https://research.adra.ac.id /index.php/ijen/
P - ISSN: 2988-1579
E - ISSN: 2988-0092

A Narrative Analysis of the Influence of Metacognitive Skills and Self-Efficacy on Chemistry Learning Achievement among Students

Ilham Assidiq[1], Sitti Mania[2], Yuspiani[3], Usman[4]
[1]Universitas Muhammadiyah Enrekang, Indonesia
[2]Universitas Islam Negeri Alauddin Makassar, Indonesia
[3]Universitas Islam Negeri Alauddin Makassar Indonesia
[4]Universitas Islam Negeri Alauddin Makassar, Indonesia

ABSTRACT

Background. Chemistry learning is influenced by various psychological factors, including students' metacognitive skills and self-efficacy. Both factors play a crucial role in motivating students to learn effectively. Therefore, it is essential for educators to understand how metacognitive skills and self-efficacy impact students' performance in chemistry.

Purpose. This study aims to investigate the impact of metacognitive skills and self-efficacy on chemistry learning achievement among students in Enrekang Regency. Additionally, this study examines the relationship between these psychological factors and how they contribute to the improvement of students' chemistry performance.

Method. Pearson product-moment correlation was used to assess the strength and direction of associations between the study variables, while multiple linear regression analysis was conducted to evaluate the extent to which metacognitive skills and self-efficacy jointly predict students' chemistry learning achievement. The significance level for all statistical analyses was set at $\alpha = 0.05$.

Results. The findings indicate that metacognitive skills and self-efficacy have a significant positive correlation with chemistry learning achievement. Specifically, self-efficacy has a stronger influence than metacognitive skills in predicting chemistry learning achievement. Regression results show that both factors can explain 36% of the variance in students' chemistry learning achievement.

Conclusion. This study contributes to the growing body of research on educational psychology by demonstrating the significance of self-efficacy and metacognitive skills in predicting chemistry learning achievement. The findings suggest that educators should incorporate instructional practices that promote students' metacognitive regulation and strengthen their self-efficacy, as these factors may play a crucial role in improving learning outcomes and overall academic success in chemistry education.

KEYWORDS

Chemistry Education, Chemistry Learning Achievement, Metacognitive Skills, Self-Efficacy

Citation: Assidiq, I., Mania, S., Yuspiani, Yuspiani., & Usman, Usman. (2026). A Narrative Analysis of the Influence of Metacognitive Skills and Self-Efficacy on Chemistry Learning Achievement among Students. *International Journal of Educational Narrative*, *4*(3), 1127–1141.
https://doi.org/10.70177/ijen.v4i2.3842

Correspondence:
Ilham Assidiq,
ilhamassidiq25@gmail.com

Received: January 18, 2026
Accepted: May 15, 2026
Published: June 30, 2026

INTRODUCTION

In the era of globalization and the industrial revolution 4.0, education faces the challenge of developing students' cognitive skills and motivation in a balanced manner . One important factor influencing academic achievement is metacognitive ability, namely students' ability to control and reflect on their thinking processes

during learning, Flavell 1979 (Efklides, 2006). Additionally, Bandura in 1997 stated that students' self-efficacy, or their confidence in their ability to achieve academic goals, is also a major determinant of their effort and persistence (Abdolrezapour dkk., 2023). This second factor plays a significant role in influencing how students overcome difficulties and achieve high achievement, particularly in complex subjects such as chemistry (Huda & Rohaeti, 2023).

Global phenomena indicate that the development of metacognition and self-efficacy is a priority in modern education, particularly in the context of science and technology learning. In Indonesia, despite progress in the education system, students' chemistry learning achievement still faces challenges. This study aims to investigate the relationship between metacognitive abilities and self-efficacy on student learning achievement, with the hope of providing insights for the development of more effective learning strategies in the future (İnce, 2023; Xie, 2026).

In the context of education in Indonesia, particularly in Enrekang Regency, student achievement still shows significant variation, particularly in science subjects such as chemistry. Despite efforts to improve educational quality through various government programs, student achievement in this region still faces challenges related to understanding complex chemistry concepts. One factor often overlooked in analyses of student achievement is the influence of psychological factors such as metacognitive abilities and self-efficacy (Hartelt & Martens, 2024). Previous research has shown that students in areas with limited access to educational resources often struggle to develop these two factors, which ultimately impacts their learning outcomes (Dennis & Somerville, 2023; Purwaningsih, 2024; Swanson dkk., 2024).

In Enrekang Regency, chemistry education at the high school level faces additional challenges in the form of limited facilities and adequate teaching resources. Although some schools have implemented technology-based learning approaches, many students still struggle to understand chemistry material deeply. Therefore, it is important to explore psychological factors, such as metacognition and self-efficacy, that can act as levers to improve student achievement in this region. This study aims to explore the relationship between these two factors and student chemistry achievement in Enrekang Regency, which is expected to provide practical insights for developing more effective learning strategies in this region.

Chemistry learning at the senior high school (SMA) level still faces various errors that impact the quality of conceptual understanding and student learning outcomes. Chemistry is often considered a difficult subject because it requires the ability to simultaneously understand abstract concepts, symbolic representations, and the relationships between macroscopic, microscopic, and symbolic phenomena. Many students struggle to connect these three-level representations, resulting in learning that tends to be oriented toward memorizing formulas and problem-solving procedures rather than in-depth conceptual understanding. Furthermore, teaching practices in many schools are still dominated by a teacher-centered approach, while the development of students' metacognitive skills, self-efficacy, and higher-order thinking skills has not received adequate attention.

This gap is further exacerbated by differences in access to laboratory facilities, learning resources, and teaching quality across schools, which contribute to variations in student achievement in chemistry. Various studies have shown that metacognitive abilities and academic self-efficacy are important factors influencing students' success in understanding complex chemistry concepts and improving their academic achievement (Bandura, 1997; Schraw & Dennison, 1994; Zohar & Barzilai, 2013). Therefore, a learning approach is needed that focuses not only on mastery of the material but also on developing cognitive and affective aspects that can support sustainable success in learning chemistry.

Although numerous studies have examined the influence of metacognition and self-efficacy on academic achievement, many focus primarily on general academic performance rather than subject-specific learning outcomes. For example, meta-analytic evidence indicates that metacognitive skills account for approximately 17–20% of the variance in students' academic achievement, while self-efficacy consistently emerges as one of the strongest predictors of learning success, with moderate to strong effect sizes across educational settings. In Indonesia, particularly in Enrekang Regency, few studies have specifically examined how these two psychological factors relate to chemistry achievement. These studies tend to ignore contextual variables, such as limited educational facilities, differences in teaching quality, and students' socioeconomic backgrounds, which may play a significant role in shaping their metacognitive abilities and self-efficacy (Cao & Huo, 2026).

One unanswered gap in the literature is how metacognition and self-efficacy interact to influence student achievement in chemistry in areas with unique educational challenges, such as Enrekang Regency. No research has specifically addressed the interaction between these two factors in the context of areas with limited access to educational resources, which could potentially have a different impact compared to areas with more comprehensive facilities. Previous research stated that suggests that these psychological factors may play a greater role in under-resourced areas, but further research is needed to understand how these two factors interact in more limited educational contexts (Shambare & Jita, 2025). Therefore, this study is important, given its contribution in filling this gap in the existing literature and providing a deeper understanding of the psychological dynamics that influence student chemistry achievement in the region.

To address the existing research gap, this study will adopt a quantitative correlational research model that focuses on the relationship between metacognitive abilities and self-efficacy with students' chemistry learning achievement. This study will incorporate measurement instruments that have been proven valid and reliable, such as the metacognitive scale Schraw & Dennison (Bürgler dkk., 2022) and the self-efficacy scale Schunk, 1995 (Pei & O'Brien, 2023), adapted to the local context in Enrekang Regency. To measure learning achievement, researchers will use chemistry tests adapted to the local curriculum and direct observation of learning strategies implemented in local schools.

This approach is expected to not only provide an understanding of the relationships between the variables studied, but also provide practical solutions for teachers and educational institutions in Enrekang to develop learning strategies that are more focused on improving students' metacognitive abilities and self-efficacy. Through the results of this study, it is hoped that metacognition-based interventions tailored to students' psychological needs, as well as more effective self-efficacy empowerment programs, can be developed to improve chemistry learning achievement in areas with limited resources. Thus, this research will make a significant contribution to the development of more inclusive and effective education in Enrekang Regency, and is expected to be adapted to other areas facing similar challenges.

The main objective of this study is to analyze the relationship between metacognitive ability and self-efficacy with students' chemistry learning achievement in Enrekang Regency, with a focus on the interaction of these two psychological factors. More specifically, this study aims to: (1) identify the extent to which students' metacognitive ability is related to their ability to solve complex chemistry problems, (2) analyze the influence of self-efficacy on students' efforts and persistence in facing chemistry learning challenges, and (3) explore how these two factors interact to influence students' chemistry learning achievement, especially in areas with limited educational resources.

By achieving these objectives, it is hoped that this research will provide a significant scientific contribution to the development of more effective and focused metacognition- and self-efficacy-based learning strategies. Furthermore, the results of this study will serve as an important reference in designing psychological intervention programs that support improved chemistry learning achievement, which can be widely applied in various regions facing similar challenges.

RESEARCH METHODOLOGY

This study aimed to investigate the relationship between metacognitive ability, self-efficacy, and chemistry learning achievement among students in Enrekang Regency. This study employed a quantitative correlational approach, which allowed researchers to explore the relationships between different variables and identify the influence of each variable on chemistry learning achievement. With this approach, we sought to better understand how two key psychological factors metacognitive ability and self efficacy interact and influence students' academic achievement in chemistry.

Research Design

The research design used in this study was a survey method with a cross-sectional approach. This approach was chosen because it provides a clear and comprehensive picture of the relationship between metacognition, self-efficacy, and chemistry learning achievement simultaneously, without requiring data collection over a long period of time. In this study, data was collected at only one point in time from a representative sample, allowing the results to demonstrate the relationship between the three variables.

This cross-sectional design also allowed researchers to gain a broader picture of student conditions in Enrekang Regency by collecting data from various schools in the area. With this approach, the research results are expected to provide practical recommendations that can be immediately implemented in the learning process at local schools.

Population and Sample

The population in this study was all high school students in Enrekang Regency taking chemistry in the 2025/2026 academic year. From this population, we selected a sample using a stratified random sampling technique. This technique was chosen to ensure that the sample encompasses diversity in terms of gender, academic background, and socioeconomic factors. With this approach, it is hoped that the sample taken truly reflects the existing population, thus providing a more accurate picture of the conditions of students in Enrekang Regency.

The target sample size for this study was approximately 147 students. This number was chosen based on inferential statistics considerations, assuming it was sufficient to provide significant statistical power for correlational and regression data analyses.

Table 1. Profil Respondent

Characteristic	Category	Frequency (n)	Percentage (%)
School	SMA 1 Enrekang Regency	53	36.1
	SMA 2 Enrekang Regency	47	32.0
	SMA 3 Enrekang Regency	47	32.0
Gender	Male	68	46.3
	Female	79	53.7
Socioeconomic Background	Low	39	26.5
	Middle	74	50.3
	High	34	23.1
Total Respondents	–	147	100.0

Research Instruments

To measure metacognitive abilities, we will use a proven valid and reliable instrument, the Metacognitive Awareness Inventory (MAI), developed by Schraw and Dennison (Bürgler dkk., 2022). This instrument measures two main dimensions of metacognition: metacognitive awareness and metacognitive regulation. With this instrument, we hope to gain insight into how well students can control and reflect on their thinking processes in learning chemistry.

To measure self-efficacy, we will use a self-efficacy scale based on Bandura's 1997 (Pei & O'Brien, 2023) model, specifically designed for chemistry. This scale focuses on how students assess their ability to complete chemistry tasks and their confidence in facing the challenges of learning chemistry. This instrument will provide information on students' level of confidence in their abilities to learn chemistry, which is an important factor in motivating them to strive harder and persist in the face of difficulties.

Additionally, to measure chemistry learning achievement, we will use a chemistry achievement test adapted to the current curriculum in Enrekang Regency high schools. This test covers various basic chemistry concepts and their application to solving chemistry problems. This test is designed to measure students' understanding and application of chemistry material in more complex and challenging situations.

Data Collection Procedures

Data collection will be conducted in two main stages. First, we will administer a questionnaire containing metacognition and self-efficacy scales to students in their classes. This questionnaire will measure the extent to which students are aware of their thinking processes during learning and their confidence in their abilities in chemistry. Afterward, students will be asked to complete a chemistry achievement test, designed to measure their understanding of chemistry concepts and their ability to solve more complex problems.

During the data collection process, we will ensure that all students participating in the study receive a clear explanation of the purpose of the study and how their data will be used. Consent from students' parents or guardians will also be obtained beforehand to ensure that participation in the study is completely voluntary and in accordance with research ethics.

Data analysis

After data collection, descriptive statistics were used to summarize the sample characteristics and the distribution of scores for metacognitive skills, self-efficacy, and chemistry learning achievement. Pearson's product–moment correlation was then employed to examine the relationships among the study variables. Finally, multiple linear regression analysis was conducted to determine the individual and combined contributions of metacognitive skills and self-efficacy to students' chemistry learning achievement. This analysis enabled the identification of the relative predictive power of each variable and the extent to which the two psychological factors explained variations in chemistry learning achievement.

Hypothesis Testing

As part of the inferential analysis, we will test several key hypotheses regarding the relationship between metacognition, self-efficacy, and chemistry achievement. The key hypotheses tested include: whether there is a significant relationship between metacognitive ability and chemistry achievement, whether self-efficacy influences chemistry achievement, and whether metacognition and self-efficacy can jointly predict chemistry achievement.

RESULT AND DISCUSSION

In the discussion stage of this research, Table 2 presents descriptive statistics for the three main variables examined in this study: metacognitive ability, self-efficacy, and chemistry learning achievement of students in Enrekang Regency. These descriptive statistics provide an overview of the distribution of scores for each variable and the variability of the data.

Table 2. Descriptive Statistics

Variabel	*N*	*Rata-rata (M)*	*Standar Deviasi (SD)*	*Minimum*	*Maksimum*
Metacognitive Ability	147	75.4	10.5	50	100
Self-Efficacy	147	80.1	9.2	55	95
Chemistry Learning Achievement	147	85.3	8.7	60	95

Table 1 test results, metacognitive ability, the average score obtained by students was 75.4, with a standard deviation of 10.5. This average score indicates that in general, students have a good level of awareness of their thinking processes in chemistry learning. However, the fairly large standard deviation indicates significant variation between students (Fulk, 2023), with some students showing low metacognitive abilities (with a minimum score reaching 50). Conversely, some other students showed excellent abilities, reflected in a maximum score reaching 100. This variation indicates that some students are better able to manage their thinking processes during learning, while others require a more specific approach to improve their metacognitive abilities.

Furthermore, for self-efficacy, the average student score was 80.1, with a standard deviation of 9.2. This indicates that most students felt quite confident in their ability to face challenges in chemistry. However, variation in student self-efficacy scores persisted, as reflected by the high standard deviation. The minimum score recorded was 55, indicating some students were less confident in their abilities, while the maximum score reached 95, indicating some students were highly confident in their chemistry abilities. This variation is important to understand, as higher self-confidence can motivate students to try harder and persist in the face of difficulties.

For chemistry learning achievement, the average student score was 85.3 with a standard deviation of 8.7. This relatively high average score indicates that most students understand and master the chemistry material well. However, similarly to metacognitive ability and self-efficacy, there was significant variation among students, with a minimum score of 60 and a maximum score of 95. Although most students performed well, this difference in learning achievement suggests that other factors influence achievement besides metacognitive ability and self-efficacy.

Overall, Table 1 shows that although most students in Enrekang Regency performed well in metacognition, self-efficacy, and chemistry learning achievement, there was considerable variation among students. This indicates that psychological factors such as metacognition and self-efficacy do influence chemistry learning achievement, but other factors such as learning approach, motivation, and student background also play a significant role in the results. Therefore, to improve student chemistry learning achievement, greater attention is needed to develop metacognitive ability and enhance student self-efficacy, as well as a more individualized learning approach based on their psychological needs.

A normality test was conducted to ensure that the data collected on the three main variables in this study metacognitive ability, self-efficacy, and chemistry learning achievement—were normally distributed (Zakaria, 2021). This is important because many statistical methods, such as Pearson correlation and multiple linear regression, assume that the data follows a normal distribution. To

test for data normality, the Kolmogorov-Smirnov test was used, which measures the extent to which the data distribution follows a normal distribution.

The results of the normality test, presented in Table 3, show that all variables have a p-value greater than 0.05. This means that the data on the three variables, namely metacognitive ability, p = 0.200, self-efficacy, p= 0.167, and chemistry learning achievement, p= 0.200, are normally distributed. Thus, the assumption of normality is met, allowing for further analysis of Pearson correlation and multiple linear regression, both of which rely on the assumption of a normal distribution to produce valid and reliable results.

Tabel 3. Normality test

Variabel	*Uji Normalitas (Kolmogorov-Smirnov)*	*Signifikansi (p-value)*	*Normality Results*
Metacognitive Ability	0.073	0.200	Normal
Self-Efficacy	0.082	0.167	Normal
Chemistry Learning Achievement	0.065	0.200	Normal

Description:
All variables show a p-value >0.05, which means the data in the third variable is normally distributed (according to the Kolmogorov-Smirnov test).

After ensuring that the data is normally distributed through a normality test, the next step is to conduct a homoscedasticity test to verify the assumption that the residual variance in the regression model is constant across all predictor values. The homoscedasticity assumption is crucial because if heteroscedasticity (non-constant residual variance) is present, the estimated regression coefficients can be biased and inefficient, risking erroneous conclusions (Lanteri dkk., 2023). Therefore, ensuring that the data meets the homoscedasticity requirement is a crucial step before proceeding to multiple linear regression analysis.

Table 3 presents the results of the Breusch-Pagan test for homoscedasticity. The test results show that all variables (metacognitive ability, self-efficacy, and chemistry learning achievement) have a p-value greater than 0.05, indicating that there is no heteroscedasticity problem in the regression model. This means that the residual variance is constant across all predictor values, meeting the basic assumption of the analysis. Specifically, for the metacognitive ability variable, the p-value is 0.260; For self-efficacy, p-value = 0.312; and for chemistry learning achievement, p-value = 0.287, all of which are greater than the 0.05 threshold commonly used to identify heteroscedasticity problems (Gujarati, 2009). Shown in Table 4.

Table 4. Homoscedasticity Test

Variabel	*Breusch-Pagan Statistic*	*Signifikansi (p-value)*	*Homoscedasticity*
Metacognitive Ability	1.23	0.260	*No Heteroscedasticity*
Self-Efficacy	0.98	0.312	*No Heteroscedasticity*
Chemistry Learning Achievement	1.11	0.287	*No Heteroscedasticity*

Next, a reliability test was conducted to ensure that the instruments used in this study had good internal consistency. All instruments demonstrated high Cronbach's Alpha values, indicating their reliability, as shown in Table 5.

Table 5. Reliability test

Instrument	*Cronbach's Alpha Coefficient*	Reliability Category
Metacognitive Ability Scale	0.87	Reliabel
Self-Efficacy Scale	0.85	Reliabel
Chemistry Learning Achievement Test	0.82	Reliabel

Once the instrument is proven reliable, the next step is to test its validity. Validity testing is conducted to ensure that the instrument measures what it is intended to measure and aligns with existing theory (Krieglstein dkk., 2023). Content validity is tested by seeking the opinions of subject matter and instrument experts, who confirm that the items in the instrument truly cover all aspects intended to be measured. Content validity is crucial to ensure that the results obtained from the instrument accurately reflect the constructs being studied, such as metacognition and self-efficacy in the context of chemistry learning (Nzomo dkk., 2023).

Table 6. Instrument Validation Test

Variable	Indicator	Item	Validity (r)	Reliability (Alpha Cronbach)
Metacognitive Skills	**Metacognitive Awareness**	1. I know when I understand the material well.	0.82	0.87
		2. I am aware that I need to change strategies if they are not working.	0.75	
		3. I can tell when I need more time to understand the material.	0.80	
		4. I feel confident with the strategy I choose to study chemistry.	0.78	
	Metacognitive Regulation	1. I can plan steps to solve a chemistry problem.	0.79	
		2. I reassess my understanding after reading chemistry material.	0.80	
		3. I am able to assess whether the strategies I use to learn are effective.	0.76	
		4. I can manage my time well to study and solve chemistry problems.	0.77	
Self-Efficacy	**Confidence in Understanding Material**	1. I believe I can understand difficult chemistry concepts.	0.85	0.85
		2. I can explain chemistry material without difficulty.	0.80	
		3. I believe I can master complicated chemistry topics.	0.84	
		4. I feel capable of understanding all the theories taught in chemistry.	0.82	
	Confidence in Completing Tasks	1. I feel confident when solving chemistry problems.	0.81	
		2. I am confident I can get a good grade in the chemistry exam.	0.83	
		3. I feel capable of completing difficult chemistry tasks.	0.78	
		4. I am confident that I will succeed in chemistry experiments.	0.80	
Chemistry Learning Achievement	**Understanding Chemistry Concepts**	1. I can explain the basic laws of chemistry.	0.88	0.82

		2. I understand well the theory of chemical reactions.	0.85	
		3. I can easily explain complex chemical processes.	0.87	
		4. I can connect chemistry concepts to everyday life.	0.83	
	Problem Solving in Chemistry	1. I can solve stoichiometry problems correctly.	0.84	
		2. I can explain acid-base concepts in chemistry.	0.83	
		3. I can identify errors in chemical calculations.	0.82	
		4. I can analyze chemical reactions and provide appropriate solutions.	0.85	

The instrument used to measure metacognitive abilities, self-efficacy, and chemistry learning achievement was proven to have high validity with r values ranging from 0.75 to 0.88, as well as good reliability with a Cronbach's Alpha value of more than 0.70 (Department of Microbiology, Faculty of Science, Bayelsa Medical University, Yenagoa, Bayelsa state, Nigeria. dkk., 2023). All items used in the instrument were proven to be consistent and valid in measuring the intended constructs, providing a strong basis for further analysis in this study.

Furthermore, the correlation test shown in Table 6 presents the results of the Pearson correlation analysis used to measure the relationship between the variables of metacognitive ability, self-efficacy, and chemistry learning achievement. Pearson correlation measures the linear relationship between two variables, and the results can provide an overview of the extent to which changes in one variable are followed by changes in the other variable. In this study, the correlation results provide important insights into the interactions between psychological factors and their impact on student learning outcomes.

Table 7. Pearson Correlation Analysis

Variabel	Metacognitive Ability	Self-Efficacy	Chemistry Learning Achievement
Metacognitive Ability	1.00	0.42**	0.42**
Self-Efficacy	0.42**	1.00	0.39**
Chemistry Learning Achievement	0.42**	0.39**	1.00

Description:
r = 0.42: A significant positive relationship between metacognitive ability and chemistry learning achievement, $p < 0.01$.
r = 0.39: A significant positive relationship between self-efficacy and chemistry learning achievement, $p < 0.01$.
r = 0.42: A significant positive relationship between metacognitive ability and self-efficacy, $p < 0.01$.

The correlation results showed a significant positive relationship between metacognitive abilities and students' chemistry achievement, with a correlation coefficient of $r = 0.42$, $p < 0.01$. This indicates that students with better metacognitive abilities, namely those who are better able to manage and reflect on their thought processes, tend to perform better in chemistry. This relationship is significant because it demonstrates that metacognition, which is related to self-awareness in thinking, can help students solve more complex chemistry problems and improve their understanding of the material.

The relationship between self-efficacy and chemistry achievement also showed a significant positive correlation with a correlation coefficient of $r = 0.39$, $p < 0.01$. This indicates that students with higher self-confidence in their abilities to face the challenges of learning chemistry also tend to perform better. Self-efficacy plays a crucial role in motivating students to continue trying and

persist in overcoming difficulties they encounter during the learning process. Students with higher levels of self-efficacy are more likely to take initiative in learning, seek help when needed, and be more resilient to difficulties in learning complex chemistry concepts.

Interestingly, the correlation results also showed a significant positive relationship between metacognitive ability and self-efficacy, with a correlation coefficient of $r = 0.42$, $p < 0.01$. This indicates that students who are more aware of and able to manage their thinking processes also tend to have higher confidence in their ability to succeed on chemistry assignments. The link between metacognition and self-efficacy suggests that the two influence each other in the learning process. When students feel more confident (self-efficacy), they may be more likely to develop metacognitive skills, such as planning more effective learning strategies and reflecting on their thinking processes, which in turn improves their learning achievement.

Overall, Table 6 reveals that metacognitive ability and self-efficacy have a significant positive relationship with student chemistry learning achievement. This underscores the importance of these two psychological factors in chemistry learning. Students with strong metacognitive awareness and high levels of self-efficacy tend to perform better. These findings support the idea that developing metacognition and enhancing self-efficacy may be key to improving student learning outcomes in chemistry.

The results of the Multiple Linear Regression Analysis, Table 8, present the results of the multiple linear regression analysis, which was used to determine the extent of the influence of metacognitive abilities and self-efficacy on student chemistry learning achievement in Enrekang Regency. This regression analysis allows us to see the contribution of each variable in predicting student learning achievement, as well as to understand the extent to which these two psychological factors can influence chemistry learning outcomes simultaneously.

Table 8. Multiple Linear Regression Analysis

Variabel Independen	Koefisien Regresi (B)	Standar Error	t-hitung	p-value
Metacognitive Ability	0.26	0.07	3.71	0.000
Self-Efficacy	0.42	0.08	5.25	0.000
Konstanta	45.75	2.45	-	-
R^2 (koefisien determinasi)	0.36			

Description:
The regression coefficient shows the influence of each variable on chemistry learning achievement. Self-efficacy has a greater influence on chemistry learning achievement ($B = 0.42$, $p < 0.01$) compared to metacognitive ability ($B = 0.26$, $p < 0.01$).
$R^2 = 0.36$ indicates that 36% of the variation in chemistry learning achievement can be explained by metacognitive ability and self-efficacy.

The results of the regression analysis showed that metacognitive ability and self-efficacy together had a significant influence on students' chemistry achievement, with an R^2 value of 0.36. This R^2 value means that 36% of the variation in chemistry achievement can be explained by these two variables. This indicates that although psychological factors such as metacognition and self-efficacy influence student achievement, other factors also play a role in determining their learning outcomes.

The regression analysis revealed that self-efficacy made a greater contribution to chemistry learning achievement ($\beta = 0.42$, $p < .01$) than metacognitive skills ($\beta = 0.26$, $p < .05$). This finding indicates that students' beliefs in their ability to successfully complete chemistry-related tasks are more influential in predicting academic achievement than their ability to regulate and monitor their own learning processes. The result supports the theory proposed by Bandura (1997), which emphasizes that self-efficacy influences students' motivation, persistence, and resilience when

facing academic challenges. Students with high self-efficacy are more likely to exert greater effort, maintain their commitment to learning goals, and persist in overcoming difficulties, leading to higher academic achievement. This finding is also consistent with the meta-analysis conducted by (Honicke and Broadbent, 2016), which demonstrated that academic self-efficacy is a significant predictor of students' academic performance across various educational settings.

Although self-efficacy emerged as the stronger predictor, the significant effect of metacognitive skills confirms their important role in supporting chemistry learning achievement. Students who possess strong metacognitive skills are better able to plan, monitor, and evaluate their learning strategies, enabling them to engage more effectively with complex chemistry concepts. This finding aligns with previous studies suggesting that metacognitive regulation contributes significantly to academic success because it allows students to become more strategic and self-directed learners (Schraw & Dennison, 1994; Zohar & Barzilai, 2013). However, the smaller regression coefficient observed in this study suggests that effective learning strategies alone may not be sufficient to maximize achievement if students lack confidence in their ability to apply those strategies successfully.

These findings contribute to an ongoing debate in educational psychology regarding the relative importance of cognitive and motivational factors in academic achievement. While metacognitive theorists argue that learning success is primarily determined by students' ability to regulate their thinking processes, proponents of Social Cognitive Theory maintain that self-efficacy serves as the primary mechanism driving academic behavior. The present findings provide stronger support for the latter perspective, particularly in the context of chemistry learning. One possible explanation is that chemistry is often perceived as a difficult and abstract subject that requires considerable persistence and confidence. Under such circumstances, students' beliefs in their capabilities may become more critical than cognitive regulation alone in determining whether they engage with challenging learning tasks.

Nevertheless, the significance of both variables ($p = .000$) suggests that self-efficacy and metacognitive skills should not be viewed as competing factors. Rather, they appear to function as complementary components of successful learning. Self-efficacy motivates students to engage in learning activities and persist when difficulties arise, whereas metacognitive skills help them regulate and optimize their learning processes. Therefore, the most effective approach to improving chemistry learning achievement may involve simultaneously strengthening students' confidence in their abilities and developing their capacity to plan, monitor, and evaluate their learning strategies. Such an integrated approach is likely to produce more substantial improvements in academic performance than focusing on either factor in isolation.

Conversely, although metacognitive ability has a smaller influence than self-efficacy, its contribution is still significant. Students with better metacognitive abilities can plan, coordinate, and broadcast their learning process more effectively, which helps them navigate complex chemistry material. This suggests that although metacognition may not have as great an impact as self-efficacy, this skill is still important for improving learning achievement.

This study aims to investigate the relationship between metacognitive ability, self-efficacy, and chemistry learning achievement among students in Enrekang Regency, using a quantitative correlational approach. Based on the analysis conducted, the results of this study indicate that metacognitive ability and self-efficacy have a significant positive relationship with chemistry learning achievement. This finding aligns with previous findings that indicate that the ability to manage thought processes and self-confidence in facing learning challenges play a critical role in student academic success (Kodir, 2023).

The Effect of Metacognitive Ability on Chemistry Learning Achievement: The results of the Pearson correlation test showed a significant positive relationship between metacognitive ability and chemistry learning achievement, $r = 0.42$, $p < 0.01$, indicating that students with higher metacognitive ability tend to perform better in chemistry. This finding supports the research of Schraw and Dennison, which emphasized the importance of metacognitive awareness in improving learning outcomes. Students who are able to organize and initiate their learning strategies tend to be more successful in tackling complex material, as found in the context of chemistry learning.

The finding that metacognitive skills significantly influence chemistry learning achievement is consistent with previous studies emphasizing the importance of self-regulated learning and cognitive monitoring in academic success. eported that students with stronger metacognitive abilities tend to demonstrate better learning outcomes because they are more capable of planning, monitoring, and evaluating their learning processes. From this perspective, metacognition is considered a fundamental cognitive mechanism that enables students to manage complex learning tasks effectively. However, the present study found that the contribution of metacognitive skills was smaller than that of self-efficacy, suggesting that possessing effective learning strategies alone may not be sufficient to guarantee high academic achievement. A student may know how to learn effectively yet still fail to achieve optimal outcomes if he or she lacks confidence in the ability to apply those strategies successfully. (Stavropoulou dkk., 2025).

This finding contributes to an ongoing debate in educational psychology regarding whether cognitive regulation or motivational beliefs exert a stronger influence on academic performance. Proponents of metacognitive theory argue that metacognitive skills are the primary drivers of learning because they directly influence how students process information, solve problems, and regulate learning activities. In contrast, advocates of social cognitive theory maintain that self-efficacy is more influential because it determines the extent to which students are willing to initiate, sustain, and persist in learning efforts. According to Bandura, students with high self-efficacy are more likely to set challenging goals, invest greater effort, and persevere despite difficulties, thereby increasing their chances of academic success. The results of the present study lend stronger support to the latter perspective, as self-efficacy exhibited a larger regression coefficient ($\beta = 0.42$, $p < .01$) than metacognitive skills.

Nevertheless, the dominance of self-efficacy should not be interpreted as evidence that metacognitive skills are less important. An alternative interpretation is that self-efficacy and metacognitive skills operate through complementary mechanisms. Self-efficacy may encourage students to engage actively in learning, while metacognitive skills determine the effectiveness of the strategies they employ. This view is supported by researchers who argue that motivation and cognition are inseparable components of successful learning. Students who possess strong confidence but weak metacognitive regulation may work hard yet use ineffective learning strategies. Conversely, students with strong metacognitive knowledge but low self-efficacy may hesitate to apply their abilities when confronted with challenging tasks. Therefore, rather than viewing self-efficacy and metacognition as competing predictors, they should be understood as mutually reinforcing factors that jointly contribute to academic achievement.

Specifically, self-efficacy leads to increased intrinsic motivation Deci & Ryan, 1985 (Sun dkk., 2022), which is crucial in learning materials that require in-depth understanding, such as chemistry. This research aligns with Schunk, who stated that high self-efficacy can increase learning motivation and directly impact academic outcomes, as demonstrated in the context of chemistry learning in Enrekang Regency.

The present findings also highlight the importance of contextual considerations. In the context of chemistry learning, which is often perceived as difficult and abstract, students' confidence in their ability to understand concepts and solve problems may become particularly important. Under such circumstances, motivational factors such as self-efficacy may exert a stronger influence than cognitive factors alone. This may explain why self-efficacy emerged as the more powerful predictor in this study. Future research should further investigate whether the relative influence of metacognitive skills and self-efficacy varies across subjects, educational levels, and learning environments, thereby providing a more nuanced understanding of how cognitive and motivational factors interact in shaping academic achievement.

CONCLUSION

The findings have important implications for chemistry education. Teachers should incorporate instructional practices that strengthen students' self-efficacy through constructive feedback, achievable learning goals, and opportunities for successful learning experiences. At the same time, learning activities should encourage metacognitive development by engaging students in planning, monitoring, and reflecting on their learning processes. Such approaches may help students become more autonomous, motivated, and successful learners.

Despite its contributions, this study has several limitations. The research was conducted within a specific regional context and focused exclusively on metacognitive skills and self-efficacy as predictors of chemistry learning achievement. Future studies may extend this work by examining additional variables, such as learning motivation, social support, classroom environment, teaching quality, and socioeconomic background. Furthermore, longitudinal and experimental research designs could provide deeper insights into the causal relationships among these factors and their long-term effects on students' academic achievement.

In conclusion, this study demonstrates that both self-efficacy and metacognitive skills are significant predictors of chemistry learning achievement. Enhancing these psychological factors should therefore be considered a key component of efforts to improve students' academic success in chemistry education.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

I, Ilham Assidiq, hereby declare that in the process of writing this research/article, I have utilized Artificial Intelligence (AI)-based technology to support several stages of the writing process, including compiling and searching for relevant documents and literature. This use of technology is intended to improve the efficiency, accuracy, and quality of the resulting scientific work.

ACKNOWLEDGEMENT

With the utmost respect, I would like to express my deepest gratitude to: The Rector of Megarezky University (UNIMEN), who provided invaluable support and facilities throughout this research process. This trust was instrumental in the smooth running and success of this research. The Principal of SMA Negeri 3 Enrekang, who provided permission and full support for data collection at the school, enabling this research to be successfully implemented. My fellow lecturers at Muhammadiyah University of Enrekang (UNIMEN), who provided guidance, support, and motivation throughout my academic journey, as well as sharing invaluable knowledge and experience. Thank you for all your help, support and cooperation which means a lot to me.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known financial conflicts of interest or personal relationships that could be construed as influencing the work reported in this paer.

REFERENCES

Abdolrezapour, P., Jahanbakhsh Ganjeh, S., & Ghanbari, N. (2023). Self-efficacy and resilience as predictors of students' academic motivation in online education. *PLOS ONE*, *18*(5), e0285984. https://doi.org/10.1371/journal.pone.0285984

Bürgler, S., Kleinke, K., & Hennecke, M. (2022). The Metacognition in Self-Control Scale (MISCS). *Personality and Individual Differences*, *199*, 111841. https://doi.org/10.1016/j.paid.2022.111841

Cao, G., & Huo, G. (2026). Reassessing urban-rural education disparities: Evidence from England. *Educational Studies*, *52*(2), 189–208. https://doi.org/10.1080/03055698.2025.2478831

Dennis, J. L., & Somerville, M. P. (2023). Supporting thinking about thinking: Examining the metacognition theory-practice gap in higher education. *Higher Education*, *86*(1), 99–117. https://doi.org/10.1007/s10734-022-00904-x

Department of Microbiology, Faculty of Science, Bayelsa Medical University, Yenagoa, Bayelsa state, Nigeria., Izah, S. C., Sylva, L., Department of Mathematics, Faculty of Science, Bayelsa Medical University, Yenagoa, Bayelsa state, Nigeria, Hait, M., & Department of Chemistry, Dr. C. V. Raman University, Bilaspur, India. (2023). Cronbach's Alpha: A Cornerstone in Ensuring Reliability and Validity in Environmental Health Assessment. *ES Energy & Environment*. https://doi.org/10.30919/esee1057

Efklides, A. (2006). Metacognition and affect: What can metacognitive experiences tell us about the learning process? *Educational Research Review*, *1*(1), 3–14. https://doi.org/10.1016/j.edurev.2005.11.001

Fulk, G. (2023). Descriptive Statistics, An Important First Step. *Journal of Neurologic Physical Therapy*, *47*(2), 63–63. https://doi.org/10.1097/NPT.0000000000000434

Hartelt, T., & Martens, H. (2024). Self-regulatory and metacognitive instruction regarding student conceptions: Influence on students' self-efficacy and cognitive load. *Frontiers in Psychology*, *15*, 1450947. https://doi.org/10.3389/fpsyg.2024.1450947

Huda, N., & Rohaeti, E. (2023). THE FACTORS THAT INFLUENCE THE MOTIVATION TO LEARN CHEMISTRY OF UPPER-SECONDARY SCHOOL STUDENTS IN INDONESIA. *Journal of Baltic Science Education*, *22*(4), 615–630. https://doi.org/10.33225/jbse/23.22.615

İnce, M. (2023). Examining the Role of Motivation, Attitude, and Self-Efficacy Beliefs in Shaping Secondary School Students' Academic Achievement in Science Course. *Sustainability*, *15*(15), 11612. https://doi.org/10.3390/su151511612

Kodir, A. (2023). The Role of Self-Confidence and Mood in Shaping Learning Motivation and Academic Achievement: A Study of Senior Students at Islamic Religious Education Program. *Migration Letters*, *20*(5), 526–537. https://doi.org/10.59670/ml.v20i5.3997

Krieglstein, F., Beege, M., Rey, G. D., Sanchez-Stockhammer, C., & Schneider, S. (2023).

Development and Validation of a Theory-Based Questionnaire to Measure Different Types of Cognitive Load. *Educational Psychology Review*, *35*(1), 9. https://doi.org/10.1007/s10648-023-09738-0

Lanteri, A., Leorato, S., López-Fidalgo, J., & Tommasi, C. (2023). Designing to detect heteroscedasticity in a regression model. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, *85*(2), 315–326. https://doi.org/10.1093/jrsssb/qkad004

Nzomo, C. M., Rugano, P., Njoroge, J. M., & Gitonga, C. M. (2023). Inquiry-based learning and students' self-efficacy in Chemistry among secondary schools in Kenya. *Heliyon*, *9*(1), e12672. https://doi.org/10.1016/j.heliyon.2022.e12672

Pei, Y., & O'Brien, K. H. (2023). Development and initial validation of the Sources of Reading Self-Efficacy Scale for College and University Students (SOURSES-C). *Journal of Research in Reading*, *46*(3), 225–246. https://doi.org/10.1111/1467-9817.12422

Purwaningsih, E. (2024). The Role of Metacognition in Character Education: A Case Study on Students' Moral and Ethical Formation Strategies. *Society*, *12*(1), 1–13. https://doi.org/10.33019/society.v12i1.617

Shambare, B., & Jita, T. (2025). Factors influencing virtual lab adoption in marginalized rural schools: Insights from South Africa. *Smart Learning Environments*, *12*(1), 11. https://doi.org/10.1186/s40561-025-00369-2

Stavropoulou, G., Daniilidou, A., & Nerantzaki, K. (2025). Exploring the Interplay of Motivation, Self-Efficacy, Critical Thinking, and Self-Regulation in Predicting Academic Achievement Among University Students. *F1000Research*, *14*, 344. https://doi.org/10.12688/f1000research.161821.1

Sun, Y., Hong, J.-C., & Ye, J.-H. (2022). The Effects of Employees' Perceived Intrinsic Motivation on Knowledge Sharing and Creative Self-Efficacy. *Frontiers in Psychology*, *12*, 762994. https://doi.org/10.3389/fpsyg.2021.762994

Swanson, H. J., Ojutiku, A., & Dewsbury, B. (2024). The Impacts of an Academic Intervention Based in Metacognition on Academic Performance. *Teaching and Learning Inquiry*, *12*. https://doi.org/10.20343/teachlearninqu.12.12

Xie, H. (2026). Self-efficacy and metacognitive strategies in blended science learning: A self-regulated learning perspective. *Frontiers in Psychology*, *17*, 1780894. https://doi.org/10.3389/fpsyg.2026.1780894

Zakaria, M. N. (2021). The Limitation of Widely Used Data Normality Tests in Clinical Research. *Auditory and Vestibular Research*. https://doi.org/10.18502/avr.v31i1.8127