JPPIPA 9(7) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Mapping Metacognitive Levels of Students in Solving Gender-Based Inheritance Problems

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Received: January 18, 2023
Revised: July 4, 2023
Accepted: July 25, 2023
Published: July 31, 2023

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DOI: 10.29303/jppipa.v9i7.2950

Abstract: Metacognition ability has a strategic role in solving problems in learning, one of which is solving the problem of genetic inheritance. The aim of the study was to determine the metacognitive level in solving the problem of inheritance of class IX students based on gender. The quantitative descriptive research method was carried out at SMPN 1 Bendo December 2022-January 2023. The research population was 239 class IX students. The research sample was 239 class IX students using saturated sampling technique. Research instrument with metacognitive level essay questions in solving valid and reliable inheritance problems. Quantitative descriptive data analysis technique and one way ANOVA. The results showed that the highest percentage of male and female students' metacognitive levels was at the strategic use level and the lowest was at the reflective use level. Tacit use metacognitive level, the highest percentage of male students 27% and 22% of female students. The metacognitive level of aware use has the highest percentage of male students 21% and 20% female. Strategic use metacognitive level, highest percentage of male students 38% and lowest is female students, 42%. The highest percentage of metacognitive reflective use is 15% of male students and 15% of female students. The results of the one-way ANOVA test with an alpha of 5% showed no difference in metacognitive level in solving problems of inheritance based on the gender of male and female students.

Keywords: Female Gender; Heredity; Male Gender; Metacognition; Problem Solving

Introduction

Metacognitive abilities play an important role in supporting student success in problem solving (Anggo, 2011). In learning activities metacognitive abilities play an important role in improving learning outcomes and problem solving (Kurniawan & Wijayanti, 2022). Metacognitive abilities assist students in finding appropriate problem-solving strategies (Zakiah, 2020). Metacognitive abilities regulate and control one's cognitive processes in learning and thinking, so that learning and thinking done by students in learning becomes more effective and efficient (Iskandar, 2014). Students' metacognitive abilities can be seen from their ability to solve problems encountered in everyday life. Metacognition is very closely related to problem solving (Hastuti et al., 2022).

Metacognitive is an important component that needs to be considered for learning so that students are able to think and solve problems during the learning process (Lukitasari et al., 2021). In fact, the results of research Adiansyah, Muh, Ardianto, & Yani (2022) shows that students' metacognitive skills have not been properly empowered. Metacognitive in the learning process In Indonesia is still relatively low (Adiansyah et al., 2021; Hastuti et al., 2022; Rumahlatu & Sangur, 2019). Metacognitive abilities are very important in supporting the learning process in all fields (Anthonysamy, 2021) .

Metacognitive abilities in solving problems in each student have different abilities, both female and male students. The character and mindset of each individual is different from one another (Fatima et al., 2021). The male and female brains have different functions (Zulfikar & Masni, 2021). In line with this which state that mastery of concepts in boys is different from female

How to Cite:
Sari, T.N.I. (2023). Mapping Metacognitive Levels of Students in Solving Gender-Based Inheritance Problems. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 4970–4976. https://doi.org/10.29303/jppipa.v9i7.2950

students (Ma et al., 2022). Research result Marpaung (2022) that female students occupy a metacognition level at a higher level than male students. While research conducted by Fatima et al. (2021) there is no difference in metacognitive abilities in problem solving between male and female students. Male and female students have their own characteristics to find the right strategy to solve problems.

There are metacognitive level criteria in solving problems, namely for the planning, monitoring, and evaluation problem solving stages. Each stage of problem solving consists of a metacognitive level which includes tacit use, aware use, strategic use, and reflective use (Hatip, 2015; Mahromah & Manoy, 2013). First, tacit use, namely the use of thought without awareness. Aware use is the use of thinking with students' awareness of what and why students do these thoughts. Strategic use, namely the use of thoughts related to individual regulation in the process of thinking consciously by using special strategies that can increase the accuracy of thinking. Reflective use, namely the use of thoughts related to individual reflection in the thought process before and after or even during the process taking into account the continuation and improvement of the results of his thinking (Zakiah, 2020).

The results of observations in the field show that students still experience difficulties in solving inheritance problems. In solving problems, the nature of students has difficulty solving problems according to the stage. This is in line with research that inheritance material is one of the materials that is still difficult for students because the material has terms, lack of facilities and infrastructure to support the material so that it is classified as material that is difficult for students to understand. Students have not been able to relate learning concepts in problem solving so that students have difficulty coming up with new ideas or ideas (Latif et al., 2022). The level of students' understanding of the material is still low and does not show satisfactory results (Bilal, 2021). Research result Anoh et al. (2016) shows that the inheritance of traits is difficult material, especially in the sub-discussion of the process of inheritance which calculates the percentage of phenotype and genotype comparisons in monohybrid and dihybrid crosses in both the first and second progeny.

Metacognition ability can help students make the right, careful, systematic, logical, and consider decisions from various perspectives (Safitri et al., 2020). Metacognition ability has a strategic role in solving problems in learning, one of which is solving the problem of genetic inheritance. Based on the presentation that was conveyed, it is important to conduct research to determine the metacognitive level of students in solving problems of inheritance based on students' gender differences. Through metacognitive abilities, students can find out the cognitive strategies they have and this ability is one of the important factors in determining student learning success. In addition, metacognitive abilities help students solve problems in everyday life and society (Iskandar, 2014). So, the purpose of this study is to determine the metacognitive level in solving the problem of inheritance in class IX students based on student gender.

Method

Quantitative descriptive research method. Place at SMPN 1 Bendo Magetan. The research was conducted in December 2022-January 2023. The research population totaled 239 class IX students which were divided into 8 grades, namely classes IX A to IX B. The research sample was 239 students in class IX with a total of 112 female students and 127 male students. The sampling technique uses saturated sampling techniques. Research instrument to measure metacognitive abilities in solving inheritance problems compiled by Rahmawati et al. (2022) problem amounted to 9 questions which were declared valid and reliable. Instrument reliability value with a degree of reliability of 0.882. The data collection technique uses essay test questions to measure metacognitive abilities in solving heredity problems. The data analysis technique used in this research is quantitative descriptive analysis. Data on metacognitive abilities in solving problems were analyzed using the oneway ANOVA test. There are several prerequisite assumptions that must be met in the one-way ANOVA test, namely the normality test and homogeneity test. Normality test using Shapirowilk. If the value of Sig. < 0.05, then the data comes from samples that are not normally distributed, while the Sig. > 0.05, the data comes from normally distributed samples. Homogeneity test using Levene test. If the levene statistic value is > 0.05, it can be said that the data variations are the same and the levene statistic value is <0.05, then it can be said that the data variations are not the same. Criteria for decision making in the one-way ANOVA test if significance > 0.05, then H0 is accepted and significance <0.05, then H0 is rejected. Data were analyzed with the help of SPSS 27 for windows software.

Table 1. Indicators of metacognitive ability to solve inheritance problems

Basic Competence	Indicator
3.3 Applying the concept of inheritance in breeding and survival of living things	Solve the problem of recessive dominant monohybrid crosses to F2 offspring
	Solve the problem of intermediate monohybrid crosses to produce F1 offspring
	Solve the problem of dihybrid crosses to produce F2 offspring
	Solve the problem of dihybrid crosses to the percentage of F2 progeny
	Solve the problem of crossing the inheritance of the shape of the attachment of the earlobe to the resulting offspring.
	Solve the problem of cross inheritance of finite albino traits the resulting offspring
	Solve a family tree chart color blindness

Table 2. Metacognitive level in solving problems

Indicator Metacognitive Level in Solving Problems		Analysis
Tacit use	Planning	Students cannot explain what is known.
		Students could not explain what was asked.
		Students cannot explain the problem clearly.
	Monitoring	Students do not show awareness of what is being monitored
		Students are not aware of errors in the concepts and results obtained
	Evaluation	Students do not evaluate
Aware use	Planning	Students experience difficulties and confusion because they think about the concepts and methods used.
		Students only explain part of what is written
		Students do not understand the problem
	Monitoring	Students experience confusion because they cannot continue what they are doing
		Students are aware of errors in concepts and how to calculate but cannot fix them
	Evaluation	Students do not evaluate and doubt the results obtained
Strategic use	Planning	Students understand the problem because they can express it clearly
		Students do not experience difficulties and confusion to find formulas and how to calculate
		Students can explain most of what is written
	Monitoring	Students are aware of a suitable strategy and immediately use it to solve problems
		Students realize the error of the concept and how to calculate
		Students are able to give reasons to support their thoughts
	Evaluation	Students do less evaluation and are less sure of the results obtained
Reflective use	Planning	Students know the methods used to solve problems
		Students are able to explain the strategies used to solve problems
		Students understand the problem well because they can identify important information in the problem
		Students can explain what is written on the answer sheet
	Monitoring	Students are aware of the existence of other strategies and are able to apply these strategies to the same problem and other problems
		Students are aware of the misconceptions they have made and can correct them

Result and Discussion

Result

Descriptive Statistics of Metacognitive Ability in Solving Problems of Inheritance

Metacognitive level instruments in solving inheritance problems were given to students for 1 month during December 2022. Based on the results obtained, the demographic results of class IX students as respondents were 127 male students and 112. The results in Table 3 show that the average results students' metacognitive in solving problems of inheritance of male students 64, with a minimum score of 30 and a maximum of 95.

Table 3. Metacognitive level descriptive statistics

Gender	N	Mean	Std. Dev	Minim	Max
Male	127	64,755	13,573	30	93
Female	112	63,035	14,243	25	95
Total	239	63,949	13,888	25	95

While the average metacognitive results of female students in solving problems of inheritance of traits is 53, a minimum score of 25 and a maximum value of 95. Based on the results of descriptive statistics shows that

the standard the lowest deviation in the results of male students is 13 and 14 female students. These results also show that the overall average descriptive statistics of female and male students are different but not too large (Table 3).

Distribution of Metacognitive Ability in Solving Inheritance Problems based on gender

The metacognitive level in solving inheritance problems is divided into four levels, namely tacit use, aware use, strategic use, and reflective use (Hatip, 2015; Mahromah & Manoy, 2013). The results of the study in Table 4 show that the highest percentage of female and male students at the metacognitive level of male and female students is at the strategic use level and the lowest is at the reflective use level. At the tacit use metacognitive level, the highest percentage was for male students, namely 27% and 22% for female students. The metacognitive level of aware use has the highest percentage of male students 21% and 20% of female students. Strategic use metacognitive level the highest percentage of male students is 38% and the lowest is 42% of female students. Finally, the level of metacognitive reflective use has the highest percentage of male students, 15% and 15% female students (Table 4).

Table 4. Distribution of metacognitive levels in solving gender-based problems

Metacognitive Level in Solving Problems	Gender			
	Female		Male	
	Total	%	Total	%
Tacit use	30	22%	28	27%
Aware use	23	20%	26	21%
Strategic use	42	43%	54	38%
Reflektive use	17	15%	19	15%
Total	112	100%	127	100%

Normality test

The results of the metacognitive level normality test in solving male students' problems using Shapiro Wilk with a sig 0.055 > 0.050 so that the data comes from a normally distributed population. While the normality test for female students was sig 0.083 > 0.050 so that the data came from a normally distributed population (Table 5).

Table 5. Metacognitive level normality test in solving gender-based problems

Gender	Shapiro-Wilk		
	Statistic	df	Sig.
Male	.980	127	.055
Female	.980	112	.083

Homogeneity Test

The results of the metacognitive level homogeneity test in solving problems used the Levene test with a sig 0.65 > 0.050 so that the variance of the data is homogeneous (Table 6).

Table 6. Metacognitive level homogeneity test in solving gender-based problems

		Levene Statistic	df1	df2	Sig.
Result Meta	Based on Mean	.281	1	237	.597
	Based on Median	.198	1	237	.657
	Based on Median and with adjusted df	.198	1	235.225	.657
	Based on trimmed mean	.292	1	237	.589

One Way Anova test

The results of the one-way ANOVA test between metacognitive levels in solving male and female students' problems show a sig value of 0.340 > 0.05 so that H0 is accepted, meaning that there is no difference in metacognitive levels in solving problems of inheritance based on the gender of male and female students (Table 7).

Table 7. Metacognitive level one-way anova test in solving gender-based problems discussion

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	176.107	1	176.107	.913	.340
Within Groups	45731.290	237	192.959		
Total	45907.397	238			

Discussion

Metacognitive Levels in Solving Gender-Based Inheritance Problems

Metacognition has an important role in the learning process, especially in terms of problem solving. Eye cognitive activity involves the interaction of several individuals in solving a problem. In the problem-solving process, students will understand the problem, plan a solution strategy, make decisions about what to do, and carry out decisions so that students monitor and recheck what they have done. If the decision taken is not right, then students should try other alternatives or make a judgment. The process of realizing an error, monitoring the results of work and looking for other alternatives are some aspects of metacognition that are necessary in solving mathematical problems (Alkadrie et al., 2015). Each student has different problem-solving strategies in solving chemistry problems depending on their level of understanding. Thus, each student has a different metacognitive level or level in solving problems

(Sophianingtyas & Sugiarto, 2013). In general, students' metacognitive levels in solving problems consist of 4 levels (Table 2). The results of the study in Table 4 show that the metacognitive level of class IX boys and girls at SMPN 1 Bendo varies quite a lot.

The results of the study in Table 4 show that the percentage of tacit use metacognitive levels of female students is 22% and 27% of male students. Tacit use is a metacognitive level related to the type of thinking related to decision making without thinking about the decision. At this level students tend to apply strategies without special awareness or through trial and error and randomly answering in solving problems (Maulyda et al., 2020). This is in line with the results of the study Pamungkas et al. (2018) that students who have a tacit use metacognitive level do not have declarative knowledge, causing students' critical thinking skills at the low clarification stage because students answer by trial and error.

The results of the study in Table 4 show that the percentage of the metacognitive level of aware use of female students is 20% and that of male students is 21%. Aware use is a level, which is a type of thinking that shows someone is aware of what and when students do something. Students are aware of everything that is done in solving problems. This is in line with research results Santoso et al. (2018), that someone who has a metacognitive level in solving students' awareness use problems means that overall students are at the thinking awareness stage, students are able to solve problems according to their awareness of thinking but not well. Students are able to mention and explain concepts, but students still do not have procedural knowledge which causes students' critical thinking skills at the inference stage to still experience difficulties so students are not able to propose steps for solving (Pamungkas et al., 2018).

The results of the study in Table 4 show that the percentage of metacognitive strategic use level of female students is 43% and 38% of male students. This percentage shows that students have declarative and procedural knowledge which causes students to have critical thinking skills at the stages of clarification, assessment and inference so that students are able to mention and explain concepts and propose steps for completion. However, students do not yet have conditional knowledge which causes students' critical thinking skills at the strategy stage to still experience difficulties so that students are not able to provide reasons for selecting steps for completion and are not able to make improvements to the results of their thinking (Pamungkas et al., 2018).

The results of the study in Table 4 show that the percentage of the metacognitive level of reflective use of female students is 15% and 15% of male students. This percentage is a small percentage compared to other metacognitive levels (Table 4). This is in line with the results of the study that the percentage of students at the reflective use level was 10.1%. This shows that 10.1% of students have procedural, declarative and conditional knowledge which causes students to have critical thinking skills at the stages of assessment, inference and strategy clarification. This is shown from the ability of students to explain concepts, propose steps for completion, and provide reasons for selecting steps and evaluating the steps for solving the given problem (Santoso et al., 2018). Students with a metacognitive level reflective use means that students can express problems and concepts clearly and precisely. Thus, where reflective use shows left brain dominance students have high metacognitive abilities (Pamungkas et al., 2018). This is in line with the research that students with high metacognitive abilities almost always make plans for existing problems (Lusiana et al., 2020).

Based on the results of research that has been done, this is in line with the statement Sari, Amrullah, Azmi, & Sarjana (2021) in solving student problems indirectly involves metacognition because there are several aspects in students that need to be developed to support their ability to solve problems, namely problem solving strategies, metacognitive processes and students' beliefs and behavior towards mathematics. Students' metacognition abilities can assist students in solving problems through effective design, involving the process of knowing problems, understanding problems, solving problem solving solutions and understanding effective strategies to solve a problem (Saputra & Andriyani, 2018).

Relationship between Metacognitive Level in Solving Problems of Inheritance and Student Gender

Based on the results of statistical tests of gender analysis with students' metacognitive abilities in solving inheritance problems, it shows that there is no significant relationship between gender and students' metacognitive abilities in solving problems (Table 7.) This is in line with the results of the study (Sudia, 2015) that the metacognitive abilities of female and male students in solving problems at each stage are almost the same or have no significant differences. The results showed that the metacognitive skills of male and female students were not significantly different. This shows that male and female gender have the same contribution in empowering metacognitive skills (Darmawan et al., 2018).

Conclusion

There is no significant difference between the metacognitive levels of male and female students. From

the metacognitive level distribution of male and female students, the metacognitive level with the highest percentage is the metacognitive level of aware use and the lowest is reflective use. This distribution is in line with the one-way ANOVA test with an alpha of 5% which shows there is no relationship between student gender and students' metacognitive level in solving inheritance problems. This shows that male and female gender have the same contribution in empowering metacognitive skills.

Acknowledgments
Thank you to the Principal of SMPN 1 Bendo Magetan, Mr. and Mrs. Teachers of SMPN 1 Bendo Magetan and the students of SMPN 1 Bendo Magetan who have allowed this research to be carried out. Thank you to Yogyakarta State University for granting permission to leave for research. Last thanks to Azizah Fitri Rahmawati Biology Education Student 2018 University of Muhammadiyah Malang, who allowed the metacognitive level instrument to be used in my research.

Author Contributions
I wrote this article myself. Starting from the preparation activities, data collection, data processing with IBM SPSS 27 software, preparation of the article framework (introduction, methods, results & discussion, to conclusions), and finally the article publication activities.

Funding
This research received no external funding.

Conflicts of Interest
No Conflicts of interest.

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