



Metacognitive awareness profile of junior high school students in biology learning: an analysis based on planning, monitoring, and evaluating aspects

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Abstract. Metacognitive awareness plays an important role in Biology learning. It enables students to regulate their cognitive processes through planning, monitoring, and evaluating activities. However, previous studies indicate that the metacognitive abilities of junior high school students tend to be at a low to moderate level. In addition, studies that specifically examine students' metacognitive awareness profiles using the Metacognitive Awareness Inventory (MAI) in the context of Biology learning at the junior high school level are still limited. Therefore, this study aims to analyze students' metacognitive awareness profiles based on the aspects of planning, monitoring, and evaluating. This study employed a quantitative approach with a descriptive design, and the research subjects consisted of 120 seventh- and eighth-grade students from SMP Negeri 11 Serang City, selected through purposive sampling. Data were collected using a Likert-scale MAI questionnaire and analyzed descriptively by calculating mean scores and percentages for each indicator. The results show that students' metacognitive awareness was generally in the moderate category, with variations across classes. The planning aspect showed the highest mean score in Class 7B, the evaluating aspect was highest in Class 7C, and the monitoring aspect was highest in Class 7E. These findings indicate that students exhibit different metacognitive awareness profiles, reflecting variations in how they regulate their learning processes. The findings suggest the need for Biology learning strategies that provide balanced opportunities for students to develop planning, monitoring, and evaluating skills in order to enhance their metacognitive awareness.

Keywords: *Biology learning, Junior high school students, Metacognitive awareness*

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INTRODUCTION

Education is not only oriented toward achieving learning outcomes in the form of content mastery but also toward developing students' ability to manage and reflect on their thinking processes during learning. One of the key abilities supporting this is metacognitive awareness. Metacognitive awareness refers to an individual's ability to plan, monitor, and evaluate their own thinking processes when dealing with tasks or solving problems (Schraw & Dennison, 1994). This ability plays an important role in helping students understand concepts more deeply, select appropriate learning strategies, and improve problem-solving skills (Muhali et al., 2020).

In Biology education, metacognitive awareness is particularly important because students are required to understand complex concepts, analyze phenomena, solve problems, and draw conclusions based on scientific thinking processes (Zaskia et al., 2025). Students with a higher level of metacognitive awareness tend to have better control over their learning processes, which leads to more optimal learning outcomes (Adiansyah et al., 2023; Hindun et al., 2020). However, in practice, the learning process is still often teacher-centered, limiting students' opportunities to develop their ability to plan, monitor, and evaluate their thinking processes (Suratno et al., 2024).

Several studies indicate that students' metacognitive abilities remain in the low to

moderate category. Research conducted by Taufik and Vandita (2023) shows that the monitoring and evaluating aspects are relatively weak among students. Similarly, Almubarakah et al. (2025) found that junior high school students' metacognitive skills in solving Biology-related problems are still low. In addition, Septiyani et al. (2020) reported that students' metacognitive abilities in Biology learning vary across indicators. In line with these findings, Sukarelawan et al. (2021), through a Rasch analysis of the Junior Metacognitive Awareness Inventory (Jr-MAI), demonstrated that the MAI instrument has good psychometric quality and is valid for measuring students' metacognitive awareness in Indonesia. These findings also confirm that the MAI is a reliable instrument for measuring the three main aspects of metacognition, namely planning, monitoring, and evaluating. These findings indicate that students may still experience difficulties in reflecting on their thinking processes and evaluating the learning strategies they have used (Almubarakah et al., 2025; Septiyani et al., 2020; Taufik & Vandita, 2023). These findings indicate that the development of metacognitive awareness remains a challenge in classroom learning.

Although research on metacognition has been widely conducted, most studies focus on its relationship with critical thinking skills, learning outcomes, or the development of measurement instruments. Studies that specifically describe the level of junior high school students' metacognitive awareness in Biology learning using the Metacognitive Awareness Inventory (MAI), particularly at SMP Negeri 11 Serang City, are still limited. This limitation indicates a research gap that needs to be addressed through mapping students' metacognitive awareness profiles based on the aspects of planning, monitoring, and evaluating.

Therefore, this study aims to describe the level of students' metacognitive awareness in Biology learning based on the aspects of planning, monitoring, and evaluating. Although several previous studies have examined metacognitive awareness in Biology education, most of them have focused on general measurement or intervention-based approaches, while studies describing detailed variations of metacognitive components across classroom contexts are still limited. Therefore, this study is important because it provides more specific empirical data on students' metacognitive profiles, which can be used as a basis for designing Biology learning strategies that are more effective and oriented toward higher-order thinking skills.

METHOD

This study employed a quantitative approach with a descriptive research design. This design aimed to describe students' metacognitive awareness levels in Biology learning at SMP Negeri 11 Serang City, and the research subjects consisted of 120 seventh- and eighth-grade students from three classes (7B, 7C, and 7E) at SMP Negeri 11 Kota Serang. The sample was selected using purposive sampling based on specific criteria, namely students who had studied the relevant biology material and were suitable for completing the metacognitive awareness and motivation instruments used in this study.

Data were collected using the Metacognitive Awareness Inventory (MAI) instrument developed by Schraw and Dennison (1994). The instrument consisted of several items representing the aspects of planning, monitoring, and evaluating, measured using a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Each item was adapted to the context of junior high school Biology learning, and prior to its use, the instrument underwent content validity testing by experts and reliability testing to ensure its consistency in measuring students' metacognitive awareness (Anthonysamy et al., 2025; Asrafi et al., 2024). The MAI instrument has been widely used to measure metacognitive awareness, namely planning, monitoring, and evaluating.

The questionnaire was administered directly to students during class time, with a completion duration of approximately 30–40 minutes in a single administration, and the collected data were analyzed using descriptive quantitative techniques by calculating the mean

scores and percentages for each indicator. The results were then categorized into three levels-high, moderate, and low-based on interpretation criteria adapted from previous studies (Anthonysamy et al., 2025; Sahila et al., 2025). This analysis aimed to provide a structured and systematic description of students' metacognitive awareness profiles.

RESULTS AND DISCUSSION

Results

Based on the data analysis, the mean scores for each indicator of metacognitive awareness (*planning*, *monitoring*, and *evaluating*) were obtained (Table 1). The data are presented in diagram form to facilitate the interpretation of differences across aspects (Figure 1).

Table 1. Students' metacognitive awareness across classes

Class	Planning	Monitoring	Evaluating	Mean
7B	3.04	3.03	2.74	2.94
7C	3.01	3.02	2.94	2.99
7E	2.74	3.05	2.79	2.86

Table 1 shows variations in students' metacognitive awareness across classes. Class 7C demonstrates the highest overall mean score, followed by class 7B and class 7E. Across classes, monitoring tends to be relatively higher compared to planning and evaluating, while evaluating consistently shows lower scores. This indicates that students are more active in monitoring their learning process but still face challenges in reflective thinking skills.

Based on the data analysis, the mean scores of metacognitive awareness indicators (planning, monitoring, and evaluating) showed variations across aspects. Planning and monitoring tended to have slightly higher scores compared to evaluating. This indicates that students are relatively better at organizing and controlling their learning processes, while evaluation skills still need further improvement. These differences may be influenced by the dominance of teacher-centered learning practices, which provide fewer opportunities for students to engage in self-reflection during learning activities.

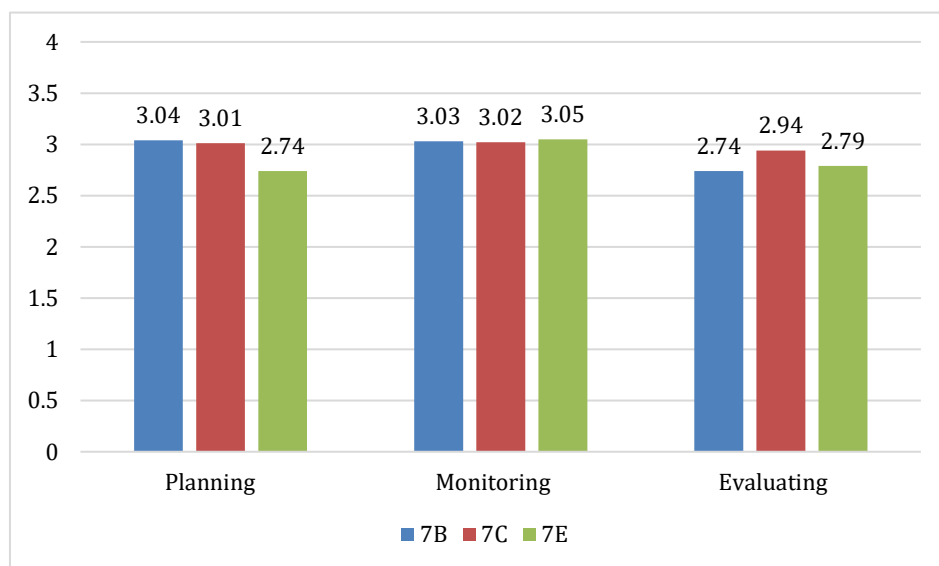


Figure 1. Mean scores of students' metacognitive awareness across aspects

As shown in Figure 1, there are differences in metacognitive awareness across classes. In class 7B, the planning aspect has the highest mean score (3.04), followed by monitoring

(3.03), and evaluating (2.97). In class 7C, the evaluating aspect shows the highest mean score (3.05), followed by monitoring (3.02), and planning (3.01). Meanwhile, in class 7E, the highest mean score is found in the monitoring aspect (2.94), followed by evaluating (2.79) and planning (2.74).

To further describe the distribution of students' metacognitive awareness levels, the results are presented in terms of categorical classification (very high, high, medium, and low) across the three metacognitive aspects. The visualization is shown in Figure 2.

Figure 2 shows that most students are in the high and very high categories across the three metacognitive aspects. Planning and monitoring are dominated by the high category, while evaluating shows a relatively wider distribution with a noticeable proportion of students in the medium category. This indicates that although students generally demonstrate good metacognitive awareness, the evaluating aspect remains the weakest compared to planning and monitoring.

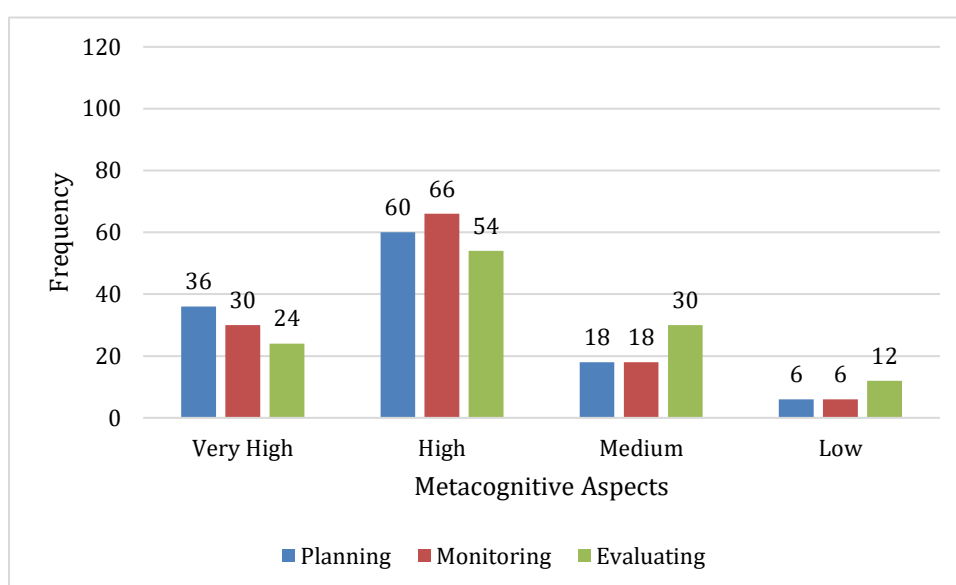


Figure 2. Distribution of students' metacognitive awareness levels across planning, monitoring, and evaluating aspects

Discussion

The analysis of students' metacognitive awareness in Biology learning showed variations across the three indicators, namely planning, monitoring, and evaluating. These variations indicate that students tend to perform better in planning and monitoring their learning processes compared to evaluating. This condition may be related to classroom learning practices, where students are more frequently guided to complete learning tasks than encouraged to critically reflect on and evaluate their own learning processes (Handayani & Widiantie, 2020). As a result, students' metacognitive development appears to be stronger in procedural aspects than in reflective aspects of learning. Previous studies also emphasize that metacognitive awareness is strongly influenced by the learning environment, particularly the extent to which students are given opportunities to engage in reflective and self-regulated learning activities (Adiansyah et al., 2023).

In the first analysis, the planning aspect obtained the highest mean score of 3.045, followed by monitoring with a mean score of 3.040, while evaluating obtained the lowest mean score of 2.97. The relatively high achievement in planning indicates that students had a good ability to formulate learning goals and determine strategies before engaging in learning

activities. Planning is an important component of cognitive regulation because it enables students to organize their learning processes in a more systematic and goal-oriented manner. Schraw and Dennison (1994) explained that planning is a component of cognitive regulation that functions to organize the steps required before a task is performed. Through effective planning, students can determine learning objectives, select appropriate strategies, and anticipate the steps required to complete a task.

The relatively high planning score in this study is consistent with Goren and Kaya (2022), who emphasized the role of metacognitive skills in helping students manage their learning processes in a more organized manner. Putri and Granita (2024) also reported that planning represents an initial stage of the metacognitive process that helps students determine problem-solving strategies and supports successful learning in the future. Furthermore, Sari et al. (2023) found a positive relationship between metacognitive awareness and students' learning outcomes, with the ability to plan effective learning strategies being one of the contributing factors. These findings suggest that students who are able to establish learning goals and select appropriate strategies before beginning a task have a stronger foundation for regulating their subsequent learning activities. In Biology learning, such planning is particularly relevant because students are often required to integrate concepts, interpret biological phenomena, and determine appropriate strategies for solving scientific problems.

The monitoring aspect obtained a mean score of 3.040. This indicates that students had a relatively good ability to monitor their thinking processes and their level of understanding during learning activities, with monitoring enabling students to recognize whether they understand the material being studied, identify difficulties, and determine whether the strategies they are using are appropriate for achieving the intended learning objectives. Students with adequate monitoring skills are therefore more capable of recognizing errors. More than that, students make adjustments during the learning process (Nurmi et al., 2024). This finding is consistent with Fariq et al. (2024), who stated that metacognitive awareness plays an important role in controlling students' thinking activities. Effective monitoring allows students to continuously assess their understanding and make appropriate adjustments when they encounter difficulties.

The role of monitoring is also supported by Asaidah et al. (2022), who found a positive correlation between metacognitive awareness and Biology learning outcomes. The ability to monitor thinking processes and levels of understanding enables students to select and modify learning strategies according to their learning needs. In the context of Biology learning, this ability is particularly important because students encounter concepts that require continuous interpretation and integration, rather than simply recalling factual information. Through monitoring, students can identify concepts that have not yet been fully understood. By monitoring, students reconsider their reasoning and modify the strategies used to understand biological concepts; the development of monitoring skills may contribute to more effective and independent learning.

Meanwhile, the evaluating aspect obtained a mean score of 2.97. It represents the lowest score among the three metacognitive aspects in the first analysis. This finding indicates that students' ability to reflect on and assess their learning outcomes still requires further development. Unlike planning, which occurs before learning, and monitoring, which takes place during learning. Evaluating requires students to review the effectiveness of the strategies they have used and assess the extent to which the learning objectives have been achieved. Effective evaluation enables students to identify strengths and weaknesses in their learning processes. More than that, students' evaluation can determine improvements for subsequent learning activities. This finding is consistent with Hajiriah et al. (2023), who emphasized that metacognitive skills need to be continuously measured and developed because they assist students in reflecting on their thinking activities and evaluating the effectiveness of the learning

strategies used during the learning process.

The relatively lower achievement of evaluating compared with planning and monitoring may indicate that students are more accustomed to preparing for and carrying out learning activities than to systematically reflecting on the outcomes of those activities. Reflection requires students to move beyond determining what they have done and instead consider whether the strategies used were effective, why difficulties occurred, and what should be changed in future learning (Sudrajat et al., 2024). Therefore, learning activities that explicitly provide opportunities for reflection may be necessary to strengthen this aspect of metacognitive awareness.

The findings of this study indicate that students' metacognitive awareness varies across its components, with planning, monitoring, and evaluating showing different levels of development. Overall, students tend to demonstrate stronger abilities in planning and monitoring their learning processes compared to evaluating, which involves reflecting on and assessing the effectiveness of learning strategies. This suggests that students are more accustomed to regulating their learning activities than critically evaluating their learning outcomes.

These conditions may be influenced by teacher-centered learning practices that limit opportunities for students to engage in reflective thinking and self-assessment, thereby affecting the development of metacognitive awareness (Handayani & Widiyantje, 2020; Zaskia et al., 2025). Previous studies also show that metacognitive awareness is an important factor in biology learning and is positively related to students' ability to plan, monitor, and evaluate learning processes (Adiansyah et al., 2023; Hasniati et al., 2017). These findings emphasize the importance of learning approaches that support all components of metacognitive regulation in a balanced manner.

The higher achievement in evaluating is consistent with Reinhard et al. (2021), who emphasized the importance of metacognitive reflection in helping students review the process of completing tasks and strengthen the problem-solving strategies they have employed. Evaluation allows students to consider not only whether an answer is correct. But also whether the process used to obtain the answer was effective. In Biology learning, this reflective process can support students in examining the reasoning they use when interpreting biological phenomena, analyzing relationships among biological concepts, and solving scientific problems. Therefore, a relatively strong evaluation ability may indicate that students have begun to develop the capacity to critically review their own learning processes.

The monitoring aspect obtained a mean score of 3.02. It was categorized as moderate, and this finding indicates that students had a fairly good ability to monitor their learning behavior, manage their time, and monitor their thinking processes and level of understanding during learning activities. Monitoring helps students develop awareness of their learning processes and recognize areas that require improvement. Nuraeni and Wiyanti (2026) reported that monitoring is related to students' self-awareness in managing learning time and improving weaknesses identified during learning. Thus, monitoring serves as an important mechanism that connects students' initial learning plans with their subsequent evaluation of learning outcomes. Students who are able to monitor their learning can identify difficulties while learning is taking place and make adjustments before completing a task.

In contrast, planning obtained a mean score of 3.01 and represented the lowest achievement in this analysis. This finding indicates that students still require greater habituation in formulating learning goals, selecting appropriate strategies, and organizing systematic steps before beginning a task. Planning is important because it provides the foundation for subsequent monitoring and evaluation processes (Majid et al., 2024). Without adequate planning, students may begin learning activities without clearly identifying what they need to accomplish or which strategy is most appropriate for a particular task. In addition, Sholeh et

al. (2024) emphasized that planning contributes to students' ability to analyze information, evaluate arguments, make decisions, and solve problems effectively. Therefore, the relatively lower achievement of planning suggests that Biology learning should provide more explicit opportunities for students to formulate objectives and strategies before engaging in problem-solving activities (Situmorang et al., 2025).

The differences in the dominant metacognitive aspects across the analyses suggest that students' metacognitive development may vary according to their learning experiences, characteristics, and the instructional strategies implemented in Biology classrooms. Metacognitive awareness is not a single ability but consists of interconnected processes through which students plan, monitor, and evaluate their own learning. Consequently, differences in the achievement of individual aspects should not be interpreted as weaknesses in isolation. Rather, they provide information regarding which components of metacognitive regulation may require greater instructional attention.

These findings are consistent with Marthaliakirana et al. (2022), who stated that metacognition helps students reflect on and analyze their thinking processes, draw conclusions, and apply learning outcomes to solve problems. The development of metacognitive awareness is also closely associated with students' ability to regulate their own learning. Students who are able to plan, monitor, and evaluate their learning tend to demonstrate stronger self-regulated learning abilities. Suwarti et al. (2022) demonstrated that self-regulation plays an important role in supporting students' learning success. In Biology learning, self-regulated learning is particularly important because students are expected to actively construct an understanding of biological concepts, identify difficulties in understanding complex phenomena, and select appropriate strategies to overcome those difficulties.

The findings also have implications for Biology instruction. Teachers need to provide explicit opportunities for students to engage in metacognitive activities before, during, and after learning. At the planning stage, students can be encouraged to formulate learning objectives, identify relevant information, and select strategies for solving biological problems. During learning, teachers can provide prompts that encourage students to monitor their understanding, identify misconceptions, and assess whether the strategies they are using are effective (Mukhlis & Paidi, 2025). At the evaluation stage, students can be guided to reflect on their learning outcomes, identify difficulties, and determine strategies that should be maintained or improved in subsequent learning activities. Such instructional practices can help students develop more independent, systematic, and reflective approaches to learning Biology (Faris et al., 2025).

The differences in the dominant metacognitive aspects also indicate that students may require different forms of instructional support. Students with relatively stronger planning skills may benefit from activities that emphasize monitoring and reflection, whereas students with weaker planning skills may require more explicit prompts before beginning a task. Similarly, when evaluation is relatively weak, teachers can incorporate reflection questions that require students to explain what strategy they used, whether it was effective, what difficulties they encountered, and what they would do differently in a subsequent task. Therefore, metacognitive instruction should not merely focus on increasing the overall metacognitive score but should facilitate the development of all three regulatory processes in an integrated manner.

Overall, the findings indicate that students' metacognitive awareness in Biology learning has developed across the three dimensions of planning, monitoring, and evaluating, although the level of achievement differs across the dimensions and analyses. This finding is also supported by Fariah et al. (2024), who reported a positive relationship between metacognitive awareness and students' learning outcomes. Metacognitive awareness enables students to regulate their thinking through continuous planning, monitoring, and evaluation. In

Biology learning, these abilities are important because they support students in understanding scientific concepts, monitoring their level of understanding, evaluating the learning strategies they use, and reflecting on the results of their learning. Students with stronger metacognitive awareness tend to have greater capacity to understand scientific concepts than those with lower metacognitive awareness (Goren & Kaya, 2022). Therefore, the development of planning, monitoring, and evaluating as an integrated set of metacognitive processes is important for supporting more independent, reflective, and effective Biology learning.

CONCLUSION

Based on the results, students' metacognitive awareness in Biology learning at SMP Negeri 11 Kota Serang was generally within the moderate-to-fairly-good range, with variations in the dominant metacognitive aspect across classes. Planning showed the highest mean score in Class 7B, evaluating was the highest in Class 7C, and monitoring was the highest in Class 7E. These findings indicate that students demonstrated different profiles of metacognitive regulation, although all three aspects-planning, monitoring, and evaluating-were evident in the learning process. The findings suggest that Biology learning should provide balanced opportunities for students to develop all three metacognitive processes. Learning activities can explicitly encourage students to formulate learning goals and strategies before learning, monitor their understanding during learning, and reflect on the effectiveness of their strategies after completing learning activities. Such practices may support the development of more independent, reflective, and effective learning among junior high school students. Future research is recommended to investigate the effectiveness of metacognitive-based learning models in improving students' metacognitive skills across different learning environments, grade levels, and subject areas.

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