



The relationship between metacognitive awareness, self-efficacy, and learning motivation on the biology learning outcomes of high school students in Maros regency

Huznul Amalia ^{(1) *}, Yusmina Hala ⁽²⁾, Andi Asmawati Azis ⁽²⁾, Firdaus Daud ⁽²⁾, Andi Mu'nisa ⁽²⁾

⁽¹⁾ Master Program in Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Makassar, South Sulawesi, Indonesia

⁽²⁾ Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Makassar, South Sulawesi, Indonesia

* Corresponding Author Email: huznulamalia.240013301018@student.unm.ac.id

Article Information	Abstract
Keyword: Metacognitive awareness; Self-efficacy; Learning motivation; Biology learning outcomes Kata Kunci: Kesadaran metakognisi; Efikasi diri; Motivasi belajar; Hasil belajar biologi History: Received : 04/05/2026 Revised : 30/05/2026 Accepted : 23/06/2026 Published : 25/06/2026	Students' biology learning outcomes in Indonesia remain suboptimal, as reflected in the 2022 PISA and the 2024 National Assessment. Internal factors such as metacognitive awareness, self-efficacy, and learning motivation are believed to play a significant role in determining students' academic achievement. This study aims to analyze the relationship between metacognitive awareness, self-efficacy, and learning motivation on the biology learning outcomes of 11th-grade students at public high schools in Maros Regency. The study employs a quantitative approach with an ex-post facto design involving 261 students selected through area random sampling. Data were collected using a combination of adapted and researcher developed questionnaires and multiple-choice tests based on higher order thinking skills. Data analysis employed descriptive statistics, correlation analysis, and multiple linear regression. The results indicated that all three independent variables fell into the moderate category, while learning outcomes were in the adequate category. Both partially and simultaneously, metacognitive awareness, self-efficacy, and learning motivation demonstrated a positive and significant relationship with biology learning outcomes, contributing a combined 63.9%. Metacognitive awareness was the dominant predictor with a contribution value of 37.4%. These findings emphasize the importance of integrating aspects of metacognition, self-efficacy, and motivation into learning strategies to improve the quality of students' learning outcomes. Abstrak. Hasil belajar biologi peserta didik di Indonesia masih belum optimal, sebagaimana tercermin dalam PISA 2022 dan Asesmen Nasional 2024. Faktor internal seperti kesadaran metakognisi, efikasi diri, dan motivasi belajar diyakini berperan penting dalam menentukan capaian akademik peserta didik. Penelitian ini bertujuan menganalisis hubungan kesadaran metakognisi, efikasi diri, dan motivasi belajar terhadap hasil belajar biologi peserta didik kelas XI SMA Negeri di Kabupaten Maros. Penelitian menggunakan pendekatan kuantitatif dengan desain ex-post facto yang melibatkan 261 peserta didik yang ditentukan melalui rumus slovin dan dipilih melalui area random sampling. Data dikumpulkan menggunakan kombinasi angket adaptasi dan pengembangan, serta tes pilihan ganda berbasis kemampuan berikir tingkat tinggi (HOTS). Analisis data menggunakan statistik deskriptif, analisis korelasi, dan regresi linear berganda. Hasil penelitian menunjukkan bahwa ketiga variabel bebas berada pada kategori sedang dan hasil belajar berada pada kategori cukup. Secara parsial maupun simultan, kesadaran metakognisi, efikasi diri, dan motivasi belajar memiliki hubungan positif dan signifikan dengan hasil belajar biologi dengan kontribusi bersama sebesar 63,9%. Kesadaran metakognisi menjadi prediktor dominan dengan nilai kontribusi sebesar 37,4%. Temuan ini menegaskan pentingnya pengintegrasian aspek metakognisi, efikasi diri, dan motivasi dalam strategi pembelajaran untuk meningkatkan kualitas hasil belajar peserta didik.

A. Introduction

In the 21st-century education era, learning demands are no longer focused solely on mastering facts, but rather on developing proficiency in the 4C skills (critical thinking, creativity, collaboration, and communication). To address these global challenges, strong internal support within students is essential, such as metacognitive awareness in managing and creative thinking processes, as well as self-efficacy and learning motivation, which serve as the primary drivers for effective communication and collaboration. The integration of the 4C skills with these internal aspects is considered crucial because it helps students consciously manage the learning process from planning, monitoring, to learning evaluation so that the learning process and outcomes become more effective and adaptable to changes in the curriculum and societal needs (Sadykova et al., 2024).

Results from international studies conducted through the Programme for International Student Assessment (PISA) consistently show that Indonesian students' science literacy skills remain low. These low achievements are also reflected in the results of the 2024 National Assessment (AN), where the literacy and numeracy indices of secondary-level students still show suboptimal scores (Kemendikdasmen, 2024). This situation indicates that the foundational skills underpinning success in science learning including biology remain suboptimal. Therefore, a study is needed on internal factors believed to play a significant role in supporting academic achievement, namely metacognitive awareness, self-efficacy, and learning motivation.

Based on a preliminary study conducted by the researcher through interviews with four biology teachers from four public high schools in Maros Regency, it was found that the biology learning outcomes of 11th-grade students were still suboptimal. The teachers reported that some students were not consistent in maintaining their enthusiasm for learning, especially when dealing with material that required critical thinking. To obtain a more concrete picture, the researcher analyzed data on the scores of daily test on the topic of Cells from one of the public high schools in Maros Regency. The data collected from 108 eleventh-grade students showed that the overall average score was 66.71, which falls into the sufficient category (<70) and remains below the Minimum Passing Criteria (KKM) of 80. Specifically, only 19 students (17.6%) achieved mastery, while the majority 89 students (82.4%) failed to meet this criterion.

The results of interviews with the four biology teachers also provided insight into three internal factors identified as potentially influencing student learning outcomes. First, students' metacognitive awareness is assessed as not yet fully developed; some students are not yet able to plan learning

strategies independently and rarely reflect on their learning outcomes. Second, students' self-efficacy still varies; some students lack confidence in solving problems that require reasoning and tend to give up easily when facing difficulties. Third, students' learning motivation is not uniform, interviews with biology teachers indicated that a significant number of students tend to study only when exams are approaching, while only a small proportion demonstrate high intrinsic motivation and learning autonomy.

These three internal factors have a strong theoretical foundation in supporting the attainment of 21st-century competencies, in which students are required not only to master conceptual knowledge but also to develop critical, creative, collaborative, and communicative thinking skills (4C). Metacognitive awareness enables students to design effective learning strategies by monitoring their own cognitive processes and has been shown to have a significant relationship with cognitive learning outcomes (Adiansyah et al., 2023). Academic self-efficacy has a significant positive relationship with academic performance through the mediation of metacognitive learning strategies, indicating that these two variables work synergistically to influence learning outcomes (Hayat et al., 2020). Meanwhile, learning motivation serves as the primary driving factor influencing students' engagement in learning activities and the use of effective metacognitive strategies (Hong et al., 2020). Without adequate motivation, metacognitive awareness and self-efficacy will not be optimally activated (Akmal et al., 2024).

Research on these internal factors has been extensive, but most studies have focused solely on two variables such as self-efficacy and motivation without considering the role of metacognitive awareness (Amandus et al., 2024). Some studies merely describe metacognitive profiles without directly linking them to learning outcomes (Marhaendra et al., 2023) or discuss self-confidence in the context of vocational schools, which have different characteristics from senior high schools (Putri et al., 2022). Specifically, although individual internal factors such as learning motivation may have been documented in public high schools in Maros Regency, a comprehensive evaluation of students' Higher-Order Thinking Skills (HOTS) in biology that simultaneously integrates metacognitive awareness, self-confidence, and learning motivation has yet to be conducted. Most local studies evaluate these variables separately, creating a gap in understanding of how they synergistically drive students' ability to solve complex, high-level biology problems. Therefore, there is still little research that comprehensively integrates these three internal factors within the context of biology learning in high school, particularly among high school students in Maros Regency.

Based on the above discussion, this study is expected to reveal how metacognitive awareness, self-efficacy, and learning motivation are related to biology learning outcomes, as well as the extent to which they contribute to students' academic success in that region.

B. Material and method

This study employed a quantitative approach with an ex-post facto design to analyze the relationship between metacognitive awareness, self-efficacy, learning motivation, and students' biology learning outcomes. The data were analyzed using descriptive and inferential statistics, specifically multiple linear regression analysis, to determine the simultaneous and partial relationships between the independent and dependent variables. The study was conducted during the second semester of the 2025/2026 academic year at several A accredited public high schools in Maros Regency. Preliminary observations at several A accredited schools in Maros Regency indicate variations in students' performance in biology despite having standard educational facilities, making it an ideal setting to investigate how internal factors such as metacognition, motivation, and self-efficacy influence their success.

The study population consisted of all 11th-grade science students at public high schools in Maros Regency. The sample was selected using area random sampling based on the schools' geographic locations (urban, semi-urban, and rural) to ensure proportional representation. The sample size for this study was 261 students. The sample size was determined using the Slovin formula. Using the slovin formula from a total population of 753 students.

The research variables consist of three independent variables metacognitive awareness (X_1), self-efficacy (X_2), and learning motivation (X_3) and one dependent variable, biology cognitive learning outcomes (Y). The research instruments initially underwent validity and reliability testing on a trial sample of 30 students sharing similar characteristics with the target population. Based on the Pearson Product-Moment table ($r_{table} = 0.361$ at a $\alpha = 0.05$ significance level), all items across the questionnaires were declared valid. Furthermore, the reliability test yielded high internal consistency using Cronbach's alpha, with coefficients of 0.838 for metacognitive awareness, 0.818 for self-efficacy, and 0.765 for learning motivation. These results confirmed that all instruments were highly valid and reliable before being administered to the actual research sample of 261 students. Metacognitive awareness was measured using a questionnaire adapted from the Metacognitive Awareness Inventory (MAI) by Schraw and Dennison (1994). Meanwhile, the questionnaires Self-efficacy and learning motivation were developed by the researcher based on well-established theoretical indicators; the self-efficacy items were

formulated based on Bandura (1997) covering the dimensions of magnitude, strength, and generality, while learning motivation items were based on Uno (2013) covering both intrinsic and extrinsic aspects. All independent variables (X_1 , X_2 and X_3) were measured using a 5 point Likert scale questionnaire. Meanwhile, biology cognitive learning outcomes were measured through multiple-choice tests designed at the Higher Order Thinking Skills (HOTS) level, namely C4 to C6 on the digestive and excretory systems.

Data collection was conducted through the distribution of questionnaires and achievement tests. The research instruments underwent validity and reliability testing using Cronbach's alpha. Data analysis was performed using descriptive and inferential statistics. Prior to hypothesis testing, prerequisite tests were conducted, including tests for normality, linearity, multicollinearity, and heteroscedasticity, using the statistical software SPSS. Data analysis in this study was performed using both descriptive and inferential statistics. Descriptive statistical analysis was conducted to calculate the mean, standard deviation, minimum, and maximum scores to outline how the baseline figures for each research variable were obtained. Meanwhile, inferential statistical analysis, specifically multiple linear regression, was applied to test the research hypotheses and obtain the correlation coefficient (R value) to determine the strength of the simultaneous relationship between the independent variables and the dependent variable, as well as the F value, R value, and coefficient of determination (R square) to evaluate the regression model significance and contribution percentage.

The data obtained for each research variable, including metacognitive awareness, self-efficacy, learning motivation, and biology cognitive learning outcomes, were classified into five categories (very high, high, moderate, low, and very low). This categorization was determined using the normative standard deviation criteria adapted from Azwar (2012), utilizing the calculated ideal mean (M) and ideal standard deviation (SD) values for each specific measurement instrument. To determine the magnitude of the independent variables' contribution to the dependent variable, the coefficient of determination was used, calculated using the Formula 1. Hypothesis testing for multiple regression using the Formula 2.

$$KD = r^2 \times 100\% \dots \dots \dots \text{Formula 1}$$

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 \dots \dots \dots \text{Formula 2}$$

Description:

- KD = Coefficient of determination
- r = Correlation coefficient
- Y = the value of the Y variable
- b_1 = the coefficient of predictor X_1
- b_2 = the coefficient of predictor X_2
- b_3 = the coefficient of predictor X_3
- a = the constant

$$SEx\% = \text{Beta}_x \times r_{xy} \times 100\% \dots \dots \dots \text{Formula 3}$$

$$SR(X)\% = \frac{SE(X)\%}{R\text{-Square}} \dots \dots \dots \text{Formula 4}$$

Description:

SE_x% = The effective contribution of a single predictor
Beta = Regression coefficients
R = Correlation coefficient
SE (X)% = Effective contribution
R-Square = Coefficient of determination.

Next, the effective contribution of each predictor is determined. This allows us to identify the effective contribution of each predictor to the dependent variable. The effective contribution can be calculated using the Formula 3 by Sugito et al. (2019). Next, the relative contributions of each independent

variable are calculated. Thus, the total relative contribution of all independent variables is 100% or 1. The effective contribution can be calculated using the Formula 4.

C. Results and discussion

Based on the results of the descriptive statistical analysis presented in Table 1, of the variables of metacognitive awareness, self-efficacy, and learning motivation, students in the 11th grade at public high schools in Maros Regency fall into the moderate category. Learning outcomes also fall into the adequate category. The distribution of learning outcomes indicates that the majority of students have not yet met the established minimum proficiency criteria.

Table 1 Descriptive statistics

Variable	Mean	Std. deviation	Minimum	Maximum	Category
Metacognitive awareness (X ₁)	68.28	9.156	47	85	Moderate
Self-efficacy (X ₂)	67.08	7.617	49	84	Moderate
Learning motivation (X ₃)	67.18	8.467	48	85	Moderate
Cognitive learning outcomes (Y)	67.71	8.399	43	80	Adequate

The average level of metacognitive awareness was 68.28. This indicates that most students already possess the basic ability to recognize their own thinking processes, but have not yet fully optimized them in their biology learning activities. Students in the moderate category tend to have begun planning their learning methods but are not yet consistent in monitoring their understanding and evaluating the strategies they use. With an average score in the middle of the scale, these results indicate that the potential to improve students' metacognitive awareness remains wide open and requires support from more reflective learning strategies in the classroom. The average self-efficacy score of 67.08 reflects that most students do not yet fully believe in their ability to understand and complete biology tasks. This condition directly implies low learning persistence and effort when facing difficult material.

The average learning motivation score was 67.18, indicating that students possess a desire to learn but have not yet fully optimized their ability to maintain consistency and active engagement in the learning process. The average learning achievement score was 67.71, indicating that most students have attained a basic understanding of the material but have not yet fully mastered the concepts in depth. Theoretically, learning outcomes are influenced not only by mastery of the material but also by the cognitive processes involved in learning. These moderate learning outcomes are likely due to students' abilities still being predominantly at the comprehension (C₂) and application (C₃) levels, meaning they have not yet maximized their ability to reach higher-order thinking levels. Improvements in

learning outcomes are significantly influenced by teaching strategies that foster active engagement and deep thinking. This situation is likely due to students who already understand the basic concepts but are not yet accustomed to developing analytical and evaluative skills (Paulsen & Kolstø, 2022). These findings align with recent research indicating that the majority of students fall into the intermediate category when faced with analysis- and evaluation-based questions (Noris et al., 2024).

The results of the preliminary analysis tests indicate that the data are normally distributed ($p > 0.05$), the relationship between variables is linear, and no signs of multicollinearity or heteroscedasticity were found. Thus, the data meet the assumptions required for correlation analysis and multiple linear regression.

The results of the simple linear regression test indicate that metacognitive awareness has a positive and significant relationship with biology learning outcomes, with a significance level of $0.000 < 0.05$. The regression coefficient (b_1) obtained was 0.637. The R value of 0.695 indicates that the relationship between the two variables is strong, while the coefficient of determination (*R Square*) of 0.483 implies that the metacognitive awareness variable contributes 48.3% to students' biology learning outcomes. Based on the questionnaire data, the planning indicator received the highest score among the other metacognitive awareness indicators, indicating that students in Maros Regency are already quite capable of formulating plans before beginning their learning activities, although the monitoring and evaluation aspects still need improvement. These

findings are supported by previous research, which found that metacognitive awareness has a positive and significant effect on the learning outcomes of 11th-grade science students at State High School 4 in Bau-Bau City (Ihsan et al., 2024). In terms of geographical and demographic context, this area shares similar characteristics with Maros Regency as a region in eastern Indonesia. In the context of biology education, metacognitive awareness plays a crucial role because the conceptual and complex nature of biology requires students not only to understand the content but also to actively monitor the extent to which they have grasped it (Moritz & Lysaker, 2018).

The results of the simple linear regression analysis indicate that the self-efficacy variable has a positive and significant relationship with the biology learning outcomes of 11th-grade students at public high schools in Maros Regency. The R value of 0.577 indicates a fairly strong relationship, and the coefficient of determination of 33.3% implies that self-efficacy accounts for one-third of the variation in biology learning outcomes. The ANOVA test results confirmed the model's validity with an F-value of 129.540 and a significance level of 0.000. The questionnaire results in this study indicate that the sub-indicators scoring highest on the self-efficacy variable were two sub-indicators from the level dimension: belief in one's ability to take actions to achieve a result and holding a positive view of one's potential to complete biology tasks. These findings align with the concept of the level dimension in Bandura's self-efficacy theory. Perceived self-efficacy relates to an individual's belief in their ability to influence events affecting their life, and this core belief serves as the foundation for motivation, performance achievement, and emotional well being (Bandura, 1997). In other words, students who scored high on the level dimension not only believe they are capable but also have the courage to persist in attempting to solve challenging biology problems, even when the difficulty level is high (Apriliani et al., 2022).

Students with high self-efficacy approach challenging situations with the confidence that they can handle them, while students with low self-efficacy view difficult tasks as a personal threat and tend to avoid them due to a lack of confidence in their own abilities. This explains why, although the average self-efficacy score falls into the moderate category overall, the most prominent sub-indicator is actually the one related to self-confidence and a positive self-image when facing biology tasks. This indicates that most students already possess sufficiently strong affective capital to face learning challenges, yet this has not been fully balanced by the strength of their beliefs and the breadth of their application of those beliefs across various learning situations. An individual's level of self-efficacy can predict behavioral changes and the

likelihood of success in facing and overcoming life's challenges, and high self-efficacy generally contributes to better performance (Honick et al., 2023). These findings are supported by previous research, which found that among 85 11th-grade science students at State Senior High School 22 in Jakarta, there was a significant relationship between self-efficacy and biology learning outcomes, with a correlation coefficient of $r = 0.742$ (Sigiro et al., 2017). A study of high school students in West Aceh Regency found that the calculated r value of 0.7277 was greater than the table r value of 0.2461, indicating a significant relationship between self-efficacy and student learning outcomes (Yolantia et al., 2021).

The learning motivation variable showed a positive and significant relationship with the biology learning outcomes of 11th-grade students at public high schools in Maros Regency, with a significance level of $0.000 < 0.05$. The R value of 0.591 indicates a fairly strong relationship, and the coefficient of determination of 35% implies that learning motivation contributes 35% to the variation in biology learning outcomes. The ANOVA test results confirm the model's validity with an F-value of 139.216 and a significance level of 0.000. Based on the questionnaire results, the highest indicator in the intrinsic aspect was the need to learn, while in the extrinsic aspect, it was the reward for learning. These two indicators reflect that students' motivation to learn in Maros Regency is supported by an awareness of their own need to develop as well as a positive response to the appreciation received from their surroundings.

The high scores on the intrinsic learning needs indicator reflect that students are already aware of the importance of learning biology for themselves, which is a tangible manifestation of the fulfillment of their basic needs for competence and autonomy. Meanwhile, the high scores on the learning reward indicator in the extrinsic aspect indicate that appreciation in the form of grades, praise, or recognition from teachers and parents remains a significant motivator for students in engaging with biology learning. The presence of high scores for the extrinsic reward indicator also suggests that appreciation from the environment still plays a significant role in fostering a spirit of learning; and as long as such rewards are informative and constructive, their effects can actually support the internalization of learning motivation within students (Jaleel & P., 2016). These findings are supported by previous research, which found that high school students tend to have intrinsic motivation measured in terms of curiosity and mastery with an average score above 2.5, and that this motivation is associated with academic performance in biology (Rochani, 2023).

Table 2 The relationship between metacognitive awareness, self-efficacy, and learning motivation and the academic achievement of public high school students in Maros regency

Model	Unstandardized coefficients		R	R square	F	Sig
	B	Std. error				
Constant	-2.210	3.171				
Metacognitive awareness	0.494	0.037	0.799	0.639	151.522	0.000
Self-efficacy	0.168	0.063				
Learning motivation	0.297	0.056				

Table 3 The effective contributions of the variable's metacognitive awareness, self-efficacy, and learning motivation to learning outcomes

Variable	Regression coefficient (b)	Correlation coefficient (r)	Effective contribution (SE)
Metacognitive awareness	0.538	0.695	0.374
Self-efficacy	0.152	0.577	0.088
Learning motivation	0.300	0.591	0.177
Total			0.639

Table 4 Relative contributions of the variable's metacognitive awareness, self-efficacy, and learning motivation to learning outcomes

Variable	Effective contribution (SE)	Determination coefficient (r ²)	Relative contribution (SR)
Metacognitive awareness	0.374		0.585
Self-efficacy	0.088	0.639	0.138
Learning motivation	0.177		0.277
Total			1

Based on Table 2, the results of the ANOVA data analysis indicate that the significance probability value is $0.000 < 0.05$. This implies that the variables of metacognitive awareness, self-efficacy, and learning motivation are simultaneously and significantly associated with the biology learning outcomes of 11th-grade students at SMAN in Maros Regency. The R value of 0.799 indicates that the strength of the simultaneous relationship is classified as strong, with a coefficient of determination (R^2) of 0.639, meaning that the three variables together contribute 63.9% to biology learning outcomes. While the remaining 36.1% is influenced by other factors not examined in this study, such as learning styles, teacher teaching methods, family environment, or students' initial cognitive abilities.

Based on Table 3, the effective and relative contributions of each variable show that metacognitive awareness provides the largest effective contribution at 37.4% with a relative contribution of 58.5%, followed by learning motivation at 17.7% (relative contribution 27.7%), and self-efficacy at 8.8% (relative contribution 13.8%). This pattern confirms that among the three variables, metacognitive awareness is the most dominant predictor of students' biology learning outcomes in Maros Regency.

Table 4 shows the relative contribution of each independent variable. The relative contribution of metacognitive awareness to learning outcomes was 58.5%, the relative contribution of self-efficacy was 13.8%, and the relative contribution of learning motivation was 27.7%. The total relative contribution

of all independent variables to learning outcomes is 100%. Thus, the variables of metacognitive awareness, self-efficacy, and learning motivation collectively contribute 100% to the biology learning outcomes of 11th-grade students at SMAN in Maros Regency.

Students with high metacognitive awareness are better able to plan and monitor their learning; however, without adequate self-efficacy, these abilities will not translate into concrete learning actions. Similarly, high learning motivation without appropriate cognitive strategies will only result in unfocused effort. Metacognition, which encompasses awareness and management of thinking processes, plays a crucial role in enhancing self-efficacy, and students with strong metacognitive abilities have been shown to be better prepared to learn effectively and achieve higher academic outcomes (Wass et al., 2023).

The dominant contribution of metacognitive awareness (37.4%) compared to the other two variables can be explained by the nature of biology as a subject, which demands a deep conceptual understanding rather than mere memorization. Students who are able to plan, monitor, and evaluate their learning process will be more successful in understanding and retaining biological knowledge. Meanwhile, the fact that the contribution of learning motivation (17.7%) is greater than that of self-efficacy (8.8%) in a simultaneous context indicates that the drive to learn whether stemming from internal needs or external rewards plays a more consistent supporting role compared to self-belief alone when all

three variables are considered together. Students' self-efficacy and learning motivation have a positive and significant influence on learning outcomes, both partially and simultaneously; therefore, learning outcomes can be improved by enhancing both factors simultaneously (Fauziah et al., 2018).

These findings are supported by previous research; a study of 107 11th-grade science students at a public high school in Gowa Regency found that the combined relationship between metacognitive skills, motivation, and mental readiness and biology learning outcomes was strong, with a correlation coefficient of 0.633 (Usman et al, 2017). This value is lower than the findings in this study ($R = 0.799$), indicating that the inclusion of self-efficacy as a third predictor was able to simultaneously strengthen the relationship. This underscores the importance of considering self-efficacy as a variable that is inseparable from metacognitive awareness and motivation in explaining biology learning outcomes (Stanton et al, 2021). Furthermore, there was a positive and significant combined effect of metacognitive awareness and learning motivation on learning outcomes, with an F-value of 40.528 and a p-value of 0.000 (Riyanti et al., 2020).

D. Conclusion

Based on the research findings, it can be concluded that the metacognitive awareness, self-efficacy, and learning motivation of 11th-grade students at public high schools in Maros Regency fall into the moderate category, while their biology learning outcomes fall into the adequate category. Both partially and simultaneously, these three variables have a positive and significant relationship with learning outcomes (with $R = 0.799$, $F = 151.522$, $p < 0.001$), confirming that students' internal factors play a crucial role in determining success in biology learning. This finding contributes scientifically to reinforcing the understanding that learning success is not determined solely by cognitive aspects but also by students' ability to manage their thinking processes, self-confidence, and learning motivation in an integrated manner. Therefore, the development of learning strategies that integrate metacognition, self-efficacy, and learning motivation is essential for improving the quality of learning outcomes. Further research is recommended to examine other factors that may influence learning outcomes, such as critical thinking skills, learning styles, and environmental support, as well as to test learning models that can specifically enhance these three aspects.

E. References

- Adiansyah, R., Amin, M. A., Yani, A., & Safitri, D. (2023). The correlation between metacognitive awareness and cognitive learning outcomes based on gender of biology education students. *Biosfer*, 16(2), 244–259. DOI: <https://doi.org/10.21009/biosferjpb.26765>
- Akmal, A. U., Yohandri, & Razak, A. (2024). Profile of students' 21st century skills in digital learning using the contextual teaching and learning (CTL) model. *International Journal of Elementary Education*, 7(4), 731–741. DOI: <https://doi.org/10.23887/ijee.v7i4.66570>
- Amandus, V., Ihsan, I., & Nurhidaya, N. (2024). Hubungan efikasi diri dan motivasi belajar dengan hasil belajar biologi peserta didik di SMA Negeri 1 Kecamatan Komodo Kabupaten Manggarai Barat. *EDUKASI*, 22(2), 883–894. DOI: <https://doi.org/10.33387/j.e.v22i2.9432>
- Apriliani, M. A., Nurhasanah, N., & Maksun, A. (2022). Hubungan efikasi diri dengan hasil belajar PPKn kelas IV SDN Kecamatan Bekasi Timur. *Jurnal Pemikiran dan Pengembangan Sekolah Dasar (JP2SD)*, 10(2), 214–227. DOI: <https://doi.org/10.22219/jp2sd.v10i2.21831>
- Azwar, S. (2012). *Sikap manusia: Teori dan pengukurannya*. Pustaka Belajar.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman and Company.
- Fauziah, H. A., Setyowati, A. P., Dewantari, R., Wulandari, A. D., & Prayitno, B. A. (2018). Profil kesadaran metakognisi siswa di salah satu SMA swasta di Sragen. *BIOSFER: Jurnal Biologi dan Pendidikan Biologi*, 3(2), 21–29. DOI: <https://doi.org/10.23969/biosfer.v3i2.975>
- Hayat, A. A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: A structural equation model. *BMC Medical Education*, 20(1), 76. DOI: <https://doi.org/10.1186/s12909-020-01995-9>
- Hong, W., Bernacki, M. L., & Perera, H. N. (2020). A latent profile analysis of undergraduates' achievement motivations and metacognitive behaviors, and their relations to achievement in science. *Journal of Educational Psychology*, 112(7), 1409–1430. DOI: <https://doi.org/10.1037/edu0000445>
- Honicke, T., Broadbent, J., & Fuller-Tyszkiewicz, M. (2023). The self-efficacy and academic performance reciprocal relationship: The influence of task difficulty and baseline achievement on learner trajectory. *Higher Education Research & Development*, 42(8), 1936–1953. DOI: <https://doi.org/10.1080/07294360.2023.2197194>
- Ihsan, I., Mustafa, H. I. R., & Lestari, A. F. (2024). Pengaruh kesadaran metakognitif dan minat belajar terhadap hasil belajar siswa kelas XI IPA SMA Negeri 4 Kota Bau-Bau. *Jurnal Ilmiah Wahana Pendidikan*, 10(10), 1239–1247. DOI: <https://doi.org/10.5281/zenodo.12144227>

- Jaleel, S., & P., P. (2016). A study on the metacognitive awareness of secondary school students. *Universal Journal of Educational Research*, 4(1), 165–172. DOI: <https://doi.org/10.13189/ujer.2016.040121>
- Kemendikdasmen. (2024). *Rapor publik asesmen nasional 2024: Peserta didik SMA/SMK/MA/MAK/ sederajat*. Direktorat Jenderal Pendidikan Anak Usia Dini, Pendidikan Dasar, dan Pendidikan Menengah. Retrieved from <https://pusmendik.kemendikbud.go.id/publikasi>
- Marhaendra, G. Y., Keliat, N. R., & Tapilouw, M. C. (2023). Profil kesadaran metakognitif siswa SMA. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 13(3), 288–295. DOI: <https://doi.org/10.24246/j.js.2023.v13.i3.p288-295>
- Moritz, S., & Lysaker, P. H. (2018). Metacognition—What did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions. *Schizophrenia Research*, 201, 20–26. DOI: <https://doi.org/10.1016/j.schres.2018.06.001>
- Noris, M., Jannah, M., Suyitno, M., & Rizal, S. U. (2024). Analysis of students' critical thinking ability profile using HOTS-based questions. *Jurnal Penelitian Pendidikan IPA*, 10(2), 530–538. DOI: <https://doi.org/10.29303/jppipa.v10i2.5435>
- OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing. Retrieved from https://www.oecd-ilibrary.org/education/pisa-2022-results-volume-i_53f2383e-en
- Paulsen, V. H., & Kolstø, S. D. (2022). Students' reasoning when faced with test items of challenging aspects of critical thinking. *Thinking Skills and Creativity*, 43(2), 100969. DOI: <https://doi.org/10.1016/j.tsc.2021.100969>
- Putri, A. E., Soenarno, S. M., & Suryana, A. (2022). Analisis efikasi diri dalam pembelajaran biologi di SMK Bunda Auni. *EduBiologia: Biological Science and Education Journal*, 2(2), 101–105. DOI: <https://doi.org/10.30998/edubiologia.v2i2.12924>
- Riyanti, R., Kristiani, & Sari, D. P. (2020). Pengaruh kesadaran metakognisi dan motivasi belajar terhadap hasil belajar siswa. *Tata Artta: Jurnal Pendidikan Akuntansi*, 6(1), 17–31. DOI: <https://doi.org/10.20961/tatarta.v6i1.39824>
- Rochani, S. (2023). Identifikasi motivasi intrinsik dan ekstrinsik siswa dan hubungannya terhadap hasil belajar mata pelajaran biologi. *Jurnal Lingkar Mutu Pendidikan*, 20(2), 83–89. DOI: <https://doi.org/10.54124/jlmp.v20i2.101>
- Sadykova, A., Iskakova, M., Ismailova, G., Ishmukhametova, A., Sovetova, A., & Mukasheva, K. (2024). The impact of a metacognition-based course on school students' metacognitive skills and biology comprehension. *Frontiers in Education*, 9, 1–9. DOI: <https://doi.org/10.3389/feduc.2024.1460496>
- Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19(4), 460–475. DOI: <https://doi.org/10.1006/ceps.1994.1033>
- Sigiro, O. N., Sigit, D. V., & Komala, R. (2017). Hubungan efikasi diri dan penalaran ilmiah dengan hasil belajar biologi siswa SMA. *Biosfer: Jurnal Pendidikan Biologi*, 10(2), 30–34. DOI: <https://doi.org/10.21009/biosferjpb.10-2.4>
- Sugito, S., Suyitno, Y., & Kuntoro, K. (2019). Pengaruh masa kerja dan motivasi kerja terhadap kinerja guru sekolah dasar di Desa Samudra dan Samudra Kulon. *Jurnal Dinamika Pendidikan Dasar*, 11(1), 1–18. DOI: <https://doi.org/10.30595/dinamika.v11i1.5980>
- Stanton, J. D., Sebesta, A. J., & Dunlosky, J. (2021). Fostering metacognition to support student learning and performance. *CBE—Life Sciences Education*, 20(2), 1–7. DOI: <https://doi.org/10.1187/cbe.20-12-0289>
- Uno, H. B. (2013). *Teori motivasi & pengukurannya: Analisis di bidang pendidikan*. PT Bumi Aksara.
- Usman, A., Hala, Y., & Paggara. (2017). Hubungan antara kemampuan metakognisi, motivasi, dan kesiapan mental dengan hasil belajar biologi siswa kelas XI IPA SMA Negeri di Kabupaten Gowa. *UNM Journal of Biological Education*, 1(1), 47–56. DOI: <https://doi.org/10.35580/ujbe.v1i1.5437>
- Wass, R., Rogers, T., Brown, K., Smith-Han, K., Tagg, J., Berg, D., & Gallagher, S. (2023). Pedagogical training for developing students' metacognition: Implications for educators. *International Journal for Academic Development*, 1–14. DOI: <https://doi.org/10.1080/1360144X.2023.2246442>
- Yolantia, C., Artika, W., Nurmaliah, C., Rahmatan, H., & Muhibbuddin, M. (2021). Penerapan modul problem based learning terhadap self-efficacy dan hasil belajar peserta didik. *Jurnal Pendidikan Sains Indonesia*, 9(4), 631–641. DOI: <https://doi.org/10.24815/jpsi.v9i4.21250>