Gender Differences in Metacognitive Awareness: A Study on Pre-Service Physics Teachers

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Abstract *- This research aims to analyze gender-based differences in metacognition awareness among pre-service physics teachers. The research sample consisted of 55 first semester active students selected using cluster random sampling. Data were collected using the Metacognitive Awareness Inventory (MAI) questionnaire and analyzed by independent t-test, which showed a significant difference (p = 0.000) between females (78.31) and males (70.26) students. Females score higher in Procedural Knowledge, while males were higher in Debugging Strategies. However, both had the lower score on Information Management Strategies, indicating difficulty in managing information during learning. These findings provide important implications in designing teaching strategies that are more suitable to the differences in metacognitive awareness between males and females, which can have an impact on learning outcomes that can support students' awareness in learning and thinking more effectively.*

Keywords*: Metacognitive Awareness Inventory; Gender; Pre-Service Physics Teacher; Learning Strategies.*

INTRODUCTION

Metacognition awareness is an important ability in the learning process that enables individuals to become more effective learners by consciously planning, monitoring, and evaluating their own learning process. Metacognition awareness consists of two main components, specifically metacognitive knowledge and metacognitive regulation (Schraw & Dennison, 1994). Metacognition refers to an individual's understanding of how their own thinking works, while metacognition regulation relates to the ability to manage their cognitive processes such as planning learning strategies, monitoring understanding, and evaluating the effectiveness of these strategies (Erlin et al., 2021; Fernandez-Duque et al., 2000). Metacognition awareness plays an important role in improving learning effectiveness, because it allows individuals to identify weaknesses and strengths of understanding material and adjust more optimal learning strategies (Zhao et al., 2014). In other words, individuals who have good metacognition are able to recognize their strengths and weaknesses in learning, so that they can determine the most effective strategy for them.

In education, metacognition awareness is a crucial aspect that not only contributes to students' learning outcomes, but also to their independence and critical thinking skills (Wardana et al., 2021; Wilson & Conyers, 2016). The 2013 curriculum in Indonesia recognizes the importance of metacognition by including it as one of the Graduate Competency Standards. In the context of higher education, metacognition awareness is increasingly necessary because students are expected to be able to learn independently, understand complex concepts, and solve various academic problems critically and analytically (Kusuma & Nisa, 2018; Livingston, 2003). This ability becomes even more important for pre-service teachers, who are not only responsible for their own understanding, but also for the understanding of the students

they will teach in the future (Jamaludin et al., 2022). A teacher who has good metacognition awareness tends to be more reflective in teaching, able to adjust learning methods according to student needs, and develop a more effective learning environment that supports independent problem solving (Schneider, 2008; Soodla et al., 2017).

Some previous studies have shown that there are significant differences in metacognition awareness based on gender. For example, research by Esbjørn et al. (2013), showed that females tend to have higher levels of metacognition awareness than males especially in aspects of metacognition regulation such as planning learning strategies and evaluating comprehension. Rapee et al. (2009) explained that this difference can be attributed to higher levels of academic anxiety in females, which causes them to be more careful in regulating their learning strategies. Another research conducted by Tazkia & Hidayah (2022), showed that the average level of metacognition awareness in males was 51.38% while in females it was higher at 58.85%. In this research, females showed superiority in two main sub-components, specifically declarative knowledge at 61.04% and planning at 61.67%. This shows that females are superior in understanding how they think and are more thorough in designing their learning strategies than males.

Although there have been many research on differences in metacognition awareness based on gender, there are still limitations in studies that specifically examine pre-service physics teachers. Most of the previous studies focused on high school students or college students in general, without considering specific factors related to prospective educators (Narimo et al., 2021; Retnasari et al., 2023). Pre-service physics teachers have different academic and pedagogical needs compared to students from other disciplines. Physics is a field study that demands a deep understanding of concepts, the ability to think abstractly, and complex problem-solving skills (Ananingtyas et al., 2024). Therefore, prospective physics teachers are expected to have high metacognition awareness in order to understand, analyze, and explain physics concepts effectively to their students in the future. However, the limited research on how metacognition awareness develops within the student population of pre-service physics teachers makes it important to further explore this aspect, especially in relation to gender differences.

Different from previous research that focused more on the general population, this study specifically targets pre-service physics educators to understand how gender affects their level of metacognition awareness. The results of this research are expected to contribute to the development of more effective teacher education programs, especially in designing learning strategies that support the development of metacognition awareness. With a deeper understanding of the factors that influence students' metacognition awareness, educational institutions can develop a curriculum that not only improves understanding of physics concepts, but also trains students to become reflective and adaptive educators. In addition, this research can provide insights for educators and other decision makers in designing interventions aimed at reducing the gender gap in metacognition development. Thus, this research is not only relevant in the academic context, but also has broad implications in improving the quality of physics learning at various levels of education.

RESEARCH METHODS

This research used a quantitative approach with a descriptive correlational design to analyze the effect of gender differences on metacognition awareness in pre-service physics teachers. Correlational descriptive design allows researchers to describe the level of metacognition awareness in pre-service physics teachers based on gender and analyze whether there is a relationship between the two variables (Creswell & Creswell, 2017). This research was conducted on first semester students of a state university in Malang which has a physics education program.

The sampling technique used cluster random sampling, which is by randomly selecting groups from the student population in one class. From the population of students in one year of college, two classes were randomly selected with a total number of respondents of 55 students. This technique was chosen because it is efficient in data collection and still maintains population representation based on existing groups, so that the research results can be better generalized (Sugiyono, 2013).

The research instrument is a questionnaire consisting of two main parts. The first part collects respondent data regarding the gender of the respondent. The second part measures the level of metacognition awareness of students. The metacognition awareness questionnaire includes two main indicators of Knowledge of Cognition and Regulation of Cognition, as shown in Table 1 as developed in the Metacognitive Awareness Inventory (MAI) by Schraw & Dennison (1994). The instrument consists of 52 statement items with a 4-point Likert scale.

Table 1. Indicators of Metacognition Awareness

Indicators	Sub-Indicators	Question Number
Knowledge of Cognition	Declarative Knowledge	1, 2, 3, 4, 5, 6, 7, 8
	Procedural Knowledge	9, 10, 11, 12
	Conditional Knowledge	13, 14, 15, 16, 17
Regulation of Cognition	Planning	18, 19, 20, 21, 22, 23, 24
	Information Management Strategies	25, 26, 27, 28, 29, 30, 31, 32, 33, 34
	Monitoring	35, 36, 37, 38, 39, 40, 41
	Debugging Strategies	42, 43, 44, 45, 46
	Evaluation	47, 48, 49, 50, 51, 52
Total		52

The Metacognitive Awareness Inventory (MAI) instrument was validated by physics education expert lecturers to assess the suitability of content, construction, and language aspects. This validation aims to ensure that the instrument used is in accordance with the indicators of metacognition awareness, is easily understood by respondents, has a clear sentence structure and does not cause ambiguity, and can measure the level of metacognition awareness precisely and accurately.

The validation process uses a 4-point Likert scale, which allows experts to provide an assessment of the level of suitability of the instrument with predetermined criteria. Feedback from expert lecturers serves as a basis for revision to ensure that the instrument more accurately represents students' metacognition awareness. The validation results were compared with the predetermined validity criteria, as shown in Table 2 (Arikunto, 2006). If the instrument falls into the valid or very valid category, it is deemed suitable for use in research (Arikunto, 2015).

Table 2. Instrumen Validity Criteria

Score	Criteria
$4{,}20 \leq \bar{X} \leq 5{,}00$	Very good
$3{,}40 \leq \bar{X} < 4{,}20$	Good
$2{,}60 \leq \bar{X} < 3{,}40$	Good enough
$1{,}80 \leq \bar{X} < 2{,}60$	Not good
$1{,}00 \leq \bar{X} < 1{,}80$	Very not good

The data were analyzed using parametric statistics with independent sample t-test to determine whether there is a significant difference in metacognition awareness between male and female students. The t-test was chosen because this research involved two independent groups with the dependent variable being an interval-scale metacognition awareness score. Before conducting the t-test, the data was tested for normality assumptions. If the data were normally distributed ($p > 0.05$), then the analysis continued with the t-test. The t-test results were then compared with the significance level of $p < 0.05$ to determine if there was a significant difference between students' metacognition awareness based on gender.

RESULTS AND DISCUSSION

Average Difference of Metacognition Awareness of Female and Male

The results of the descriptive analysis showed a difference in the average score of metacognition awareness between female and male students. Female students have an average score of 78.31, which indicates that they tend to have a higher awareness of their own thinking process. On the other side, male students had an average score of 70.26, which indicates a lower level of metacognition awareness compared to females as shown in Table 3. This difference indicates that females are more often aware of the learning strategies they use and are able to manage the learning process more effectively.

Table 3. Average Metacognition Awareness Score of Female and Male

Group Statistics

	Genders	N	Mean	Std. Deviation	Std. Error Mean
Metacognition Awareness	Male	23	70.26	2.544	.531
	Female	32	78.31	3.831	.677

Statistical test results using independent sample t-test showed a significant difference in metacognition awareness between male and female students. Based on Levene's test, a significance value of 0.012 ($p < 0.05$) was obtained, indicating that the assumption of equality of variance was not met. Therefore, the interpretation of the results is based on the Equal variances not assumed line. The significance value of the t-test result of 0.000 ($p < 0.05$) indicates that the average metacognition awareness score of female students is significantly higher than that of male students. The results of the independent sample t-test are shown in Table 4.

Table 4. Results of Independent t-test of Metacognition Awareness

Group Statistics

	Genders	N	Mean	Std. Deviation	Std. Error Mean
Metacognition Awareness	Male	23	70.26	2.544	.531
	Female	32	78.31	3.831	.677

Analysis of Metacognition Awareness on Each Indicator

Comparison of the average metacognition awareness between females and males on each sub-indicator generally showed that females scored higher than males, as shown in Figure 1. Females had the highest average metacognition awareness on the Procedural Knowledge sub-indicator at 84.0 and the lower on the Information Management Strategies sub-indicator at 75.0. This shows that females are superior in understanding the steps or procedures to complete a task compared to the ability to manage information in their thinking process (Anggreini & Asmarani, 2022).

On the other side, males had the higher metacognition awareness on the Debugging Strategies sub-indicator at 75.0 and the lower on the Information Management Strategies sub-indicator at 66.0. Higher scores on the Debugging Strategies sub-component indicate that males are able to identify and correct errors in the learning process well. The low ability of Information Management Strategies in females and males shows that students still have difficulties in processing information effectively. They are less able to organize, describe, summarize, and focus on relevant new information.

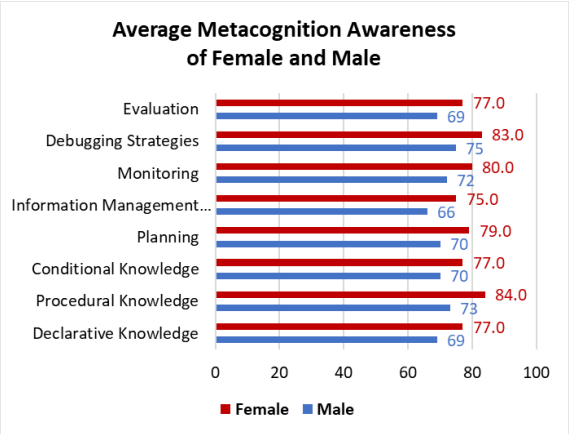

Figure 1. Average metacognition awareness of female and male

These results are in line with previous research by Esbjørn et al. (2013) and Tazkia & Hidayah (2022), which showed that females tend to have higher levels of metacognition. This can be attributed to females' tendency to plan, monitor, and evaluate their learning process more systematically (Aulia & Murtiyasa, 2023). In addition, psychological factors such as higher anxiety levels in females push them to be more reflective and structured in their learning (Flavell, 1979; Novitria & Khoirunnisa, 2022).

Other studies by Kaur & Embi (2011) and Mahmud & Sahril (2018) confirm that females are more active in applying learning strategies that include self-regulation, planning, and evaluation, which have a positive impact on their academic achievement. The research found that females used self-regulation and planning-based learning strategies more often than males. Meanwhile, research Yu (2024) showed that female students engage more frequently in social and reflective learning strategies, which contribute to their increased metacognition awareness. In addition, involvement in various academic and extracurricular activities is also a factor that supports the development of their reflective thinking skills.

Although the findings of this research are in line with previous studies that showed females' superiority in metacognition, there are differences in specific indicators. Previous studies Mahmud & Sahril (2018) and Yu (2024) reported that females were superior in Planning and Evaluation, while in this research they showed the higher score on Procedural Knowledge, indicating a more systematic understanding and application of academic procedures. This difference indicates that although females have higher metacognition awareness overall, the specific aspects that are dominant can be

different depending on the learning context and measurement method.

Thus, the findings of this research provide a new perspective on differences in metacognition awareness based on gender. Females consistently showed higher scores, but the indicators on which they excel are not always the same as previous research. Factors such as the learning environment, learning strategies used, and teaching approaches applied can influence aspects of metacognition.

These differences suggest that gender can influence the development of metacognition. The findings provide valuable insights in designing teaching strategies that better suit the differences in metacognition awareness between males and females, which can have an impact on learning outcomes. The implications of this research are particularly important for educational institutions in developing learning programs for prospective physics teachers. By understanding the influence of gender on metacognition, educational programs can be designed to improve students' reflection and self-regulation abilities, so that they not only excel academically but are also able to manage the learning process more strategically.

CONCLUSION

This research showed significant differences in metacognition awareness between males and females. Females had a higher mean score (78.31) than males (70.26). Females were superior in Procedural Knowledge, which reflects the understanding and systematic application of learning procedures. Meanwhile, males were superior in Debugging Strategies, which is the ability to identify and correct errors in thinking. Both showed the lower score on Information Management Strategies, which indicates difficulty in managing information during learning.

These results imply the need for learning strategies that consider gender differences in metacognition awareness to improve the effectiveness of physics teacher education. However, this research has limitations because it only involves students from one year of college with a limited sample size and uses quantitative methods. Further research with a qualitative approach is needed to explore the factors that influence differences in metacognition awareness in more depth.

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