

## GENDER DIFFERENCE IN MATHEMATICAL LITERACY AND FACTOR THAT MAY AFFECT IT

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Received October 17, 2023; Revised December 17, 2023; Accepted December 21, 2023

### Abstract:

Many research studies have shown that female students' mathematical literacy is better than male students. However, the previous research viewed students' mathematical literacy qualitatively. Maybe there are differences between the mathematical literacy of male and female students, but is it genuinely significant? Therefore, this research aimed to quantitatively investigate the differences in mathematical literacy between male and female students to provide empirical proof. In this study, 116 students at junior high school were the samples. The mathematical literacy test collected data about students' mathematical literacy. The data were then analyzed using a comparison test of Mann-Whitney U to examine the hypotheses. The result showed no significant difference between male and female students' mathematical literacy and whether, in general, and viewed from gender, students have low mathematical literacy. The factor that may affect the low and no significant difference between male and female students regarding mathematical literacy is teachers rarely provide students with mathematical literacy problems during the teaching and learning process.

**Keywords:** Gender, Mathematical Literacy, Mathematics, PISA

## PERBEDAAN GENDER DALAM LITERASI MATEMATIS DAN FAKTOR YANG MUNGKIN MEMENGARUHINYA

### Abstrak:

Banyak penelitian yang menunjukkan bahwa literasi matematis siswa perempuan lebih baik daripada siswa laki-laki. Namun, penelitian sebelumnya melihat literasi matematis siswa secara kualitatif. Mungkin memang ada perbedaan antara literasi matematis siswa laki-laki dan perempuan, tetapi apakah perbedaan tersebut benar-benar signifikan? Oleh karena itu, penelitian ini bertujuan untuk menyelidiki secara kuantitatif perbedaan literasi matematis antara siswa laki-laki dan perempuan untuk memberikan bukti empiris. Dalam penelitian ini, 116 siswa sekolah menengah pertama menjadi sampel. Tes literasi matematis digunakan untuk mengumpulkan data tentang literasi matematis siswa. Data tersebut kemudian dianalisis menggunakan Mann-Whitney U untuk menguji hipotesis. Hasil penelitian menunjukkan tidak ada perbedaan yang signifikan antara literasi matematis siswa laki-laki dan perempuan, dan baik secara umum ataupun dilihat dari jenis kelamin,

siswa memiliki literasi matematis yang rendah. Faktor yang mungkin mempengaruhi rendahnya dan tidak adanya perbedaan yang signifikan antara siswa laki-laki dan perempuan dalam hal literasi matematis adalah guru jarang memberikan siswa masalah yang berhubungan dengan literasi matematis pada saat proses pembelajaran.

**Kata Kunci:** Gender, Literasi Matematis, Matematika, PISA

*How to Cite:* Qirom, M. S., Turmudi, & Juandi, T. (2023). Gender Difference in Mathematical Literacy and Factor that May Affect It. *MaPan: Jurnal Matematika dan Pembelajaran*, 11(2), 353-367. <https://doi.org/10.24252/mapan.2023v11n2a10>

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## INTRODUCTION

Mathematical literacy is known as the essential skill that we have in this 21st century. It makes mathematical literacy can be considered part of 21st-century skills (Rizki & Priatna, 2019). Mathematical literacy refers to being able to reason mathematically and formulate, employ, and interpret mathematics in various situations in the real world (OECD, 2018). Individuals with mathematical literacy can support themselves by being informative, contributive, constructive, engaged, and reflective 21st-century citizens (Geiger, Forgasz, & Goos, 2015; OECD, 2018).

In addition, it shows students how mathematics as a tool to solve problems can help them see mathematics positively (Attard, 2012; Popovic & Lederman, 2015). Hence, in school, mathematical literacy must always be integrated into the teaching and learning process to help the young generation of students possess the skills to adapt to rapid change and face many challenges in the 21st century (OECD, 2018; Rizki & Priatna, 2019), as well as, to improve their positive attitudes towards mathematics (Sanchal & Sharma, 2017). Furthermore, the definition of mathematical literacy makes mathematical literacy have a strong relation with mathematics. Students must understand mathematics concepts, facts, and procedures to perform better and master mathematical literacy (OECD, 2018). It also strongly develops mathematical literacy in mathematics teaching and learning, even though the skills can be created in other subjects. It is a task for teachers, especially mathematics teachers, to support and develop students' mathematical literacy during learning and instruction.

Since mathematical literacy is strongly connected with mathematics, it seems that the student's ability in mathematics will affect it. The previous

study also showed that students' mathematical ability is strongly related to mathematical literacy (Kharis, Salsabila, & Haeruman, 2021; Yulia, Kustati, & Afriadi, 2021). Since mathematics ability can affect students' mathematical literacy, gender might also affect students' mathematical literacy. Even though some studies show males and females do not have significant differences in terms of mathematics (Gabay-Egozi, Nitsche, & Grieger, 2022; Keller, Preckel, Eccles, & Brunner, 2022), some studies show a substantial difference between male and female students' mathematical ability (Hyde & Mertz, 2009; Pina, Martella, Chacon-Moscoso, Saracostti, & Fenollar-Cortes, 2021). Therefore, there is a probability that students' mathematical literacy based on gender might be different too.

Regarding gender and mathematical literacy, most studies showed that females have better mathematical literacy than males (Aufa & Manoy, 2022; Lanya, Zayyadi, Sulfiah, & Roziq, 2021; Ma'rup, Husniati, Usman, & Kristiawati, 2020; Sari & Khotimah, 2023). However, most previous research views the differences from a qualitative study. As a result, it cannot be generalized and only applies to particular research subjects. This research was conducted to fill that gap. Therefore, this study will explore and investigate the differences in students' mathematical literacy based on gender from another perspective, that is a quantitative approach. It can help us to see whether the difference is significant or not. Since the previous study only reported qualitatively, maybe there are differences between male and female students in terms of mathematical literacy. However, we cannot ensure whether the difference exists (significant).

This study contributes as a supplement to the previous research about gender differences in mathematical literacy. It can be the empirical proof of the differences reported by previous research; it may support the previous findings or even oppose them. Therefore, it can help teachers to identify whether gender indeed contributes to differences in students' mathematical literacy. In addition, this study also discusses factors that may affect the finding later, whether it will be significantly different or not. Consequently, they can provide better strategies to ensure that male or female students can be facilitated equally in class to improve their mathematical literacy and create differentiated learning.

## **METHODS**

This study was descriptive quantitative research. Because this research only focuses on gathering the result that naturally occurs in the field without any modification or manipulation of any variables (Gay, Mills, & Airasian, 2012). The subject of this research was 116 students at the 7th grade level of junior high school in Mataram, Indonesia. The students consist of 55 male students and 61 female students. The data collection technique was using a test. The subjects were given mathematical literacy tests as instruments for collecting data. The instrument was adapted from mathematical literacy on PISA 2012 on ratio and proportion topics. When the study was conducted, two topics were taught at the school where this study was conducted, namely integers and ratios and proportions. Since the integers are the prerequisite topic to learn about ratio and proportion, the ratio and proportion topic was chosen. Before the instrument was used, it was validated theoretically by three mathematics education experts, i.e., mathematics education lecturers, to justify whether the adapted instrument satisfies the mathematical literacy indicator and is well translated from English to Indonesia.

Table 1. Instrument Specification

No	Content	Cognitive Level	Context
1	Direct proportion	Knowing	Personal
2	Indirect Proportion	Applying	
3	Direct and indirect Proportion	Reasoning	

Table 1 shows the instrument specification in this study; it includes the content, cognitive level, and context. The content is focused on direct and indirect proportion as part of the ratio and proportion topic. The context only uses one type, namely personal. Meanwhile, the cognitive level is divided into knowing, applying, and reasoning. Furthermore, the difficulty level of questions also follows the cognitive level consecutively; they are easy, medium, and hard.

After the students' mathematical literacy scores are gathered, they will be analyzed using a comparison test to determine the differences in mathematical literacy between female and male students. Therefore, normality and homogeneity of data must be determined before deciding on a comparison test that will be used, either parametric (t-test) or non-parametric (Mann-Whitney U) analysis. Using a significance level of 5%, the hypothesis of

this study is depicted in table 2. In this study, the analysis process will be assisted by SPSS 26. Meanwhile, table 3 shows the guidance for interpreting students' mathematical literacy scores. It is used to enrich the general information about students' mathematical literacy level when viewed from the gender perspective.

Table 2. Hypothesis

Statistical Hypothesis	Research Hypothesis
$H_0: \mu_1 = \mu_2$	There is no significant difference between male and female students' mathematical literacy.
$H_1: \mu_1 \neq \mu_2$	There is a significant difference between male and female students' mathematical literacy.

Table 3. Mathematical Literacy of Students

Score	Category
$X > Mi + 0.5Sd_i$	High
$Mi - 0.5Sd_i < X \leq Mi + 0.5Sd_i$	Moderate
$Mi - 0.5Sd_i \leq X$	Low

Adapted from Sari and Wijaya (2017)

Description:

$Mi$  : average of ideal score =  $\frac{1}{2}$  (max ideal score - min ideal score)

$Sd_i$  : deviation standard =  $\frac{1}{6}$  (max ideal score - min ideal score)

## RESULTS AND DISCUSSION

### 1. Profile of Students' Mathematical Literacy

Table 4. Interval Score of Students' Mathematical Literacy

Score	Category
$X > 58.3$	High
$41.67 < X \leq 58.33$	Moderate
$X \leq 41.67$	Low

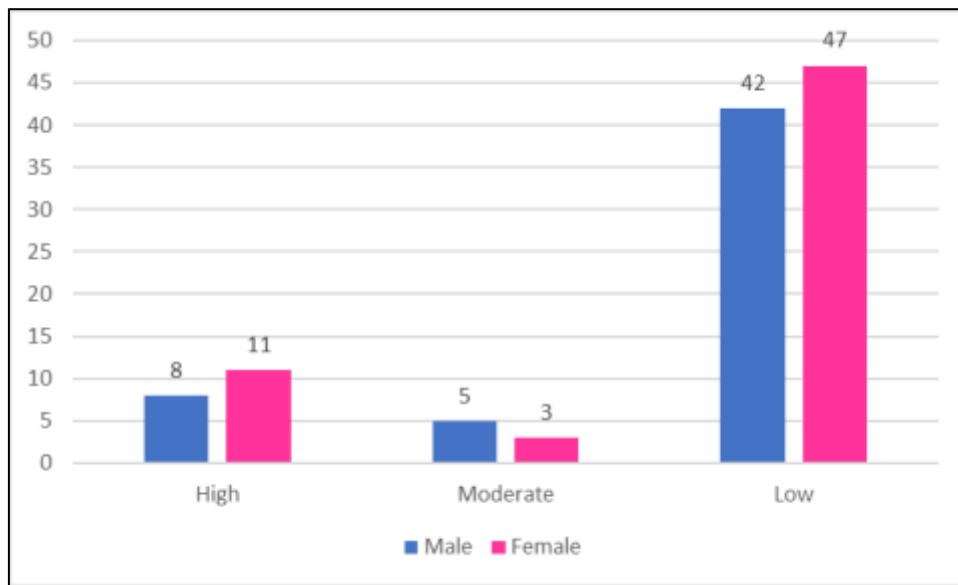


Figure 1. Frequency of Students' Mathematical Literacy Level

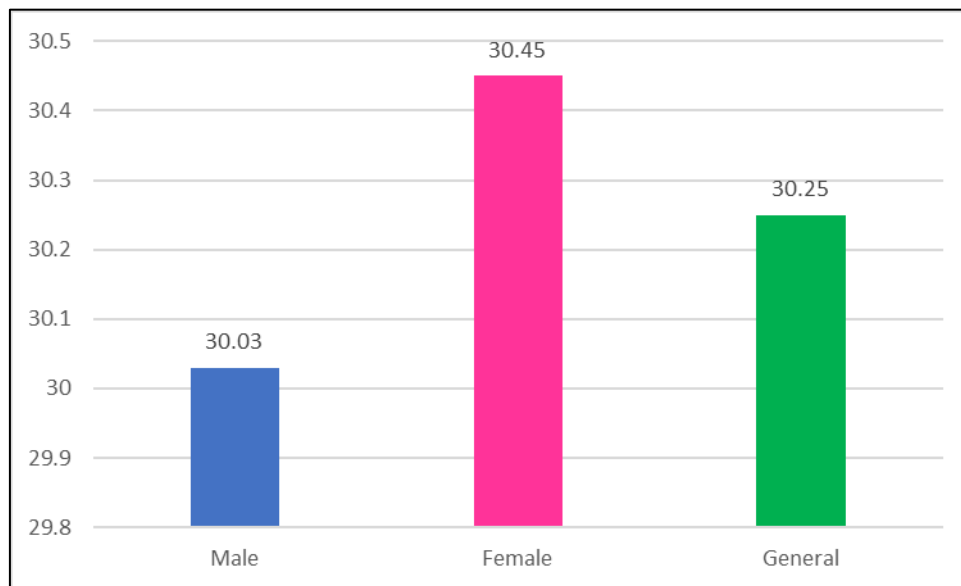


Figure 2. Average of Students' Mathematical Literacy

Table 4 below depicts the interval scores of students and their interpretations. On the other hand, figure 1 shows the frequency of students' mathematical literacy level viewed from gender. It shows that female students' mathematical literacy (18.03%) at high levels is more than males' (14.545%). However, female students with low-level mathematical literacy (77.05%) are also more than male students (76.36%). Meanwhile, figure 2 shows the average of students' mathematical literacy viewed from gender and in general. The

finding shows that in either male or female students, and in general, students' mathematical literacy is in the low category. It is no wonder since, based on figure 1, most male and female students have low mathematical literacy. In addition, only looking at figure 1 and figure 2, the mathematical literacy of male and female students is most likely the same. However, it is still necessary to test the assumption to ensure that the difference in mathematical literacy between male and female students is significantly different or not through statistical testing.

Table 5. Normality Test

	<b>p-value</b>	<b>Decision</b>
Male	0.003	Not Normal
Female	0.000	

Table 6. Homogeneity Test

	<b>p-value</b>	<b>Decision</b>
Mathematical Literacy	0.214	Homogeneous

Table 7. Mann-Whitney Test

	<b>Mann-Whitney U</b>	<b>p-value</b>	<b>Decision</b>
Mathematical Literacy Difference of Male and Female Students	1594.5	0.646	Retain the null hypothesis

Since this research data is independent and only uses male and female groups, inferential statistics with two groups are used to examine the hypothesis. Therefore, before the analysis process begins, normality and homogeneity checking will be conducted first to determine what type of analysis will be used to examine the assumptions. Table 5 shows the normality test for each group sample. It shows that the data is not normal. However, the data on students' mathematical literacy scores is homogeneous (table 6). Therefore, the non-parametric Mann-Whitney U test was used to examine the hypotheses proposed in table 2. Based on table 7, the p-value is more than 5%. Thus, the null hypothesis must be retained. It can be interpreted that there is no significant difference between male and female students' mathematical literacy.

## 2. Male vs. Female in Mathematical Literacy

This research aims to provide empirical proof of students' mathematical literacy when viewed from the gender perspective. Based on the analysis result, it was found that there is no significant difference between male and female students' mathematical literacy. This result seems to oppose the previous findings that show female students' mathematical literacy is better than male students (Aufa & Manoy, 2022; Lanya, Zayyadi, Sulfiah, & Roziq, 2021; Ma'rup, Husniati, Usman, & Kristiawati, 2020; Sari & Khotimah, 2023). However, the finding supports previous PISA results that showed no significant difference between the mathematical literacy of male and female students in Indonesia (Kemdikbud, 2019). In addition, in general, or even viewed from gender (male and female), students' mathematical literacy is in a low category. It is in line with the PISA result that shows the mathematical literacy of Indonesian students is below Level 2 (OECD, 2019) and previous research that reveals Indonesian students' mathematical literacy is at a low level (Fointuna, Kaluge, & Fernandez, 2020; Sari & Wijaya, 2017).

## 3. What are the factors that affect it?

To investigate the factors that may affect it, the low level of students' mathematical literacy, and the lack of difference between genders, we tried to interview mathematics teachers and identify students' mathematical literacy process through their answer sheets.

Based on our interview with the mathematics teachers, our findings show that students' mathematical literacy is low because the teacher rarely integrates it during teaching and learning. It is in line with the previous research that shows that the low students' mathematical literacy may be because of the lack of integration of mathematical literacy in the teaching and learning process (Hendroanto, Istiandaru, Syakrina, Setyawan, Prahmana, 2018; Nurwahid & Ashar, 2022).

Based on interviews, teachers want to focus only on developing students' ability to solve pure mathematics problems first. It includes improving students' calculation skills, one of the mathematical literacy predictors (Andersson, 2007; Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Holenstein, Bruckmaier, & Grob, 2021). Because teachers believe that it is a fundamental thing to have, therefore students can solve word problems, including mathematical literacy problems. From teachers' point of view, since students find it challenging to solve pure mathematics skills, solving word



problems will be more difficult for them. That is why they rarely provide students with mathematical literacy problems, one type of word problem.

However, a strategy that only focuses on pure mathematics problems may harm students' experience in learning mathematics. They may see mathematics as only about symbols, formulas, procedures, and equations (Dogan-Dunlap, 2004; Sam & Ernest, 2000). Ultimately, those negative perspectives can lead students to see mathematics as abstract (Yeh, Cheng, Chen, Liao, & Chan, 2019) and make them reluctant to learn mathematics (Aguilar, 2021).

In addition, mathematical literacy is a skill; training and exercise more often is necessary to master it (Fery, Wahyudin, & Tatang, 2017; Indrawati, Wardono, & Junaedi, 2022; Khotimah, Budi, & Sumantri, 2019). As a result, teachers need to ensure that mathematical literacy is well implemented during teaching and learning, such as giving students mathematical literacy problems during exercises or as homework. It does not matter if students face difficulty solving mathematical literacy problems because it is also acquired as a learning process. The teacher is responsible for supporting students in overcoming the challenges by exercising and experiencing them. Balancing the type of tasks that students are given can be an alternative solution to this problem. Teachers can alternate pure mathematics and mathematical literacy problems as exercises and examples during teaching and learning.

As mentioned before, the definition of mathematical literacy focuses on three processes: formulating, employing, and interpreting. Based on OECD (2018), formulating refers to recognizing and identifying chances to use mathematics and then apply it to a situation provided in some contextualized form; on the other hand, employing refers to using mathematical concepts, facts, procedures, and reasoning to reach mathematical conclusions; and interpreting focuses on reflecting mathematical answers and understanding them in the context of the real-life. It makes the three processes of mathematical literacy connected. Students must be able to formulate the real problem into the mathematical model (formulating), then solve the mathematical model (employing), and translate the mathematical solution based on the problem context (interpret). Therefore, students must fulfill the previous process to reach the next one.

After analyzing students' answers, most fail in the first process, formulation. Neither male nor female students can make a proportion model that fits the problem given. Most of them use information randomly without

any reason. It can be identified that students cannot select the needed information from the information given to answer the question. Fortunately, most do not have significant difficulty employing the process. They can solve the proportion model (even though the model is wrong) they made adequately. However, since the model was wrong at the beginning, it led to the failure to interpret the solution based on the appropriate context of the problem.

The type of error students experience is almost the same as the previous research about students' errors and difficulty when solving word problems. They are errors in defining the problem (Yusuf & Ratnaningsih, 2022) and evaluating the result (Herawati & Marfuah, 2021; Pomalato, Ili, Ningsi, Fadhilaturrahmi, Hasibuan, & Primayana, 2020). What students experience above is because of the teachers. They rarely provide students with mathematical literacy problems. Consequently, students need to become more familiar with that type of question, especially when they need to identify and analyze prominent information from a ton of information given.

Furthermore, previous research shows that males and females have similarities in learning (Hyde & Linn, 1988). It indicates that when both students get the same treatment in teaching and learning, the result of treatment will probably be the same across genders. Therefore, since both students, male and female, rarely experience mathematical literacy problems, it is no wonder both students in this study show low levels of mathematical literacy.

In addition, mathematical literacy is the capacity to solve world problems in every context using mathematics (Mullis, Martin, Foy, Kelly, & Fishbein, 2020; Ojose, 2011). Therefore, students' mathematical understanding is needed to solve mathematical literacy problems. However, previous research shows that male and female students have no significant difference in mathematical ability (Gabay-Egozi, Nitsche, & Grieger, 2022; Keller, Preckel, Eccles, & Brunner, 2022). Hence, it is no wonder male and female students have no difference in mathematical literacy.

## CONCLUSION

The findings show no significant difference between male and female students' mathematical literacy. Also, either in general or viewed from gender, the mathematical literacy of students is in the low category. This study also suggests the importance of implementing mathematical literacy in the

classroom to support students in mastering mathematical literacy. The lack of implementation of mathematical literacy in the classroom causes students to have a low level of mathematical literacy.

In addition, even though this study reveals the factors that potentially affect students' mathematical literacy, further research still needs to be conducted to see what variables significantly affect students' mathematical literacy. Besides, the phenomena we investigate in this research are only for one school; it will be better if the scale of analysis is extended. Therefore, more factors can be identified regarding mathematical literacy. Also, different school grades can have other factors that may affect their mathematical literacy. Thus, the research also suggests conducting the same analysis on various stages of schools, especially elementary school or preschool.

### ACKNOWLEDGMENT

The first author (MSQ) would like to express his deepest gratitude to LPDP (*Lembaga Pengelola Dana Pendidikan*/Education Fund Management Institution) under the Ministry of Finance of the Republic of Indonesia as the sponsor for his master's studies.

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