Al-Ishlah: Jurnal Pendidikan
Vol.15, 4 (December, 2023), pp. 5893-5903
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v15i4.4527

The Effect of Metacognition Awareness on the Critical Thinking Skills of Elementary School Prospective Teachers

Chumdari[1], Idam Ragil Widianto Atmojo[2], Roy Ardiansyah[3], Aisyah Shintawati[4]

[1] Universitas Sebelas Maret, Surakarta, Indonesia; chumdari@staff.uns.ac.id
[2] Universitas Sebelas Maret, Surakarta, Indonesia; idamragil@fkip.uns.ac.id
[3] Universitas Sebelas Maret, Surakarta, Indonesia; royardiansyah@staff.uns.ac.id
[4] Universitas Sebelas Maret, Surakarta, Indonesia; aisyahshinta@student.uns.ac.id

ARTICLE INFO

Keywords:

metacognitive awareness;
critical thinking;
PGSD students

Article history:

Received 2023-08-08
Revised 2023-10-23
Accepted 2023-12-20

ABSTRACT

The ability to engage in critical thinking is crucial for students to effectively navigate the challenges of contemporary society. Metacognition awareness is a key indicator of an individual's critical thinking abilities. Metacognitive awareness can enhance one's cognitive control by incorporating critical thinking to regulate the thinking process. This study aimed to examine the impact of metacognitive awareness on the critical thinking abilities of PGSD (Primary School Teacher Education) students at Universitas Sebelas Maret during the 2022/2023 academic year. This study employed a quantitative methodology known as associative research. The study's population consisted of second-semester students who were selected using cluster random selection as the sampling technique. The study employed data analysis approaches that encompassed descriptive statistical analysis as well as inferential statistics, which involved doing preliminary analysis tests and hypothesis testing. The study's findings were determined by a significance test of the regression coefficient (T-test). The results indicated that the calculated t-value (2.049) was greater than the critical t-value (1.982), and the significance level (Sig.) of 0.042 was less than the threshold of 0.05. The multiple linear regression coefficient exhibited a positive value of 0.384, signifying a unidirectional link. The heightened awareness of metacognition led to a subsequent improvement in critical thinking abilities, with a determination coefficient of 20%. The findings demonstrated that the metacognitive awareness had an impact on the critical thinking abilities of PGSD students at Universitas Sebelas Maret during the 2022/2023 academic year.

Corresponding Author:
Idam Ragil Widianto Atmojo
Universitas Sebelas Maret, Surakarta, Indonesia; idamragil@fkip.uns.ac.id

1. INTRODUCTION

In the 21st century, a workforce that is of high quality and able to compete globally is needed (Nuraini, 2017). Rapid technological developments and global competition in the 21st-century demand that everyone must have life skills, both in the fields of science and technology as well as knowledge to form quality human resources (M. Haviz.,2018). According to the results of a review of the Human Development Index (HDI) over five consecutive years, the quality of human resources in Indonesia is

ranked 110th out of 183 countries with an index of 0.689. Unluckily, the ranking is still below some small countries in the African continent that have become independent. It indicates that the quality level of human resources in Indonesia is still relatively low based on the data (M. Munawwarah, N. Laili, 2020). The quality of human resources in Indonesia is poor. The measurement results of the Program For International Student Assessment (PISA) from 2000 to 2018 show that the score obtained by Indonesia has decreased and shows unsatisfactory achievements. The 2018 PISA results placed Indonesia in 69th place out of 79 countries with an average score of 396 in science (OECD, 2018). Whereas, proficiency in science has an important role in equipping Indonesian students with the ability to think logically, practically, critically, analytically, systematically, and creatively. These six abilities are considered highly relevant elements of 21st-century skills (Z. Abidin and M. Tohir, 2019)

One of the important skills needed in higher education institutions is critical thinking skills, which can help students deal with complex problems in this revolutionary era (D. Wahidin and LAM Romli, 2020). These skills are at the root of the 21st-century skills needed in various aspects of everyday life (NF Wahdah, AW Jufri, 2019). Critical thinking skills are very important because they allow individuals to be more rational or logical in acting, can thoroughly analyze the information obtained, and can consistently evaluate it (W. Saputri and AD Corebima, 2020).

Research conducted by Anugraheni, (2020) shows that the critical thinking ability of Indonesian students reaches 67.19% which is classified as moderate. One of the causes of students' difficulties in developing critical thinking skills is the lack of experience in solving problems that require critical thinking skills. In addition, the lack of creativity in determining and implementing appropriate learning strategies to overcome the problems encountered can also be a contributing factor (Anugraheni, 2020).

In contrast, the research by Kamaliyah et al., (2022) revealed that for students' critical thinking skills to improve well, it is hoped that students will be able to have metacognition abilities. The existence of metacognition has the potential to develop one's critical thinking skills in the process of finding solutions and evaluating (Kamaliyah et al., 2022). Based on the data that has been presented, it can be synthesized that students' critical thinking skills are classified as low with an average percentage of 22.5%. One of the causes of low critical thinking is the low awareness of students' metacognition, metacognition as part of higher-order thinking skills, plays an important role in planning problem-solving strategies, providing levels of cognitive ability, and using the information that has been obtained to achieve the specified goals (Wahdah et al., 2016).

In addition, low critical thinking skills among Indonesian students were also found in previous studies such as (S. Kassiavera, A. Suparmi, C. Cari, 2019). The findings revealed that the level of critical thinking of students is low. The condition is strengthened by the component analysis of students who get the lowest score, namely 22.5%.

Metacognition influences the increase of one's critical thinking skills (L. Naimnule and A. Duran Corebima, 2018) because metacognition abilities involve a person's efforts to monitor and reflect on their thoughts, both factual knowledge about knowledge, tasks, goals, or oneself, as well as their strategic thinking which involves understanding how and when to use special procedures to solve problems (Ildayanti, 2017) Brown 1980 and Matlin 2009 (M. Maulana, 2017; R. Rasmawan, 2017) stated that metacognition is a control of one's own awareness of one's intentional cognitive activity. Metacognition has the most important role in solving students' cognitive problems so that students can control their awareness in thinking (taufik, 2019)

Metacognition awareness helps students to organize their thinking steps so that they can increase their self-confidence and become independent without depending on others (D. Aji Pangestuti, RT Rita Marpaung, 2019). Students who have metacognitive awareness can recognize themselves well, understand what is known and what is not known, and can choose appropriate strategies for themselves, and know when these strategies should be applied (D. Agustin, H. Widowati, 2017). People who have high metacognition can control their thinking. Therefore, they can also develop their critical thinking by developing metacognition (M. Ikhsan, S. Munzir, and L. Fitria, 2017). This is consistent with research findings showing that there is a relationship between critical thinking skills and metacognition abilities

in different fields of study (Sadeghi, MT Hassani, 2014; DEA Diella, 2014). The findings were also confirmed by several other studies (S. Arslan, 2015; Sodikin, 2014a; U. Albab, Budiyono, and D. Indriati, 2020) that suggest that metacognition influences individual success in solving problems.

Based on the aforementioned findings, it is assumed that the existence of metacognition awareness can influence students' critical thinking skills. The choice of students as research subjects was based on Piaget's cognitive theory which suggests that a person who is at the age of 12 years and over is capable of thinking abstractly and understanding various forms of argument and recognizing himself or herself (A. Kamaliyah.,2022) Accordingly, students have been able to manage themselves and their way of learning since they were in high school and even have more experiences after being university students (J. a Livingston, 1997; RS Schraw, 1994). In addition, students become more skilled in managing themselves by facing more complex problems (J. Pimvichai, S. Sanium, 2019).

This research aims to find the effect of metacognition awareness on students' critical thinking skills because metacognition awareness is believed to have the potential to assist students in making appropriate, logical, systematic decisions, and carefully considering things from various points of view(AM Amin.,2020)It is related to someone's ability to think critically, make decisions logically, and solve problems properly (I. Budi M and A. Ghofar CW, 2017).

Based on the background above, this research needs to be carried out because of metacognition awareness because a person can control and monitor his cognition to become an independent learner and can make a person hone his critical thinking process to know what to do in the future. The importance of this research is to find the effect of metacognition awareness on students' critical thinking skills. This is because metacognition awareness is believed to have the potential to assist students in making appropriate, logical, systematic decisions and considering things from various existing perspectives carefully. Metacognition awareness has an important role and is a factor in cultivating critical thinking skills.

2. METHODS

The research design used was associative research included in the quantitative approach. Associative research focused on roles, influences, and causal relationships between independent and dependent variables. The purpose of associative research is to investigate the relationship or influence between two or more variables (Sugiyono, 2017). The sample of this research was second-semester students. The sample was taken using the cluster random sampling technique. The research sample consisted of 108 students from classes 2A, 2C, and 2D majoring in PGSD at UNS Surakarta in the 2022/2023 academic year. Data collection was conducted using tests for critical thinking skills and psychological scales for metacognition awareness. The critical thinking ability test was in the form of two-tier essay questions and the metacognitive awareness scale was prepared using a Likert scale which had four answer choices which were separated into positive and negative statements. The metacognitive awareness scale instrument was adopted from the MAI questionnaire developed by (RS Schraw, 1994)

This research instrument was validated by several experts (raters) to assess content and construction aspects and then was calculated using the Aiken V formula. Initially, there were 30 critical thinking instruments, but after being validated, 4 questions failed, so 26 valid questions that would be used in this study remained. Furthermore, there were initially 54 items of metacognitive awareness, but 9 items failed, so there were only 45 valid items used in this study.

Before calculating the reliability, the instrument was tested, and then the quality of the items for the test instrument and the internal consistency test for the scale was analyzed. The analysis of the quality of the items included an assessment of the level of difficulty and the level of discriminating power of the questions (Budiyono, 2015). The value of the index difficulty level was good ≥0.30 or ≤0.70, and the discriminating power of good questions was more than 0.30 or equal to 0.30 (Budiyono, 2015). The results of the difficulty level testing of the critical thinking test items were 26 valid questions, but 1 item failed because it had a bad level of difficulty or ≤0.30 or ≥0.70. Then, the results of the

discriminating power test were 25 valid questions. The other 2 questions failed because they had bad quality or less than 0.30. From the selection stages, 23 questions were tested for reliability with the Alpha Cronbach formula. The result of the reliability of the critical thinking ability test instrument was 0.742, indicating that the instrument was reliable.

Initially, the internal test results for the consistency of the metacognitive awareness scale instrument had 45 items, but 4 items were not good enough, so 41 items were used in this study. The reliability of the metacognitive awareness scale was 0.914, meaning that the instrument was reliable. The analysis of the research data involved three main stages, namely the description of the research data, the prerequisite analysis test, and the hypothesis test. The prerequisite analysis tests included tests for normality, linearity, heteroscedasticity, and multicollinearity, while hypothesis testing included linear regression analysis, T-test, and coefficient of determination (R2) using the SPSS 25 program.

3. FINDINGS AND DISCUSSION

3.1. Findings

The results of the description of the research data variable awareness of metacognition and critical thinking skills are presented in the histograms of Figure 1 and Figure 2. as follows:

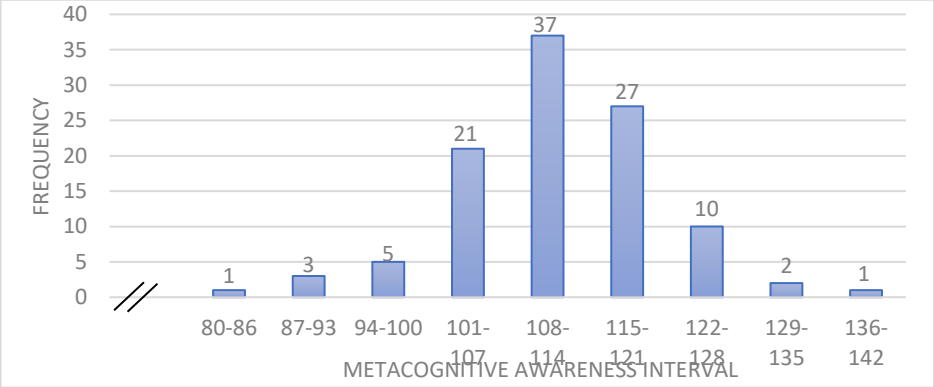

Figure 1. Metacognitive Awareness Data Description

Figure 1 interpreted that the highest frequency of metacognitive awareness scores was in the interval 108-104, while the lowest frequency was in the intervals of 80-86 and 136-142. Furthermore, a description of the data on critical thinking skills can be seen below:

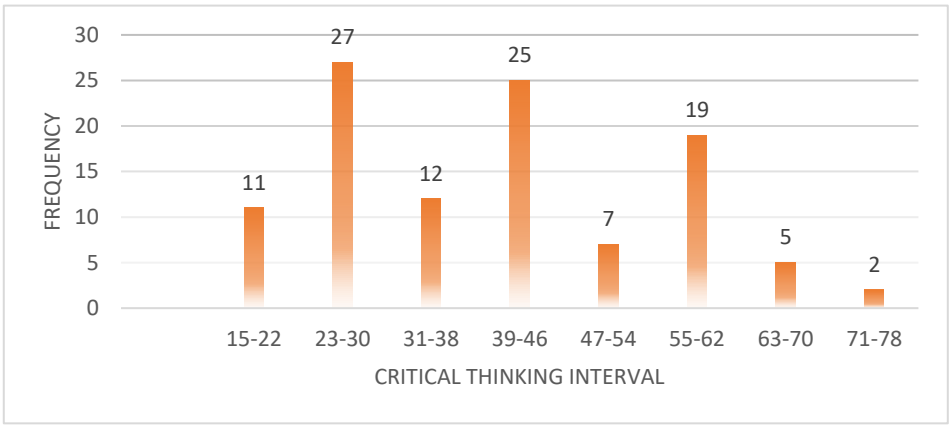

Figure 2. Data Description of Critical Thinking Ability

Figure 2. interpreted that the highest frequency of critical thinking ability scores was in the interval of 23-30, while the lowest frequency was in the interval of 71.78.

Following descriptive analysis, the data underwent tests to ensure analytical prerequisites such as normality, linearity, heteroscedasticity, and multicollinearity were met before proceeding to test the hypothesis. The normality test using the Kolmogorov-Smirnov method yielded a p-value of 0.65, which is greater than the significance level of 0.05. Therefore, it can be concluded that the study data follows a normal distribution. Moreover, the linearity test conducted on the variables of Metacognition Awareness (X) and critical thinking (Y) yielded a significant divergence from linearity with a value of 0.632. The variable demonstrated a linear association as the significance value, 0.632, was greater than the threshold of 0.05. The heteroscedasticity test yielded a result of 0.149, which exceeded the significance level of 0.05. This indicates the absence of heteroscedasticity, so satisfying one prerequisite for conducting a hypothesis test. The results of the multicollinearity test indicated that the tolerance value was larger than 0.10 and the VIF value was less than 10. Therefore, there was no occurrence of multicollinearity between the two variables in this equation. All necessary analysis requirements were fulfilled and successfully completed. Consequently, it advanced to the stage of hypothesis testing.

The results of hypothesis testing with linear regression analysis between metacognition awareness and critical thinking skills can be explained in the following table:

Table 1. The Results of Linear Regression Analysis

Variables	B	Std. Error	Beta	Sig.
Constant	7,738	15,913		0,628
Metacognitive awareness	0,292	0,142	0,195	0,042

Table 1. shows the results of the linear regression analysis, which obtained the regression equation, namely Y = 7.738 + 0.292X. This means that a constant value of 7.738 stated that the metacognition awareness variable had a value of 0, so the critical thinking variable was worth 7.738. The regression coefficient value of 0.292 was positive so it formed an unidirectional relationship, the higher the metacognition awareness, the higher the ability to think critically. It is in line with the opinion of (Agustin, et al., 2017) who stated that a student who has already had a high awareness of his metacognitive thinking patterns, implicitly can have an impact on the way students think critically and abstractly. Therefore, if the awareness of metacognition increases, the ability to think critically also increases.

The results of hypothesis testing with a significance test of the regression coefficient or T-test on the metacognition awareness variable with critical thinking skills can be explained in the following table:

Table. 2 The results of the Significance Test of the Regression Coefficient or T-test

Variables	B	Std. Error	Beta	t	Sig.
Constant	7,738	15,913		0,486	0,628
Metacognitive awareness	0,292	0,142	0,195	2,049	0,042

Table 2 showed the results of the T-test that the variable coefficient of metacognitive awareness (X) was t count = 2.049 and value (Sig.) = 0.042. The t-table value was obtained from df = n – k = 108 – 3 = 105 and using a significance limit of 5% in table T so that the t-table value was 1.982. This showed that the t-count value of 2.049 was greater than the t-table of 1.982, and the Sig. of variable X value of 0.028 was smaller than the significance level of 0.05. The results of the analysis above can be concluded that H0 was rejected, which indicates that the metacognitive awareness variable had a significant effect on the critical thinking variable.

The influence of metacognition awareness with critical thinking is also proven by the results of calculating the coefficient of determination presented in the table below:

Table 3. The Results of the Coefficient of Determination

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.140[a]	.020	.010	7.93377

Table 3 showed the results of the coefficient of determination by observing the R square value of 0.20. This means that the contribution of metacognitive awareness to critical thinking skills was 20%, while 80% of critical thinking variables were influenced by other variables which were not examined.

Hypothesis testing (Ha) showed that the regression coefficient value between the variables metacognition awareness (X1) and critical thinking ability (Y) was 0.384, which was positive, meaning that there was a unidirectional relationship. Based on the results of the data analysis, it can be seen that the t-count was greater than the t-table (1.928 <2.235) and the significance value of the regression coefficient (T-test) was smaller than the significance value (0.028 <0.05) meaning that there was a significant influence between metacognition awareness on critical thinking skills.

3.2. Discussion

The influence of metacognitive awareness on critical thinking skills was also supported by (Pimvichai et al. 2018), who stated that when people develop their metacognitive awareness, they also develop their critical thinking skills. Critical thinking enables individuals to create, change, and improve ways of thinking so they can make decisions more quickly (Maulana, 2017). Thinking is related to metacognition awareness because metacognition has two aspects. They are aspects of cognitive knowledge (declarative, procedural, and conditional knowledge) and aspects of metacognition regulation (planning, strategic information management, monitoring, and evaluation) that support students to be successful in their learning process. From these aspects, individuals are involved in critical thinking in the process of controlling their thoughts (Schraw & Dennison, 1994).

The outcomes of this study were consistent with previous research conducted by Amin et al. (2020), Naimnule and Corebima (2018), and Albab et al. (2020), which established a correlation between metacognition awareness and critical thinking. Moreover, a study conducted by Arslan (2015) found that critical thinking skill was a significant predictor of metacognition awareness. Metacognition refers to the cognitive process in which individuals actively watch and reflect upon their own thinking. This includes an awareness of factual information such as tasks, goals, and self-knowledge, as well as a strategic grasp of when and how to employ specific processes to address difficulties (Sodikin, 2014b). Through this method, students can cultivate their capacity for critical thinking, so enhancing their future learning endeavours.

The influence of metacognitive awareness on critical thinking skills was positive, meaning that if metacognitive awareness increases, critical thinking skills also increase. Agustin et al. (2017) said that a student who already has a high awareness of his metacognitive thinking patterns can implicitly influence students' thinking patterns to think critically and abstractly. Critical thinking is a high-level thinking pattern to encourage students to optimize their thinking processes. It can be optimized if someone has metacognitive awareness to change their thinking patterns into thinking patterns for their own thinking. This is in line with Pimvichai et al. (2019) who argued that when a person develops their metacognitive awareness, their critical thinking skills also develop. In this research, the higher the metacognitive awareness of students, the higher the ability to think critically. This was shown by the pattern of thinking processes.

Metacognitive awareness influences critical thinking skills because metacognition has two aspects: aspects of cognitive knowledge (declarative, procedural, and conditional knowledge) and aspects of metacognitive regulation (planning, strategic information management, monitoring, and evaluation) that support students to be successful in their learning process (Schraw, G. & Dennison, 1994). The existence of these aspects helps students to plan, sequence, and monitor the learning process to achieve

better learning results, thus helping students adapt quickly to technological developments and the demands of 21st-century competencies (Adhitama, Kusnadi, & Supriatno, 2018; Sholihah & Sofiyana, 2022).

One of the 21st-century competencies that is influenced by metacognitive awareness is critical thinking (Sholihah & Sofiyana, 2022). The opinion is supported by Keliat et al. (2021) who said that metacognition is one of the skills used in facing challenges in the 21st century. Metacognition is needed as a setting for thinking processes in learning so that one can control planning, processes, and learning to complete a task and problems encountered (Kisac & Budak, 2014). This statement is also supported by research conducted by Cakici (2018) & Hajrezayi et al. (2015) which stated that there is a relationship between metacognition and critical thinking. Metacognition awareness helps a person's critical thinking increase more easily (Cakici, 2018). In this research, student awareness in managing their thoughts which includes aspects of metacognition can shape students to have critical thinking. After students can manage cognitive knowledge and cognitive regulation, they can engage their critical thinking to carry out strategies and control their thinking.

In their research, Asy'ari et al. (2016) linked metacognition with critical and creative thinking. In addition, Asy'ari et al., (2016) argued that the characteristics of critical thinking have a close relationship with metacognition because metacognition involves self-assessment (self-regulation). Self-regulation which is always closely related to critical thinking skills and creative thinking in metacognition, includes planning, managing information, monitoring, debugging, and evaluating. If it is associated with research from Preissseisen (as quoted from Pantiwati, 2015) which reveals that metacognition is divided into four skills namely problem-solving, decision-making, critical thinking, and creative thinking. From this statement, critical thinking is one of the metacognition skills, so metacognition explicitly has a relationship with critical thinking. In this research, metacognition awareness and critical thinking have intersecting criteria. The criterion in question is that there is a similar process between the indicators of critical thinking skills and metacognition awareness, including cognition knowledge and cognition regulation.

The influence of metacognitive awareness on critical thinking skills is also related to the neuroscience learning theory by Francisco Varela. This theory emphasizes the interaction between neurological aspects and cognitive processes in learning and understanding (Schunk, 1995). The process of metacognition goes through various stages, namely emotional regulation, awareness, and monitoring of cognition processes (Fitri, 2017). Concerning neuroscientific theory, the process of higher-order thinking is a function of the prefrontal lobes (the front part of the brain), because that part is the control centre for higher-order thinking (Fitri, 2017). This section is also a place for problem-solving, regulation of emotional dimensions, character, and personality of a person. Regarding the ability to think, metacognition controls a person's thinking process, producing critical thinking skills. The development of one's metacognition in the learning process has something to do with neuroscience theory. This statement can underlie that metacognitive awareness influences critical thinking skills.

The results of this study are in line with some of the findings of previous studies, namely research conducted by Amin et al. (2020), which stated that the basis of critical thinking skills is a person's metacognition. This is in line with research from Arslan (2015), who said that one of the important predictors of metacognition awareness is critical thinking ability. Furthermore, the results of research from Naimnule & Duran Corebima (2018) also revealed that there is a positive relationship between metacognitive awareness and critical thinking skills. Then, the results of research from Albab et al. (2020) said that metacognition awareness has a positive relationship with critical thinking skills which has a contribution of 45.8%. This positive relationship indicates that metacognitive awareness has a role in developing critical thinking skills. It is also confirmed by the results of research from Gurcay & Ferah (2018) who revealed that there is a positive relationship between metacognitive awareness and critical thinking skills due to the metacognitive awareness that a person can direct and regulate his or her critical thinking abilities. The findings above strengthened the results of this study, which revealed that metacognitive awareness affects a person's ability to think critically.

Based on the results of the research above, this research provides benefits in improving students' critical thinking skills through the level of metacognitive awareness in their thinking processes that can be managed properly. Metacognition involves individual efforts to monitor and reflect on their thoughts, including an understanding of factual information such as tasks, goals, and self-knowledge, as well as a strategic understanding of how and when to use specific procedures to solve problems (Ildayanti, 2017b). It can be synthesized that metacognitive awareness affects students' critical thinking skills.

4. CONCLUSION

The relationship between metacognitive awareness and critical thinking skills of PGSD Surakarta UNS students is both good and significant. The outcome is a significance value of 0.028, which is less than the threshold of 0.05. Additionally, the tcount value exceeds the ttable value, with a tcount of 1.928 compared to a ttable of 2.235. The coefficient for multiple linear regression is 0.384, indicating a positive link. This suggests that an increase in metacognition awareness will lead to an increase in critical thinking skills. The findings of this study suggest a positive correlation between enhancing students' metacognitive awareness and improving their critical thinking abilities. Metacognitive awareness and critical thinking skills are significant aspects for lecturers and instructors to enhance their comprehension and knowledge regarding the significance of possessing metacognitive awareness and critical thinking abilities in adapting to evolving circumstances. Furthermore, this research is valuable for offering fresh insights into associated theories and expanding knowledge in line with theoretical advancements.

Acknowledgments: We would like to thank LPPM (The Institution of Research and Community Services) of Sebelas Maret University for providing opportunities for the research team and funding our research. We also thank those who assisted in this research, especially in data collection, namely undergraduate study program students of PGSD of FKIP (Faculty of Education and Teacher Training) at UNS and supporting lecturers.

Conflicts of Interest: "The authors declare no conflict of interest."

REFERENCES

A. Kamaliyah, LK Muharrami, M. Yasir, and W. H. (2022). Analysis of Metacognitive Ability of Middle School Students on Global Warming Material. *Nat. Sci. Educ. Res*, *4*(3), 258–266. https://doi.org/10.21107/nser.v4i3.9064.

Adhitama, R. S., Kusnadi, K., & Supriatno, B. (2018). Kesadaran Metakognitif Siswa dalam Pembelajaran Berbasis Proyek pada Pokok Bahasan Pencemaran Lingkungan. *Assimilation: Indonesian Journal of Biology Education*, *1*(1), 39–45. https://doi.org/10.17509/aijbe.v1i1.11455

Agustin, D., Widowati, H., & Achyani. (2017). Hubungan Kesadaran dan Regulasi Metakognitif Terhadap Kemampuan Berpikir Kritis Mahasiswa Pendidikan Biologi. *Semnasdik Fkip Univ. Muhammadiyah Metro*, 19–24.

Albab, U., Budiyono, & Indriati, D. (2020). Metacognition skills and higher order thinking skills (HOTS) in mathematics. *Journal of Physics: Conference Series*, *1613*(1). https://doi.org/10.1088/1742-6596/1613/1/012017

AM Amin, AD Corebima, S. Zubaidah, and S. M. (2020). The correlation between metacognitive skills and critical thinking skills at the implementation of four different learning strategies in animal physiology lectures,. *Eur. J. Educ. Res*, *9*(1), 143–163. https://doi.org/10.12973/eu-jer.9.1.143

Amin, A. M., Corebima, A. D., Zubaidah, S., & Mahanal, S. (2020). The correlation between metacognitive skills and critical thinking skills at the implementation of four different learning strategies in animal physiology lectures. *European Journal of Educational Research*, *9*(1), 143–163. https://doi.org/10.12973/eu-jer.9.1.143

Anugraheni, I. (2020). Analisis Kesulitan Mahasiswa dalam Menumbuhkan Berpikir Kritis Melalui Pemecahan Masalah. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 4(1), 261–267.

https://doi.org/10.31004/cendekia.v4i1.197

Arslan, S. (2015). Investigating Predictive role of Critical Thinking on Metacognition with Structural Equation Modeling. *Malaysian Online Journal of Educational Sciences*, *3*(2), 1–10.

Asy'ari, M., Prayogi, S., & Samsuri, T. (2016). Literatur reviu tentang kaitan berpikir kritis, berpikir kreatif, dan metakognisi dalam pembelajaran. *Prosiding Seminar Nasional Pusat Kajin Pendidikan Sains Dan Matematika Tahun 2016*, (March).

Budiyono. (2015). *Introduction to Assessment of Learning Outcomes, 1st ed*. Indonesia: UNS Publishing and Printing UPT (UNS Press),.

Cakici, D. (2018). Metacognitive Awareness and Critical Thinking Abilities of Pre-service EFL Teachers. *Journal of Education and Learning*, *7*(5), 116. https://doi.org/10.5539/jel.v7n5p116

D. Agustin, H. Widowati, and A. (2017). Relationship of Awareness and Metacognitive Regulation on the Critical Thinking Ability of Biology Education Students,. *Semnasdik Fkip Univ. Muhammad Metro*, 19–24. Retrieved from http://repository.ummetro.ac.id/files/semnasdik/4712feef216134e9f0830f475d9acea6.pdf

D. Aji Pangestuti, RT Rita Marpaung, and N. H. (2019). *The Effect of Discovery Learning on Student's Metacognitive Awareness and Cognitive Learning Achievement,*. *7260*(2), 52–57. Retrieved from http://ejournal.upi.edu/index.php/asimililasi

D. Wahidin and LAM Romli. (2020). Students critical thinking development in the national sciences and mathematics competition in Indonesia: A descriptive study. ," *J. Educator. IPA Indonesia.*, *9*(1), 106–115. https://doi.org/10.15294/jpii.v9i1.22240

DEA Diella. (2014). *The relationship between metacognitive abilities and critical thinking skills and scientific attitudes of class xi students on the material of the human excretory system*.

Fitri, R. (2017). Metakognitif pada Proses Belajar Anak dalam Kajian Neurosains. *Jurnal Pendidikan (Teori Dan Praktik)*, *2*(1), 56. https://doi.org/10.26740/jp.v2n1.p56-64

Gurcay, D., & Ferah, H. O. (2018). High School Students' Critical Thinking Related to Their Metacognitive Self-Regulation and Physics Self-Efficacy Beliefs. *Journal of Education and Training Studies*, *6*(4), 125. https://doi.org/10.11114/jets.v6i4.2980

Hasanpour, M., Hasanzadeh, A., Ghaedi Heidari, F., & Bagheri, M. (2015). Critical Thinking Skills of Nursing Students. *Iran Journal of Nursing*, *28*(93), 22–31. https://doi.org/10.29252/ijn.28.93.94.22

I. Budi M and A. Ghofar CW. (2017). Analysis of Critical and Metacognitive Thinking Skills of Biology Education Study Program Students. *Bioma J. Ilm. Bio*, *6*(1). https://doi.org/10.26877/bioma.v6i1.1472

Ildayanti. (2017a). ," *2017. [17] D. Aji Pangestuti, RT Rita Marpaung, and N. Hasnunidah, "The Effect of Discovery Learning on Student's Metacognitive Awareness and Cognitive Learning*.

Ildayanti. (2017b). *Hubungan Kemampuan Berpikir Kritis dan Kesadaran Mtakognitif dengan Hasil Belajar Biologi Siswa Kelas XI IPA SMA Negeri Di Kabupaten Pinrang*.

J. a Livingston. (1997). Metacognition: an overview. *Psychology*, *13*, 259–266. Retrieved from http://gse.buffalo.edu/fas/shuell/CEP564/Metacog.htm

J. Pimvichai, S. Sanium, and K. B. (2019). Exploration of Students' Metacognitive Experience in Physics Classroom. *J. Phys. Conf. Ser.*, *1340*(1). https://doi.org/10.1088/1742-6596/1340/1/012076.

Keliat, N. R., Susilo, H., Hastuti, U. S., & ... (2021). Kajian Teori-Teori Belajar Berdasarkan Sintaks Model Pembelajaran PQDiS-CSR Serta Validasi Model Pembelajaran Model PQDiS-CS: Suatu Penelitian …. … : *Jurnal Pendidikan Dan …*, 103–114.

Kisac, I., & Budak, Y. (2014). Metacognitive Strategies of the University Students with Respect to their Perceived Self-confidence Levels about Learning. *Procedia - Social and Behavioral Sciences*, *116*, 3336–3339. https://doi.org/10.1016/j.sbspro.2014.01.759

L. Naimnule and A. Duran Corebima. (2018). The Correlation between Metacognitive Skills and Critical Thinking Skills toward Students' Process Skills in Biology Learning. *J. Pedagog. Res*, *2*(2), 122–134. Retrieved from www.ijopr.com

M. Haviz, H. Karomah, R. Delfita, MIA Umar, and I. M. (2018). Revisiting generic science skills as 21st-

century skills on biology learning. *J. Educator. IPA Indonesia*, *7*(3), 355–363. https://doi.org/10.15294/jpii.v7i3.12438

M. Ikhsan, S. Munzir, and L. Fitria. (2017). Critical Thinking Ability and Student Metacognition in Solving Mathematical Problems through a Problem Solving Approach. *AKSIOMA J. Progr. Studs. Educator. Matt*, *6*(2), 234. https://doi.org/10.24127/ajpm.v6i2.991

M. Maulana. (2017). *Basic concepts of mathematics and the development of creative-critical thinking skills.* UPI Sumedang Press.

M. Munawwarah, N. Laili, and M. T. (2020). Student Critical Thinking Skills in Solving Mathematical Problems Based on 21st Century Skills. *Alifmatika J. Educator. and Learning Matt*, *2*(1), 37–58. https://doi.org/10.35316/alifmatika.2020.v2i1.37-58.

Naimnule, L., & Duran Corebima, A. (2018). The Correlation between Metacognitive Skills and Critical Thinking Skills toward Students' Process Skills in Biology Learning. *Journal of Pedagogical Research*, *2*(2), 122–134.

NF Wahdah, AW Jufri, and L. Z. (2019). "Journal of Learning as a Means of Developing Students'' Metacognition Ability." *J. Pijar MIPA*, *9*(2), 70–74.

Nuraini, N. (2017). Profile of critical thinking skills of prospective biology teacher students as an effort to prepare the 21st century generation. *J. Educator. Bio*, *1*(2), 89–96. Retrieved from https://jurnal.um-palembang.ac.id/dikbio/article/view/676

OECD. (2018). *PISA*. *24*(1), 12–17.

Pimvichai, J., Sanium, S., & Buaraphan, K. (2019). Exploration of Students' Metacognitive Experience in Physics Classroom. *Journal of Physics: Conference Series*, *1340*(1). https://doi.org/10.1088/1742-6596/1340/1/012076

R. Rasmawan. (2017). Profile of Student Critical Thinking Skills and Their Correlation with Academic Achievement Index. *EduChemia (Journal of Kim. and Education*, *2*(2), 130. https://doi.org/10.30870/educhemia.v2i2.1101.

RS Schraw, G. & D. (1994). Metacognitive Awareness Inventory (MAI). What is Metacognition? *Contemp. Educ. Psychol*, (19), 460–475. Retrieved from https://www.rcsj.edu/Tutoring-site/Gloucester-site/Documents/Metacognitive Awareness Inventory.pdf

Sadeghi, MT Hassani, and M. R. (2014). The relationship between efl learners' metacognitive strategies, and their critical thinking,. J. Lang. Teach. Res, 5(5), 1167–1175. https://doi.org/10.4304/jltr.5.5.1167-1175.

S. Arslan. (2015). Investigating Predictive role of Critical Thinking on Metacognition with Structural Equation Modeling. *Malaysian Online J. Educ. Sci*, *3*(2), 1–10.

S. Kassiavera, A. Suparmi, C. Cari, and S. S. (2019). Student Critical Thinking Skills Survey on Work and Energy Material. *Pros. SNFA (Seminar Nas. Fis. Dan Application*, *4*, 162. https://doi.org/10.20961/proceedingsnfa.v4i0.35928

Schraw, G. & Dennison, R. S. (1994). Metacognitive Awareness Inventory (MAI). What is Metacognition? *Contemporary Educational Psychology*, (19), 460–475.

Schunk, D. H. (1995). Learning Theories An Educational Perspective. In *Space Science Reviews* (Vol. 71). https://doi.org/10.1007/BF00751323

Sholihah, M., & Sofiyana, M. S. (2022). Analisis Kesadaran Metakognitif Bagi Calon Guru Di Universitas Islam Balitar. *Jurnal Pendidikan Biologi*, *12*(3), 202. https://doi.org/10.17977/um052v12i3p202-206

Sodikin. (2014a). Improvement of Student Learning Outcomes with the Group Discussion Method in Elementary School Science Learning. *UIN Maulana Malik Ibrahim*, *39*(1), 2014. Retrieved from http://dx.doi.org/10.1016/j.biochi.2015.03.025%0Ahttp://dx.doi.org/10.1038/nature10402%0Ahttp://dx.doi.org/10.1038/nature21059%0Ahttp://journal.stainkudus.ac.id/index.php/equilibrium/article /view/1268/1127%0Ahttp://dx.doi.org/10.1038/nrmicro2577%0Ahttp://

Sodikin. (2014b). PENINGKATAN HASIL BELAJAR SISWA DENGAN METODE DISKUSI KELOMPOK DALAM PEMBELAJARAN IPA SEKOLAH DASAR. *UIN Maulana Malik Ibrahim*, *39*(1), 1–15.

Sugiyono. (2017). *Quantitative, Qualitative Research Methods, and R&D*.

taufik. (2019). Differences in the Level of Self-Reflection in Student Learning at the Faculty of Medicine, University of Malahayati in 2019. *J. Malahayati*, *6*, 257–263.

U. Albab, Budiyono, and D. Indriati. (2020). Metacognition skills and higher order thinking skills (HOTS) in mathematics. *J. Phys. Conf. Ser.*, *1613*(1). https://doi.org/10.1088/1742-6596/1613/1/012017

W. Saputri and AD Corebima. (2020). The Correlation between Metacognitive Skills and Cognitive Learning Results of Biology Pre-service Teachers on Different Learnings. *J. Turkish Sci. Educ*, *17*(4), 487–503. https://doi.org/10.36681/tused.2020.40

Z. Abidin and M. Tohir. (2019). High-level Thinking Skills in Solving Two-Dimensional Arithmetic Series Based on Bloom's Taxonomy. *Alifmatika J. Educator. and Learning Matt.*, *1*(1), 44–60. https://doi.org/10.35316/alifmatika.2019.v1i1.44-60