*
Researcher : *Tell me what you have to do first in solving the problem in the problem?*
Subject F-1 : *First, see the pattern first. After that, find the number of pencils for the 3 pictures using the pattern earlier.*
Researcher : *What makes you sure of the solution you gave?*
Subject F-1 : *The question asked the number of pencils in the picture in 15 triangles, so it's like determining the 3 pictures earlier, just enter it into the pattern.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving that you have given?*
Subject F-1 : *No, I haven't, Sir*
Researcher : *Then what is the conclusion?*
Subject F-1 : *The formula of the pattern is 2n+1.*

Based on the interview results on question number 1, subject M-1 knows the information and problems that must be solved. Subject M-1 was also able to explain the pattern formed from the 4 pencil drawing arrangements so as to solve the problem requested. In item 1d, he realized the effort needed to clarify the pattern obtained. He also knew how the general formula to determine the number of pencils in the n^{th} drawing. Same as in answer number 2, subject M-1 was able to answer correctly and explain the steps of completion when interviewed. The same thing also happened to subject F-1. She was able to re-explain about her answer as well. However, there is a difference where subject F-1 confidently explained more details and specifics than subject M-1 who had doubts. Therefore, based on the test answers and supported by interviews results, it was concluded that students in the high category, both male and female, are able to perform all five indicators of mathematical exploration ability.

In the moderate category, the answers given by students are incomplete. Although they gave answers to all the questions, some of the answers given were not correct, especially section d and e. The answers of male student (M-2) and female student (F-2) are presented in Figures 6 and 7 followed by excerpts of their interviews.

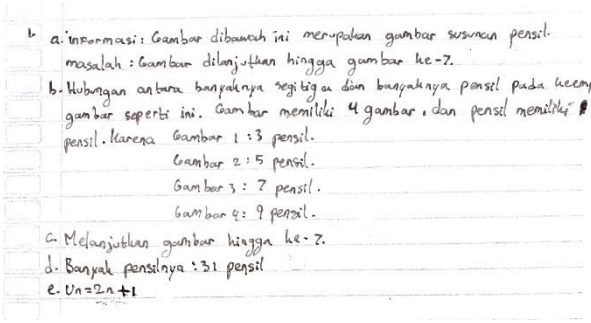

Figure 6. Answer of subject M-2

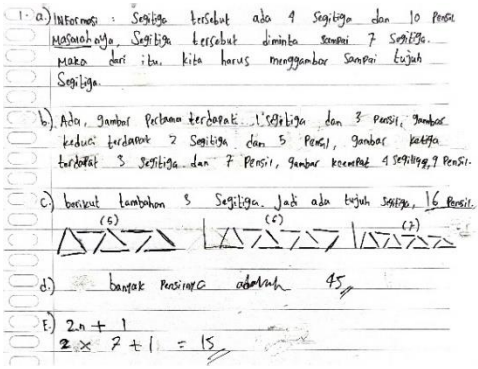

Figure 7. Answer of subject F-2

Researcher : *Are you sure you have written the information and the problem to be solved correctly?*
Subject M-2 : *Sure.*
Researcher : *How do you know the pattern formed in the given problem?*
Subject M-2 : *The picture forms a number pattern, the difference is 2.*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject M-2 : *Put the numbers into the pattern.*
Researcher : *What is the drawing then?*
Subject M-2 : *The drawing is like this, sir (while drawing a picture which then matches the answer key).*
Researcher : *Tell me what to do first in solving the problem?*
Subject M-2 : *From the previous many pencils first, then I can know.*
Researcher : *Are you sure about the solution you gave?*
Subject M-2 : *Not sure, Sir.*
Researcher : *What makes you unsure of the solution you gave?*
Subject M-2 : *15 triangles is too many, Sir.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving you have provided?*
Subject M-2 : *Yes, Sir.*
Researcher : *Try to give a reason that the conclusion you gave is correct.*
Subject M-2 : *I don't know how to get the conclusion, Sir*
*this conversation is translated from Indonesian

Researcher : *Are you sure you have written the information and the problem to be solved correctly?*
Subject F-2 : *Sure.*
Researcher : *How do you know the pattern formed in the given problem?*
Subject F-2 : *The difference is 2, so I tried the pattern. (while showing the subject's notes about the pattern obtained which actually forms a pattern of 2(many triangles)+1)*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject F-2 : *The number of pencils matches the pattern.*
Researcher : *Tell me what to do first in solving the problem?*
Subject F-2 : *Look at the number of pencils from the previous picture. Then I tried to connect the possible pattern.*
Researcher : *Are you sure about the solution you gave?*
Subject F-2 : *Not too sure, Sir.*
Researcher : *What makes you unsure of the solution you gave*
Subject F-2 : *I was confused, Sir.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving you have provided?*
Subject F-2 : *Yes, Sir.*
Researcher : *Try to give a reason that the conclusion you gave is correct.*
Subject F-2 : *I don't know, Sir*

Based on the interview results on question number 1, subject M-2 knows the information and the problem to be solved. Subject M-2 was also able to explain the pattern formed from the 4 pencil drawings although he did not realize the pattern could help solve the problem requested. In item 1d, he did not understand how the solution effort should be done. He also admitted to having difficulty in showing the general formula

for determining the number of pencils in the nth drawing. Same as in answer number 2, subject M-2 was unable to clarify the solution effort. This has also happened to F-2 where she was able to re-explain the answers, he had done even though he sounded quite hesitant. However, from the results of her answers and her interview, she explained in more detail related to the completion steps than M-2. Therefore, based on the test answers and supported by interviews results, it was concluded that students in the moderate category, both male and female, are able to perform 3 indicators of mathematical exploration ability, namely understanding the problem, examining patterns, and searching informally.

In the low category, the results of the answers given by students are almost incomplete. They only provide few answers and the answers given are still not precise. This can be seen from the answers from section b to e which are incomplete and incorrect. The answers of male student (M-3) and female student (F-3) are presented in Figures 8 and 9 followed by excerpts of their interviews.

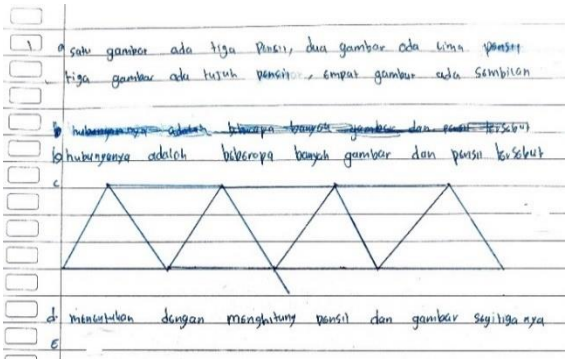

Figure 8. Answer of subject M-3

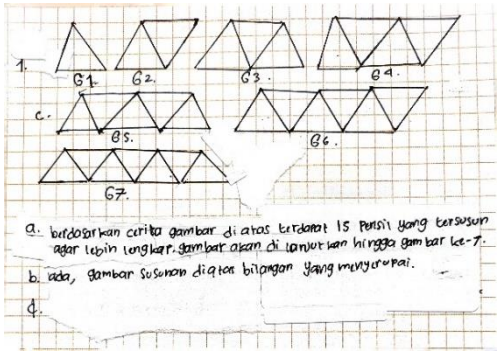

Figure 9. Answer of subject F-3

Researcher : *Are you sure you have written the information and the problem to be solved correctly?*
Subject M-3 : *Sure.*
Researcher : *How do you know the pattern formed in the given problem?*
Subject M-3 : *I don't understand, Sir so I don't know.*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject M-3 : *I don't know, Sir.*
Researcher : *How can you think of problem solving in the problem?*
Subject M-3 : *I tried to draw.*
Researcher : *Tell me what to do first in solving the problem?*
Subject M-3 : *I don't know, Sir.*
Researcher : *Are you sure about the solution you gave?*
Subject M-3 : *Not sure.*
Researcher : *What makes you unsure of the solution you gave?*
Subject M-3 : *I don't know how to do it.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving you have provided?*
Subject M-3 : *Yes, Sir.*
Researcher : *Try to give a reason that the conclusion you gave is correct.*
Subject M-3 : *I don't understand how to explain*

*this conversation is translated from Indonesian

Researcher : *Are you sure you have written the information and the problem to be solved correctly?*
Subject F-3 : *I'm sure, Sir.*
Researcher : *How do you know the pattern formed in the given problem?*
Subject F-3 : *I don't know.*
Researcher : *What did you do to ensure that the pattern formed was appropriate?*
Subject F-3 : *I don't know how to determine the pattern, Sir.*
Researcher : *How can you think of problem solving in the problem?*
Subject F-3 : *I just tried from the picture.*
Researcher : *Tell me what to do first in solving the problem?*
Subject F-3 : *I don't know, Sir.*
Researcher : *Are you sure about the solution you gave?*
Subject F-3 : *Not sure.*
Researcher : *What makes you unsure of the solution you gave?*
Subject F-3 : *I don't understand about the pattern.*
Researcher : *Do you have difficulty in stating the conclusion of the problem solving you have provided?*
Subject F-3 : *Yes, Sir. I don't get it.*
Researcher : *Try to give a reason that the conclusion you gave is correct.*
Subject F-3 : *I don't understand how to explain it.*

Based on the interview results on question number 1, it can be seen that subject M-3 knows the information and problems that must be solved. However, subject M-3 was unable to explain the pattern formed from the 4 pencil drawings and could not solve the problem requested. In item 1d, he did not understand how the solution effort should be done. He also admitted to having difficulty in showing the general formula for determining the number of pencils in the nt^{h} drawing. In question number 2, subject M-3 did not answer on the answer sheet and said that he had no clue how to answer the question. The same thing also happened to subject F-3. The answers given are also incomplete and unable to explain how the steps of completion. However, what distinguishes subject F-3 from subject M-3 is that she is more confident in her answers. This was revealed

during the interview session. Therefore, based on the test answers and supported by interviews results, it was concluded that students in the low category, both male and female, are only able to perform 1 indicator of mathematical exploration ability, namely understanding the problem.

3.4. Mathematical exploration ability studied from students' habits of mind based on gender

Based on the theoretical relation between mathematical exploration ability and habits of mind, there are also a relation between each indicator of them. Thus, in Table 5, it is shown how the habits of mind in each category of mathematical exploration ability between female and male students. Based on the table, the relation between mathematical exploration ability and students' habits of mind is explained in depth.

Table 5. Achievability of habits of mind on mathematical exploration ability

Indicators of mathematical exploration ability	Indicators of habits of mind	Achievability of habits of mind					
		High		Moderate		Low	
		M-1	F-1	M-2	F-2	M-3	F-3
Understanding the problem	Listening to others-with understanding and empathy	√	–	√	√	–	–
	Gathering data through all senses	√	√	√	√	√	√
	Responding with wonderment and awe	–	√	–	–	–	–
Examining patterns	Persisting	√	√	–	√	–	–
	Managing impulsivity	√	√	√	√	–	√
	Thinking flexibly	√	√	√	√	–	–
	Striving for accuracy and precision	√	√	√	√	√	√
Searching informally	Questioning and posing problems	√	√	–	√	–	–
	Finding humor	√	–	√	–	√	√
	Thinking interdependently	–	–	√	√	√	√
	Learning continuously	√	√	–	√	–	–
Clarifying the solution effort	Thinking about thinking	√	√	–	–	–	–
	Thinking and communicating with clarity and precision	–	√	–	–	–	–
	Creating, imagining, and innovating	√	√	–	–	–	–
Symbolization and generalization	Applying past knowledge to new situation	√	√	–	–	–	–
	Taking responsible risks	√	√	–	–	–	–

3.4.1. High category of mathematical exploration ability

When faced with problems related to mathematical exploration, both male and female students were able to have a good understanding of the problem. Male students tend to show the habit of listening to others empathetically and trying to understand what they hear. In contrast to female students, they do not show this habit, they are not used to listening to others by involving empathy. Although there are differences related to these habits, they are still able to understand the problems given because they have a habit of understanding something by utilizing their senses in observing and looking at every detail of the problem to be solved. This allows them to absorb as much information that is considered capable of being used in problem solving [29]. In the next habit, only female students show the habit to tend to be interested in the problems given and have great curiosity. This shows that male students tend to be less interested when given something new.

Mathematical exploration ability related to the ability to examine patterns is shown through their habit of working on something given seriously until completion and not giving up easily. Whether the students are male or female, they are able to examine patterns because they try continuously to look for relationships in the information obtained and make conjectures about patterns that might be appropriate [33]. In addition, they are also used to thinking before acting which helps in understanding the direction of the problem and considering alternative suitable patterns. This is of course also inseparable from the habit of flexible thinking where they are able to change their minds when receiving new data and allow them to identify other pattern relationships if the previous pattern is considered inappropriate. This habit is also because they always strive for accuracy.

In the ability related to searching informally, in the ability related to informal search, students have a habit of asking questions and proposing problems so that they can explore how to solve a given problem. However, in the habits of male and female students, there are differences when it comes to humor. Male students tend to often do humor which can certainly free up creativity to understand the situation from a different perspective on a problem, in contrast to female students who tend not to be accustomed to doing humor. Similar research into gender and humor explained that this this could be due to a lower understanding of humor in female students compared to male students [38]. However, they are used to continuous learning, which is shown through their enthusiasm and curiosity, so they will always discover new things. The habit of thinking will certainly help students in exploring unusual solutions [30]. The similarity between male and female students can also be seen from the habit of thinking interdependently on others that is not shown so this can show that both male and female students tend to work individually.

Furthermore, students who are able to clarify problem solving efforts are shown through habits related to metacognition. Previous study [25] stated that the habit of thinking metacognition makes students understand themselves, because students are aware of what knowledge they have and what plans they will do. This shows that both male and female students tend to routinely evaluate the solutions they have done because they realize and understand what they know and what they do not know [31], [32]. Female students showed a habit of thinking and communicating clearly compared to male students. This is also evident from the work of female students who tend to be clearer and more systematic than male students which indicates that female students are able to communicate their problem solving ideas well. The ability to clarify the solution effort is also inseparable from the students' habit of working and innovating by trying various solutions in solving problems and imagining how the solution will work. Both male and female students tried to explore and innovate to find the right solution.

Students who are then also able to symbolize and generalize are shown by their habit of connecting the given problem with their past experiences to solve the problem. There is no difference in habits in this phase for male and female students. They utilize old experiences and make analogies that allow them to express their solutions in the form of symbols that are generalized [39], [40]. In addition, students are also accustomed to taking risks by taking opportunities that exist and trying to present the right conclusions.

3.4.2. Moderate category of mathematical exploration ability

In the first indicator of mathematical exploration ability, students are able to identify the problem because they have a habit of understanding something they hear by involving empathy and full understanding. Just like students in the high category, they are also accustomed to utilizing their senses in observing and looking at every detail of the problem to be solved. This allows them to absorb some information that is considered capable of being used in problem solving. However, in the next habit, both male and female students did not show that they were interested in the problems given and had curiosity about something new. Nevertheless, they were still able to understand the given problem appropriately [25].

In the ability to examine patterns, students are able to find patterns to answer the questions given. In female students, they are accustomed to working on something given seriously until it is completed and do not give up easily. They understand the relationship of the pattern formed because they try continuously to find the relationship in the information obtained. In contrast to male students where they do not show these habits that make them easily give up in solving existing problems. This is aligned with previous study [22], [27], [33] which states that people who have persisting habits will try continuously until their problem-solving strategy is successful. Although different in terms of persistence, they all show the same habit of managing impulsivity by thinking before acting which helps in understanding the direction of the problem and considering alternative suitable patterns. This is of course also due to the habit of flexible thinking where they are able to change their minds when receiving new data which allows them to identify other pattern relationships if the previous pattern is not considered appropriate. It also indicates that students in this category are also used to striving for the accuracy of their answers.

Furthermore, on the indicator of searching informally, some differences were seen in habits of male and female students in this category even though they are able to conduct informal searches to solve problems. Female students tend to show the habit of asking questions and proposing problems so that they can explore how to solve a given problem and the habit of continuous learning from previously obtained problems, while male students do not show these habits. However, just like in the high category, only male students show the habit of doing humor that can exercise creativity so that they can understand the situation from different perspectives on a problem. Nevertheless, they all showed the habit of interdependent thinking where they are used to and able to work in groups and respect other people's ideas and ideas in dealing with a problem.

In the fourth indicator, students in the moderate category were unable to clarify the solution effort. Both male and female students, they all did not show any habits of mind related to the ability to clarify the solution effort. This shows that they are not used to evaluating the solutions they have done because they have not realized and understood what they know and what they do not know. They are also not used to making conjectures and expressing ideas. Previous research relevant to this issue states that this of course also results in them not being used to work and innovate to try various solutions in solving problems [29].

Just like the indicator of clarifying the solution effort, students in this category are unable to symbolize and generalize. This is also shown by the non-existing habits of mind that emerge. They do not have the habit of connecting the given problem with their past experiences to solve the problem. They were also not used to taking risks, which was shown by their lack of confidence in writing their conclusions.

3.4.3. Low category of mathematical exploration ability

In the first indicator of mathematical exploration ability, different from students in the high and medium categories, in the low category, male and female students only showed that they were used to utilizing

their senses in observing and looking at every detail of the problem to be solved. Although they did not show the habit of understanding something they heard by involving feelings and the habit of being interested in the given problem, they were still able to understand the given problem well.

In the ability to examine patterns, although students cannot find a patterns to answer problems, they still show habits of mind in dealing with problems. The habit shown by female students that is not shown by male students is used to managing impulsivity by thinking before acting which helps in understanding the direction of the problem [33]. Nonetheless, both male and female students jointly showed the habit of striving for accuracy in their answers, although it was not able to help them make conjectures about the relationships of the patterns formed. This shows that when faced with a problem, they always try to strive for improvement even though the results obtained are not as expected, they always try to find new things [41].

Similar to the pattern examining indicator, in the informally searching indicator, students in this category were not able to search informally but still showed some thinking habits. These were the habits of humor and interdependent thinking. Both male and female students showed that they were used to and able to work in groups and respect other people's ideas in dealing with a problem.

In the fourth and fifth indicators, students in the low category were unable to clarify the solution effort and were unable to symbolize and generalize. They also did not show any habits of mind, as indicated by the absence of any fulfilled habits of mind indicators. This shows that they are not used to evaluating the solutions they have done because they have not realized and understood what they know and what they do not know. They are also not used to expressing ideas and notions which of course also results in them not being used to work and innovate to try various solutions in solving problems [26].

Male and female students in this category are also not used to connecting the problems given with their past experiences. Previous study state that people who have this habit will be able to construct old knowledge with new knowledge in solving problems [41], [42]. That is, they are able to realize and connect the relation between the mathematical knowledge they have learned and the problem solving that is currently being faced. However, students in this category have not been able to do this, causing them to be unable to express solutions in the form of symbols that are generalized. Besides that, students are also not used to taking risks, which is shown by their lack of confidence in writing conclusions.

4. CONCLUSION

Based on the findings, the conclusion that can be reached is that the classification of mathematical exploration ability into high, moderate and low categories can describe how male and female students' ability to explore mathematical problem. In the high category, students are able to solve by exploring the mathematical problems. However, in the moderate category, students are less able to solve and explore the mathematical problems. Meanwhile, in the low category, students were unable to explore the mathematical problems presented. Although male and female students in each category indicated that they fulfilled the same indicators, in general, female students tended to be more able to explore mathematical problems than male students. This can be seen from the results of written answers and explanations given during the interview process by female students who are more specific and systematic than male students. The difference in exploration ability is due to the different habits of mind shown. Female students tend to show more habits of mind than male students, so that these habits help them in solving problems. This is an indication that habits of mind tend to influence students' mathematical exploration ability. Therefore, educators need to put more attention in improving students' habits of mind in order to improve their exploration ability, such as designing process-focused learning methods and being able to lead students to become accustomed to exploring.

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