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The Relationship Between Metacognitive Ability and Self-directed Learning of Chemistry Education Students as Prospective Teacher

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Abstract
Metacognitive ability and self-directed learning are crucial aspects to consider because good metacognitive skills are closely linked to academic success and self-directed learning. Students with strong metacognitive abilities are generally more capable of planning, monitoring, and evaluating their learning activities effectively. This study utilized a descriptive quantitative method with a correlational approach to examine the relationship between two variables: metacognitive ability and self-directed learning. The research was conducted in the Chemistry Education Program at FKIP Untan, focusing on 51 sixth-semester students for the academic year 2023/2024. Data were collected through indirect communication methods using the MAIT-18 and a self-directed learning questionnaire. The data analysis used descriptive statistical methods. The results indicated that the percentages of metacognitive ability and self-directed learning among sixth-semester Chemistry Education students were 79% and 68%, respectively. The Spearman Rank correlation test revealed a significance value of 0.478 > 0.05. Therefore, H_0 is accepted and H_a is rejected, indicating that there is no significant relationship between metacognitive ability and self-directed learning among the students of the Chemistry Education Program at FKIP Untan.

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INTRODUCTION

Chemistry is a branch of Natural Science that studies the composition, structure, properties, changes, and relationships between substances. This science is based on concepts, calculations, and experiments and is closely related to daily life. Phenomena like water, soil, and air pollution are closely tied to chemistry. Chemistry students need to master this knowledge well to become effective educators and share their learning experiences when teaching in schools (Alhayat et al., 2022).

Metacognition is a trending topic widely discussed in education because good metacognitive skills are strongly linked to academic and professional success (Sastria et al., 2023). The term "metacognition" was first introduced by John Hurley Flavell in 1976. In Greek, "metacognition" can be translated as "μεταγνώση" (metagnósi). This word consists of two elements: "meta," meaning "after," and "gnósis," meaning "knowledge." Thus, metacognition can be defined as cognition about cognition, knowledge about knowledge, or thinking about

thinking. Flavell (1976) defined metacognition as thinking about thinking or one's knowledge about their own thinking processes (Marhaendra et al., 2023).

In the context of chemistry education, metacognitive abilities play a crucial role in enhancing the effectiveness and efficiency of students' learning processes. Metacognition involves planning, monitoring, and evaluating the learning strategies used to understand complex chemistry material. For example, a student studying chemical reactions begins by planning learning strategies, setting specific goals, and choosing appropriate resources such as textbooks or educational videos. During learning, the student actively monitors their understanding through practice problems and discussions, and evaluates their grasp of the material. When facing challenges, such as difficulty with stoichiometry, the student assesses the effectiveness of their learning methods and makes necessary adjustments, such as using different learning techniques or seeking additional help. Reflecting after learning, such as evaluating test results and identifying areas for improvement, is also a key aspect of metacognition. Thus, applying metacognition helps students more aware of their learning processes, identify obstacles, and adopt more effective strategies to understand and apply chemistry concepts (Iskandar, 2014).

Students with strong metacognitive skills are generally better at planning, monitoring, and evaluating their learning activities effectively. This is supported by research (DN et al., 2022), which indicates that good metacognitive abilities improve learning outcomes. Metacognitive skills include aspects such as declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, and evaluation (Sastria et al., 2023). Metacognitive skills and self-directed learning are crucial aspects to consider. All levels of education, including higher education, significantly contribute to the development of metacognitive abilities and student autonomy (Sastria et al., 2023). Metacognitive skills involve awareness and self-regulation in planning, monitoring, and evaluating cognitive activities. In self-directed learning with metacognitive skills, students are aware of their own learning processes, including their abilities, strategies, and learning goals. Self-directed learning is a positive mental attitude where individuals feel comfortable planning to achieve goals by optimally positioning themselves and evaluating themselves and their surroundings (Kurnia Bungsu et al., 2019).

Meanwhile, (Santoso et al., 2023) define self-directed learning as an internal drive to engage in learning activities confidently and independently, believing in one's own abilities and completing learning tasks without involving others. It is a fundamental part of the learning process aimed at achieving effective learning goals. Self-directed learning involves aspects such as self-confidence, initiative, responsibility, motivation, discipline, and independence from others (Permata et al., 2022). Metacognitive skills face several challenges, including the perception that educators are the primary knowledge sources, leading students to be passive recipients of information. Many students lack metacognitive skills, contributing to low critical thinking abilities and unpreparedness for self-directed learning (Iskandar, 2014). This reliance on educators without independent efforts hinders students' development of self-directed learning and critical thinking. Empowering metacognition in the learning process can address these issues (Alkadrie et al., 2015).

Metacognition and self-directed learning are interrelated and interact complexly in education. Metacognition, involving awareness and management of cognitive processes, underpins self-directed learning the ability to organize and take initiative in one's own learning. Metacognitive skills help students plan, manage, monitor, and adjust their learning strategies, thus enhancing their independence. Conversely, self-directed learning strengthens metacognition by encouraging students to take full responsibility for their learning, increasing their self-awareness and motivation to apply effective metacognitive strategies. Research shows that metacognitive skills and self-directed learning reinforce each other, with metacognition supporting the development of independence and vice versa (Asmawati et al., 2019).

Understanding the relationship between metacognitive abilities and self-directed learning is crucial for the Chemistry Education program at FKIP Untan due to their significant impact on learning quality and effectiveness. Metacognitive skills, which involve awareness and management of cognitive processes, enable students to plan, monitor, and evaluate their learning strategies, while self-directed learning refers to their ability to manage learning independently. In Chemistry Education, a deep understanding of these interactions can aid in designing more effective curricula and teaching strategies. Students with strong metacognitive skills and high levels of self-directed learning are likely to handle complex chemistry material better, manage their time more efficiently, and achieve better academic results. Additionally, exploring this relationship can provide valuable insights for developing training programs for future chemistry teachers, ensuring they master chemistry content and develop the metacognitive and self-directed learning skills necessary for successful teaching and learning.

METHOD

This study aims to analyze the relationship between metacognitive abilities and self-directed learning among students in the Chemistry Education Program at FKIP Untan. To achieve this objective, a descriptive quantitative method with a correlational approach is used. The descriptive quantitative method is chosen because it allows the researcher to numerically describe the characteristics of metacognitive abilities and self-directed learning. This method provides a clear picture of the data distribution and characteristics of the two variables studied, allowing the researcher to detail the profiles of students' metacognitive abilities and self-directed learning. The correlational approach is used to measure the strength and direction of the relationship between metacognitive abilities and self-directed learning without manipulating variables. This approach helps determine whether there is a significant relationship between the two variables and the extent to which one variable affects the other. Thus, the researcher can find out if students with higher metacognitive abilities tend to have greater self-directed learning. The results of this study are expected to provide valuable insights for designing more effective educational strategies, evaluating existing programs, and offering useful information for curriculum development, with the goal of enhancing students' self-directed learning through improved metacognitive skills.

The research was conducted in the Chemistry Education Program at FKIP Untan, focusing on 51 sixth-semester students for the 2023/2024 academic year. Sixth-semester students were chosen as research subjects because they have completed PLP 2 and gained direct teaching experience in the classroom. This experience provides them with a deeper understanding of the teaching and learning process and more mature metacognitive skills compared to first-semester students. With this practical involvement, they are not only better prepared to apply learning strategies but can also offer a more comprehensive insight into how metacognitive abilities affect their self-directed learning. Therefore, sixth-semester students are an ideal group for this study, as their relevant experience and developed skills enable a more accurate and in-depth analysis of the relationship between metacognitive abilities and self-directed learning.

The data collection technique used in this study is indirect communication. This technique involves collecting data through intermediaries or specific tools designed by the researcher to obtain information from respondents. Data is collected using a questionnaire. The MAIT-18 questionnaire is used to measure students' metacognitive abilities. This questionnaire is divided into two main components: metacognitive knowledge and metacognitive regulation. The MAIT-18 consists of 18 statement items that have been validated by (Kallio et al., 2017) and used in research by (Sumila et al., 2023). Validation was conducted by calculating the Cronbach's alpha value, with the results indicating good consistency, with an alpha value of $0.90 > 0.60$. The structure of the metacognitive ability questionnaire can be seen in Table 1.

Table 1. Metacognitive Ability Questionnaire Structure

No.	Metacognitive Ability Aspect	Statement Items	Total
1.	Declarative Knowledge	1, 2, 3	3
2.	Procedural Knowledge	4, 5, 6	3
3.	Conditional Knowledge	7, 8, 9	3
4.	Planning	10, 11. 12	3
5.	Monitoring	13, 14, 15	3
6.	Evaluation	16, 17, 18	3
Total			**18**

The instrument uses a Likert scale ranging from strongly agree to strongly disagree. The MAIT-18 scores are detailed in Table 2.

Table 2. MAIT-18 Scoring

Statement	Score
SS = Strongly Agree	4
S = Agree	3
TS = Disagree	2
STS = Strongly Disagree	1

Source : Sumila et al., (2023)

The data from the questionnaire was analyzed by percentage formula to determine the level of students' metacognitive abilities.

$$\mathrm{N} = \frac{\text{Total Score}}{\text{Maximum Score}} \text{ x } 100\%$$

The categories for metacognitive abilities can be seen in Table 3.

Table 3. Metacognitive Ability Categoris

Percentage (%)	Category
82 - 100	Very Good
63 – 81	Good
44 – 62	Fair
25 – 43	Less

Source: Sumila et al., (2023)

Self-directed learning is measured using a questionnaire covering six aspects: self-confidence, initiative, responsibility, motivation, discipline, and independence from peers or others. The questionnaire consists of 23 statement items that have been validated (Permata et al., 2022). The validity test results show that $r_{count} > r_{table}$, with r_{table} being 0.367 and a reliability coefficient of 0.906. The structure of the self-directed learning questionnaire can be seen in Table 4.

Table 4. Self-Directed Learning Questionnaire Structure

No.	Self-Directed Learning Aspect	Statement Items	Total
1.	Self-Confidence	1, 2, 3	3
2.	Initiative	4, 5, 6, 7	4
3.	Responsibility	8, 9, 10	3
4.	Motivation	11, 12, 13, 14	4
5.	Discipline	15, 16, 17, 18, 19, 20	6
6.	Independence from Peers or Others	21,22, 23	3
Total			**23**

The instrument uses a Likert scale ranging from always to never. The scoring for the self-directed learning questionnaire is detailed in Table 5.

Table 5. Self-Directed Learning Questionnaire Scoring

Statement	Score
Always	4
Often	3
Rarely	2
Never	1

Source: Permata et al., (2022)

Next, the data from the questionnaire is analyzed to determine the level of students' self-directed learning by calculating the percentage using the formula:

$$N = \frac{\text{Total Score}}{\text{Maximum Score}} \text{ x } 100\%$$

The categories for self-directed learning among students in the Chemistry Education Program at FKIP Untan can be seen in Table 6.

Table 6. Percentage of Self-Directed Learning Levels

Percentage (%)	Category
86 – 100	Very High
71 – 85	High
51 - 70	Medium
0 – 50	Low

Source: Permata et al., (2022)

The data analysis technique was performed using descriptive statistical methods with SPSS version 27. The collected data was first tested for prerequisites before hypothesis testing. Prerequisite testing is used to determine the significance of the relevance between the variables used, with a significance level or error rate of 5%. The Kolmogorov-Smirnov test is a non-parametric statistical method used to check whether the collected data follows a normal distribution. This test is important for determining the suitability of the data before conducting further analysis, such as correlation or regression analysis, which often requires the assumption of normal distribution. The decision criteria for the Kolmogorov-Smirnov test are: If p-value > 0.05: The data is normally distributed. Parametric analysis such as Pearson's correlation test can be used; If p-value < 0.05: The data is not normally distributed. Consider using non-parametric methods.

The Spearman Rank Correlation test is a non-parametric statistical technique used to evaluate the strength and direction of the relationship between two ordinal variables or between two variables that do not meet the normality assumption. This test measures how well the relationship between two ranks of data is. The decision criteria for the Spearman Rank test are: If p-value > 0.05: There is not enough evidence to reject H_0. This indicates that there is no significant relationship between metacognitive ability and students' self-directed learning; If p-value < 0.05: There is enough evidence to reject H_0. This indicates a significant relationship between the two variables. The categories of correlation explained according to Table 7.

Table 7. Categories of Correlation Coefficients

Interval Coefficient	Level of Relationship
0,00 – 0,199	Very Low
0,20 – 0,399	Low
0,40 – 0,599	Medium
0,60 – 0,799	Strong
0,80 – 1,000	Very Strong

Sumber: (Sugiyono, 2016)

RESULTS AND DISCUSSION

The study on the relationship between metacognitive abilities and self-directed learning involves 51 students from the Chemistry Education Program at FKIP Untan who are currently in their sixth semester for the academic year 2023/2024.

Analysis of Students' Metacognitive Abilities

Metacognitive ability refers to the awareness and regulation of one's own thinking processes, including planning, monitoring, and evaluating learning strategies. In the context of education, metacognitive ability plays a crucial role in enhancing the effectiveness of student learning. This ability encompasses two main components: metacognitive knowledge and metacognitive regulation.

Based on the analysis of the metacognitive ability levels among sixth-semester students in the Chemistry Education Program at FKIP Untan, the results show that 18 students have a metacognitive ability level categorized as very good, accounting for 35%. Meanwhile, 33 other students have a metacognitive ability level categorized as good, representing 65%. There are no students whose metacognitive ability level falls into the sufficient or poor categories. The analysis results show that, overall, the metacognitive abilities of students are categorized as "Good," with an average percentage of 79%. This finding indicates that students can effectively implement declarative, procedural, and conditional knowledge, as well as plan, monitor, and evaluate their learning activities effectively. This result is consistent with the research by (Sumila et al., 2023), which revealed that prospective Chemistry Education teachers have a positive attitude towards metacognition, contributing to their teaching effectiveness and positive impact on students. Meanwhile, the study by (Ghofar & Wicaksono, 2018) shows that good metacognitive abilities enhance students' attention to learning strategies that align with their characteristics. Thus, strong metacognitive abilities reinforce skills and support better personal and academic development. The level of metacognitive ability of students in the Chemistry Education Program at FKIP Untan can be seen in Table 8.

Table 8. Percentage of Students' Metacognitive Ability Levels (N=51)

Interval (%)	Category	%	Frequency
82 - 100	Very Good	35	18
63 – 81	Good	65	33
44 – 62	Fair	0	0
25 – 43	Poor	0	0
Total		**100**	**51**

The analysis results in Table 9 show that the indicators of declarative and procedural knowledge fall into the "Very Good" category, with percentages of 83% and 80%, respectively. Meanwhile, conditional knowledge, planning, monitoring, and evaluation are categorized as "Good," with percentages ranging from 76% to 79%. This data indicates that students have a solid understanding of various aspects of metacognitive abilities, but there is potential to improve specific aspects, such as monitoring, to approach the "Very Good" category.

Table 9. Percentage of Metacognitive Ability Criteria (N=51)

No.	Metacognitive Ability Indicator	(%)	Category
1.	Declarative Knowledge	83	Very Good
2.	Procedural Knowledge	80	Very Good
3.	Conditional Knowledge	79	Good
4.	Planning	78	Good
5.	Monitoring	76	Good
6.	Evaluation	78	Good
Average		**79**	**Good**

The first indicator of metacognitive ability, declarative knowledge, shows a percentage of 83% with a "Very Good" category. Items reflecting this indicator include: 1) I am aware of the strengths and weaknesses in my teaching; 2) I know what skills are most important to be a good teacher; and 3) I know what I should teach. This finding indicates that students have a good awareness of important aspects of their teaching, necessary skills for effective education, and relevant material to teach.

The second indicator, procedural knowledge, records a percentage of 80% with a "Very Good" category. Items related to this indicator include: 1) I have specific reasons for choosing each teaching technique I use in class; 2) I know what teaching techniques I use while teaching; 3) I use appropriate and useful teaching techniques. This result shows that students have a high level of understanding of their teaching procedures and the ability to select and apply appropriate and effective techniques in teaching contexts.

The third indicator, conditional knowledge, shows a percentage of 79% with a "Good" category. Items related to this indicator include: 1) I use my strengths to offset my weaknesses in teaching; 2) I can motivate myself to teach when I really need to; 3) I use different teaching techniques depending on the situation. This finding suggests that students have a good understanding of how to leverage their strengths to address weaknesses, adapt teaching techniques to various situations, and self-motivate when needed.

The fourth indicator, planning, records a percentage of 78% with a "Good" category. Items reflecting this indicator include: 1) I manage my pace while teaching to ensure enough time; 2) I set specific teaching goals before I start teaching; 3) I organize my time to achieve my teaching goals as effectively as possible. This result indicates that students have good planning skills, including time management and setting clear goals to enhance their teaching effectiveness.

The fifth indicator, monitoring, shows a percentage of 76% with a "Good" category. Items related to this indicator include: 1) I periodically ask myself if I am meeting teaching goals while teaching; 2) I am confident that I have assessed the usefulness of the teaching techniques I use while teaching; 3) I regularly check how well my students understand the topic while teaching. This finding suggests that students have good monitoring abilities, routinely assessing their teaching goals, the effectiveness of techniques used, and students' understanding to ensure successful learning processes.

The sixth indicator, evaluation, shows a percentage of 78% with a "Good" category. Items related to this indicator include: 1) I ask myself how well I have achieved teaching goals after I finish teaching; 2) I ask myself if I can use different techniques after each teaching experience; 3) I ask myself if I have considered all possible techniques after teaching something. This result indicates that students consistently evaluate the effectiveness of their teaching, consider different techniques, and ensure that they have explored all possible methods to improve their teaching quality.

Analysis of Students' Self-Directed learning

Self-directed learning is a key component in education that refers to an individual's ability to effectively manage and regulate their own learning process. This concept encompasses several important aspects, including self-confidence, initiative, responsibility, motivation, discipline, and the ability to rely on oneself rather than depending on peers or others.

Based on the analysis of the self-directed learning levels among sixth-semester students in the Chemistry Education Program at FKIP Untan, the results show that 6 students have a self-directed learning level categorized as high, accounting for 12%. Meanwhile, 45 other students have a self-directed learning level categorized as moderate, representing 88%. There are no

students whose self-directed learning levels fall into the very high or low categories. The analysis results indicate that, overall, students' learning independence falls into the "Moderate" category, with an average percentage of 68%. This finding shows that students exhibit self-confidence, initiative, responsibility, as well as strong motivation and discipline without relying on others in their learning process. This result is consistent with (Astuti, 2019) study, which revealed that most counseling students have a moderate level of learning independence. However, this finding contrasts with (Adiansyah, 2022) research, which suggests that while students generally have good learning independence, there is evidence that they still need further training to enhance their initiative. The level of learning independence of students in the Chemistry Education Program at FKIP Untan can be seen in Table 10.

Table 10. Percentage of Students' Self-Directed Learning Levels (N=51)

Interval	Category	%	Frequency
86 – 100	Very High	0	0
71 – 85	High	12	6
51 - 70	Moderate	88	45
0 – 50	Low	0	0
Total		**100**	**51**

The analysis in Table 11 shows that the indicators of self-confidence and initiative each have percentages of 68% and 61%, respectively, falling into the "Moderate" category. This indicates that while students possess adequate levels of self-confidence and initiative, there is room for improvement to achieve higher learning independence. The motivation indicator also falls into the "Moderate" category with a percentage of 67%, suggesting that students' motivation is fairly stable but needs strengthening to more effectively support their learning goals. Conversely, the indicators for responsibility and independence from peers show higher percentages of 74% and 79%, respectively, categorized as "High." This indicates that students have a strong sense of responsibility and can manage their learning independently without relying on others. However, the discipline indicator has the lowest percentage at 58%, falling into the "Moderate" category, indicating that the aspect of discipline in learning still needs improvement. Overall, while some aspects of learning independence are already at a good level, there are areas, particularly discipline, that require further attention. Improving learning independence can be achieved by strengthening students' self-confidence, initiative, and motivation, and emphasizing the importance of discipline in their learning process.

Table 11. Percentage of Self-Directed Learning Criteria (N=51)

No.	Self-Directed Learning Indicator	%	Category
1.	Self-Confidence	68	Moderate
2.	Initiative	61	Moderat
3.	Responsibility	74	High
4.	Motivation	67	Moderat
5.	Discipline	58	Moderate
6.	Not Depending on Friends or Othes	79	High
	Average	**68**	**Moderate**

The first indicator of self directed learning, self-confidence, shows a percentage of 68% with a "Moderate" category. Items related to this indicator include: 1) I feel less confident in completing assignments without asking others; 2) I dare to express opinions during group discussions; 3) I complete assignments independently even when facing difficulties. This suggests that students have moderate self-confidence in handling assignments and participating in discussions but need additional support to enhance their independence in academic challenges.

The second indicator, initiative, shows a percentage of 61% with a "Moderate" category. Items include: 1) I continue to study material until I understand it; 2) I tend to delay completing assignments; 3) I study material before class; 4) I never seek additional references outside those required by the lecturer. This indicates students have moderate initiative, with a tendency to procrastinate and lack of seeking extra resources, despite efforts to understand material and prepare for class.

The third indicator, responsibility, has a percentage of 74% with a "High" category. Items include: 1) I wait for answers from friends when I receive an assignment; 2) I complete assignments on my own; 3) I strive to finish assigned tasks. This shows that students exhibit a high level of responsibility in completing and finishing assignments independently, though there is some tendency to wait for help from peers.

The fourth indicator, motivation, shows a percentage of 67% with a "Moderate" category. Items include: 1) I do not ask the lecturer if I don't understand the material; 2) I study regularly to achieve good results; 3) I do not set minimum target grades for exams; 4) I strive to meet my self-set grade targets. This indicates moderate motivation, with regular study efforts and goal-setting, though there is a tendency to avoid asking lecturers and not always proactively setting minimum grade targets.

The fifth indicator, discipline, shows a percentage of 58% with a "Moderate" category. Items include: 1) I often choose to play rather than study; 2) I study whenever I have free time; 3) I am not punctual in submitting assignments; 4) I never have a study schedule at home; 5) I always focus during lectures; 6) I study daily even without exams. This indicates moderate discipline, with a tendency to engage in non-academic activities and lack of a regular study schedule, though students make an effort to study consistently and remain focused during class.

The sixth indicator, not relying on others, shows a percentage of 79% with a "High" category. Items include: 1) I trust the answers to my assignments; 2) I always seek help from others for difficult problems; 3) I persist in solving problems assigned by the lecturer until I find answers. This suggests a high level of independence, with students confident in their work and only seeking help when absolutely necessary.

Relationship Between Metacognitive Ability and Learning Autonomy Among Students of the Chemistry Education Program at FKIP Untan

Normality Test

The normality test used the non-parametric Kolmogorov-Smirnov statistical test. The results are as follows: metacognitive ability: The significance value is 0.027 < 0.05. This indicates that the metacognitive ability variable does not follow a normal distribution dan self directed learning: The significance value is 0.200 > 0.05. This indicates that the learning autonomy variable follows a normal distribution. Detailed results of the normality tests for both variables are presented in Table 12.

Table 12. Results of the Normality Test (SPSS)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kemampuan Metakognitif	0,132	51	0,027	,943	51	0,017
Kemandirian belajar	0,089	51	0,200*	,981	51	0,596

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Correlation test

In this study, to test the relationship between metacognitive abilities and learning independence among students in the Chemistry Education Program at FKIP Untan, a non-parametric Spearman Rank correlation test was conducted using SPSS Version 27. This test was selected because the data analyzed did not meet the normal distribution assumption, making it appropriate for measuring the strength and direction of the relationship between ordinal variables.

The Spearman Rank correlation test results showed a correlation coefficient of 0.102 with a significance value (p-value) of 0.478. Since the p-value is greater than the significance level used (0.05), there is not enough evidence to reject the null hypothesis (H_0), which states that there is no significant relationship between metacognitive abilities and learning independence among students. Thus, the alternative hypothesis (H_a), suggesting a significant relationship, is rejected. The results of the Spearman Rank correlation test can be seen in Table 13.

Table 13. Spearman Rank correlation test (SPSS)

			Kemampuan Metakognitif	Learning Independence
Spearman's rho	Metacognitive Ability	Correlation Coefficient	1,000	0,102
		Sig. (2-tailed)	.	0,478
		N	51	51
	Learning Independence	Correlation Coefficient	0,102	1,000
		Sig. (2-tailed)	0,478	.
		N	51	51

Overall, this analysis indicates that there is no significant relationship between metacognitive abilities and learning independence among the sampled students. This suggests that other factors might play a more crucial role in determining students' learning independence, or the effect of metacognitive abilities on learning independence may not be strong enough to be detected in this study.

The findings imply that students' learning independence may be influenced by external factors not directly related to metacognitive abilities. Factors such as personal motivation, social support from peers, family, or instructors, as well as time management and learning strategies, could be significant in determining students' independence. Research by Sugianto et al. (2020) suggests that these factors might have a greater impact on how students manage their learning independently than metacognitive abilities alone. Therefore, further exploration is essential to identify other influencing factors and how these elements interact in the higher education context. A comprehensive mapping of these factors could aid in designing more effective educational interventions to enhance students' learning quality.

CONCLUSION

Based on the research and discussion, it can be concluded that the percentage of metacognitive ability and learning independence among students in the Chemistry Education Program at FKIP Untan are 79% and 68%, respectively. The Spearman Rank correlation test results show a significance value of 0.478 > 0.05. Therefore, the null hypothesis (H_0) is accepted and the alternative hypothesis (H_a) is rejected, indicating that there is no significant relationship

between metacognitive abilities and learning independence among students in the Chemistry Education Program at FKIP Untan.

RECOMMENDATIONS

Considering the research result, it's still need to conduct further research with a larger and more diverse sample to strengthen the findings on the relationship between metacognitive ability and self-directed learning. Other factors that may affect the relationship between metacognitive ability and self-directed learning must be explored. Learning strategies that are effective in developing metacognitive abilities with student self-directed learning is need to be developed.

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