



The Impact of Metacognition on Elementary School Students' Problem-Solving Skills in Science Learning

Fauziana^{1*}, Sarah Fazilla² 

^{1,2} Elementary School Education Department, IAIN Lhokseumawe, Lhokseumawe, Indonesia

ARTICLE INFO

Article history:

Received February 08, 2022

Accepted April 30, 2022

Available online May 25, 2022

Kata Kunci:

Kemampuan Memecahkan Masalah, Metakognisi, IPA

Keywords:

Problem Solving Skills, Metacognition, Science



This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.

Copyright © 2022 by Author. Published by Universitas Pendidikan Ganesha.

ABSTRAK

Konsep pendidikan pada jenjang pendidikan dasar berperan penting dalam pembentukan karakter dan pengembangan siswa secara kognitif, afektif, dan psikomotor. Melalui pembelajaran IPA diharapkan siswa tidak hanya mengenal konsep saja, namun diarahkan untuk mampu memecahkan permasalahan yang ada lingkungan sekitar. Namun kenyataan di lapangan menunjukkan bahwa siswa di sekolah dasar masih mengalami kesulitan untuk menyelesaikan soal analisis dalam pembelajaran IPA. Penelitian ini bertujuan untuk menganalisis pengaruh metakognisi terhadap kemampuan memecahkan masalah IPA pada siswa kelas V sekolah dasar. Metode yang digunakan dalam penelitian ini adalah metode kuantitatif. Sampel dalam penelitian ini yaitu siswa kelas 5 sebanyak 50 orang, yang dipilih dengan menggunakan teknik random sampling. Pengumpulan data dilakukan dengan menggunakan instrumen berupa angket. Metode analisis data yang digunakan adalah analisis regresi linier sederhana. Hasil penelitian menunjukkan nilai thitung lebih besar dari ttable yaitu $3.086 > 2.312$ pada taraf signifikansi $\alpha = 0.05$. Dengan demikian dapat disimpulkan bahwa terdapat pengaruh signifikan metakognisi terhadap kemampuan memecahkan masalah IPA. Implikasi dari hasil penelitian ini diharapkan dapat menjadi bahan evaluasi dan masukan bagi guru dalam memilih dan menggunakan strategi pembelajaran yang tepat sehingga mampu meningkatkan kemampuan pemecahan masalah dalam pembelajaran IPA di jenjang sekolah dasar.

ABSTRACT

The concept of education at the basic education level plays an important role in character building and students' cognitive, affective, and psychomotor development. Through science learning, it is hoped that students will not only know the concept, but are directed to be able to solve problems in the surrounding environment. However, the facts show that students in elementary schools still have difficulty solving analytical problems in science learning. This study aims to analyze the effect of metacognition on the ability to solve science problems in fifth grade elementary school students. The method used in this study is a quantitative method. The sample in this study were 50 grade 5 students, who were selected using a random sampling technique. Data was collected using an instrument in the form of a questionnaire. The data analysis method used is simple linear regression analysis. The results showed that the value of tcount was greater than ttable, namely $3,086 > 2,312$ at a significance level of $= 0.05$. Thus, it can be concluded that there is a significant effect of metacognition on the ability to solve science problems. The implications of the results of this study are expected to be used as evaluation material and input for teachers in choosing and using appropriate learning strategies so as to improve problem-solving skills in science learning at the elementary school level.

1. INTRODUCTION

The educational process at the basic education level has an important role in character building and the development of cognitive, affective and psychomotor aspects. Cognitive, attitude and personality factors are the main determinants of a person who behaves with high mobility (Long & Khoi, 2020; Sukenti et al., 2020). One of the materials taught at the basic education level is science material. Through science learning, students are not only introduced to various concepts about the surrounding environment, but are also directed to be able to solve problems and make decisions to be able to apply them in life. However, the reality in the field is that most elementary school students in Indonesia have not mastered the concept of science and have not been able to apply the concept in real life (Khairani et al., 2020; Utama, 2019).

Teaching logical thinking in science is difficult because students constantly have to understand new laws of science, knowledge and implementation of the concepts learned (Cofré et al., 2019; Soeharto et al., 2019; Sulaiman et al., 2021). The human thoughts will be very hard to recognize as a complex organ identical to the thoughts. Cognitive development in terms of memory, reasoning, thinking, spatial processing, problem-solving skills, and perception differs at different stages of growth. Although scientific research in elementary school is very important as a basis for knowledge for students, scientific research not only emphasizes knowledge but also the process of acquiring knowledge (Nisa et al., 2018; Salehi et al., 2020; Tika & Agustiana, 2021). Problem solving is the ability to logically solve a problem step by step and lead to an effective solution. The capacity to clear up troubles indicates that scholars are capable of suppose at better ranges as emphasized withinside the 2013 curriculum and are capable of broaden their cognitive capabilities in analysis. Because education designed to focus on high-level skills cannot be separated from a combination of thinking and creativity to solve questions (Pratiwi & Puspito Hapsari, 2020; Yayuk et al., 2020).

Based on the results of the PISA survey in the science category, Indonesia is ranked 71st out of 80 countries participating in this program Compared to the 2015 score, the science performance ability score of Indonesian students in 2018 decreased with a total score of 396 scores. This is relevant to the 2015 TIMS (Trends in International Math and Science) survey which also showed that Indonesia's science skills were relatively low, ranking 45 out of 48 countries. Indonesia's average score is 396 (Hadi & Novaliyosi, 2019; Yasa et al., 2020). The results of the PISA and TIMS studies are consistent with the original data: interviews and observations conducted with SDIT Lhokseumawe City teachers in the course of teaching science. Interviews showed that problem-solving skills were still low, and students tend to think based on what their teachers were communicating and explaining. Students are less able to express ideas for solving scientific problems related to everyday life. Also, students pay more attention to multiple-choice problem solving than writing questions when solving problems. This is because students are still not familiar with learning using problem solving procedures (Camellia et al., 2021; Elita et al., 2019). Thus, the teacher's role is to guide students through the problem-solving process in scientific research through the learning stages. Teachers should also be aware of the impact of metacognition on the learning process. In this way, you can improve learning outcomes by motivating students to think about their own learning (Asy'ari et al., 2019; Kalemkus et al., 2021).

Given the importance of the role of problem-solving ability in life, there is a need for improvement of problem-solving ability in natural science research, one of which is the development of metacognition. The metacognitive development of problem solving in science learning cannot be separated from the support provided by teachers, especially teachers. The teacher's role is very important in improving the skills to solve complex problems (Ali, 2019; Hobri et al., 2020). To improve the ability of students in science learning, it is necessary to have the development of metacognitive skills in elementary school-aged children. Metacognition refers to an individual's process of recognizing himself, including an awareness of one's strengths and weaknesses, as well as the introduction of strategies that may be useful for progress in certain tasks (Anthonysamy, 2021; Muncer et al., 2022). Metacognition is the ability to understand and control one's cognitive activities in the learning process. Through metacognition, students can understand the stages of the learning process and their abilities.

Metacognitive cognitive abilities equate to problem-solving steps, and students use these abilities to identify variables in a problem and determine which strategies to use (Ramadhanti et al., 2019; Sevgi & Karakaya, 2020). In research on the development of collaborative inquiry-based learning models for elementary school students, it was also found that the results of testing collaborative-based inquiry learning were feasible and able to improve the metacognitive abilities of elementary school students (Hastuti et al., 2020; Lestari et al., 2019). The use of approaches in learning will indirectly affect students' problem-solving abilities if used appropriately, such as the use of problem posing models which are usually used in mathematics, but after being tested in science material, they are able to improve children's problem solving and metacognitive skills (Akben, 2020; Dörr & Perels, 2019).

In a study related to metacognitive development in elementary school-aged children, it was found that there are several factors that can activate metacognitive regulation and have a positive impact on scientific problem solving abilities, such as anomalies in presentation tasks, conveying ideas during problem solving activities in group activities on science material (Jin & Kim, 2018; Kholid et al., 2020). Therefore it is necessary to develop teacher competence in choosing learning methods and models such as the use of PBL models with the help of technology so that they are able to activate metacognition and children's ability to solve problems scientifically during the learning process (Lobczowski et al., 2021; Sutarto et al., 2022). There are various articles that examine the relationship between metacognitive and problem-solving abilities with gender, the results show that gender has not directly affected these two aspects,

metacognition can be developed with the activeness of teachers in the learning process through appropriate learning designs (Asy'ari et al., 2022; Nunaki et al., 2019).

To apply the metacognitive strategies, teacher should give the students systematic instruction about the concept of metacognition and learning strategies (Akamatsu, 2019; Muhid et al., 2020). Through metacognition, each student is expected to be able to independently determine what will be learned, be able to be honest about their abilities and shortcomings and dare to try new things to explore knowledge. Therefore, based on these various problems, this study aims to analyze the effect of metacognition on the ability to solve science problems in fifth grade elementary school students. at the Integrated Islamic Elementary School in Lhokseumawe City, Aceh.

2. METHOD

This study uses a quantitative approach with a survey method. Lhokseumawe City SDIT can be used as a complete population because of the implemented and technology-based learning system in the learning process, while the population in this study are all 5th grade students of SDIT in Lhokseumawe City, totaling 6 schools. Sampling in this study used a random sampling technique (Random Sampling), namely taking classes randomly without being picky determined by lottery, so the samples in this study were 5th grade students from SDIT Anak Salih, SDIT Ulumuddin, and SDIT Al Markazul Islami.

The instruments used in this research are metacognitive data and students' problem-solving abilities in science learning. The instrument consists of 12 questions related to problem solving skills and 21 questions related to metacognition. Table 1 and Table 2 shows the lattice of the instruments used in this study.

Table 1. Instrument of Problem Solving in Science

No	Dimension	Indicators	Item
1	Identify the problem	Know and formulate problems Clearly	3
2	Ability to plan solutions	Using knowledge to detailing, analyzing problems from various angles	3
3	Solve problems according to plan	The ability to find and organize data, present data in the form of diagrams, pictures and tables	3
4	Evaluating the problem	The ability to make alternative solutions, assessing choices taking into account the consequences what happens with each choice.	3

Table 2. Instrumented Metacognition

No	Dimension	Indicators	Item
1	Cognitive understanding	a) Declarative knowledge	3
		b) Procedural knowledge	3
		c) Conditional knowledge	3
2	Cognition Settings	a) commitment to learning	3
		b) positive attitude in learning	3
		c) planning learning activities	3
		d) evaluate	3

The data collection technique in this study was using a questionnaire. a closed questionnaire, that is, each statement in the questionnaire is equipped with alternative answers so that the respondent only chooses according to the conditions that best suit him. Before the research is carried out, the instrument to be used must go through a trial process first to determine the level of validity (validity) and reliability (reliability). Validity shows certainty, accuracy, or accuracy of the measuring instrument, while reliability shows consistency if the measuring instrument is used. Testing the validity of this instrument using the SPSS 22 program, taking into account the number in the Corrected Item-Total Correction, namely the correlation between the item scores and the total item scores. The interpretation is done by consulting with the r table, the item is said to be valid if the calculated r value is greater than the r table value. For the reliability test, it can be seen from the Gultman split half correlation value which is compared with the r table. The item is said to be valid if the calculated r value is greater than the r table value. For the reliability test, it can be seen from the Gultman split half correlation value which is compared with the r table.

The statement items are valid if the significant value is < 0.05 . The results of the validity test obtained a correlation between each item with a total score of $N = 30$ with a r -table of 0.344. This means that if the correlation value is more than 0.344 then the item is considered valid, while if it is less than that, the item is considered invalid. The reliability test of the research instrument uses the Cronbach's alpha formula. The research instrument will be said to be reliable if the reliability value of the instrument itself has a reliability value greater than r table. Therefore, the questionnaire items will be reliable if the alpha value is 0.344, but if the alpha value is < 0.344 , the instrument is not reliable and cannot be used in research. Cronbach's alpha analysis data obtained a reliability coefficient value greater than 0.344, the data is declared reliable if the Cronbach's alpha value is > 0.344 . Based on the data obtained by Cronbach's alpha = $0.830 > 0.344$, it can be concluded that the statement in the questionnaire has a very high reliability value.

The valid and reliable data were then analyzed quantitatively using simple regression analysis using IBM SPSS 23 software. In simple regression analysis, the significance level of 0.05% was determined by: 1). Test the significance of the regression equation, 2). Test the linearity of the regression line, and 3). Correlation significance. Before testing the hypothesis, the data obtained will be tested using the classical assumption test through the following tests: 1). The normality test uses the Kolmogorov-Smirnov (K-S) non-parametric statistical test, with the basis for making the decision if the significance value is > 0.05 , the residuals are normally distributed and otherwise will be abnormally distributed if the significance value is < 0.05 . 2), 2). Multicollinearity test, 3). Heteroscedasticity test to test whether in the regression model there is an inequality of variance from the residuals of one observation to another observation using the Glejser method, with the basis for making decisions. If the significance value is > 0.05 , there is no heteroscedasticity and vice versa, 4). Autocorrelation test, the decision is based on if the value of Asymp.Sig. (2-tailed) is greater than 0.05 then the data is free from autocorrelation symptoms. The next stage is Regression Analysis Y to X, aims to see the effect of the independent variable (X) on the dependent variable (Y) and how much influence it has. The value of R ranges from 0 to 1, getting closer to 1 indicates a stronger relationship, on the contrary, getting closer to 0 means the relationship is getting weaker. Followed by the linearity test and the significance of the regression equation using SPSS 23. The final stage is to test the hypothesis, carried out to test the effect between the variables as well as to find out how big the influence between the independent variable and the dependent variable is, test the hypothesis in this study using the t test, to determine whether there is an effect of variable X on variable Y with a 95% confidence level or $= 0.05$ or Sig value < 0.05 .

3. RESULT AND DISCUSSION

Result

After going through the data collection process, data analysis was then carried out including: (1) data description for each variable; (2) testing requirements analysis, which consists of normality test and linearity test and regression significance; and (3) hypothesis testing of the relationship between the independent and dependent variables. Before testing linear regression, the classical assumption test was first performed.

Normality Test.

Normality test is part of the classical assumption test and is a requirement in regression analysis, to find out whether the residual value is normally distributed or not. A good regression model is to have a residual value that is normally distributed. Meanwhile, the method used is the Kolmogorov-Smirnov (K-S) non-parametric statistical test. If the significance value is > 0.05 , the residual is normally distributed and vice versa will be abnormally distributed if the significance value is < 0.05 . Table 3 are the results of normality testing using IBM SPSS 23.

Table 3. Normality Test

	Statistics	Unstandardized Residual
Normal Parameters	Mean	0.000
	Std. Deviation	7.301
Most Extreme Differences	Absolute	0.137
	Positive	0.137
	Negative	-0.088
	Test Statistic	0.137
	Asymp. Sig. (2-tailed)	0.020
	Exact Sig. (2-tailed)	0.279
	Point Probability	0.000

From the [Table 3](#) it can be seen that the Exact value Sig. (2-tailed) of 0.279, meaning that it is greater than 0.05. So, it can be concluded that the residual value in this study is normally distributed.

Multicollinearity Test

To see if there is multicollinearity in the simple linear regression model, a multicollinearity test is carried out. Based on the multicollinearity testing, it is known that the value of VIF Metacognition (X) is $2.332 < 10$ and the tolerance value is $0.429 > 0.10$, so it can be concluded that there is no multicollinearity. This means that there is no multicollinearity of metacognitive variables on the ability to solve science problems.

Heteroscedasticity Test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from the residual of one observation to another observation using the Glejser method. The basis for decision making for the Glejser method is if the significance value is > 0.05 , there is no heteroscedasticity and vice versa. Based on the heteroscedasticity testing, it is known that the significance value of the metacognitive variable is 0.474, this indicates that there is no heteroscedasticity because the absolute residual is greater than 0.05 and meets the regression requirements.

Autocorrelation Test

Based on the decision of the Run Test, if the Asymp.Sig.(2-tailed) value is greater than 0.05, then the data is free from autocorrelation symptoms. From the table, it is obtained that Asymp.Sig.(2-tailed) = 0.253 $>$ from 0.05, it can be concluded that there is no autocorrelation symptom, so the linear regression analysis can be continued.

Simple Linear Regression Test

Simple regression analysis aims to see the effect of the independent variable (X) on the dependent variable (Y) and how much influence it has. The value of R ranges from 0 to 1, getting closer to 1 indicates a stronger relationship, on the contrary, getting closer to 0 means the relationship is getting weaker. The regression equation that occurs between Y over X is $y = a + bX$. From this table of coefficients, a constant of 65,075 is obtained and a regression coefficient of 0.317. Thus, the form of the relationship between metacognition and the ability to solve science problems is shown by the equation of linear regression analysis is $y = 65.075 + 0.317X$. It can be interpreted that if metacognition and science problem solving ability are measured, then every increase in score in metacognition by one unit will be followed by an increase in science problem solving ability score of 0.317.

Test for Linearity and Significance of the Regression Equation

The linearity test of the regression line equation is obtained from the table in the Deviation from Linearity line, namely Fhit = 1.252 with p-value = 0.295 $>$ 0.05. this means that the regression equation Y over X is linear or in the form of a parallel line. The linearity test of the regression line equation obtained in the fifth row is Fhit = 9.523, and p-value = 0.003 $<$ 0.05. This means that H_0 is rejected. Thus, the above Y regression is significant.

Significance Test Correlation Coefficient X and Y

The significance test of the correlation coefficient obtained from the table is the correlation coefficient (r_{xy}) = 0.407 and F-hit (F-change) = 9.523, with p-value = 0.003 $<$ 0.05. this means that the correlation coefficient of X over Y means or is significant. While the coefficient of determination from the table shows R Square = 0.166 which means that only 16.6% of the variation in science problem solving ability can be explained by metacognition.

Research Hypothesis Test

Hypothesis testing is carried out with the aim of testing the influence between the variables as well as to find out how much influence the independent variable has with the dependent variable. Testing the hypothesis in this study using t-test, to determine whether there is an effect of variable X on the variable (Y) with a 95% confidence level or $= 0.05$ or Sig value < 0.05 .

The calculation results as in the hypothesis testing in [Table 4](#), it is known that the significance value for the effect of X on Y is 0.003 $<$ 0.05 and the value of t table = 2.312. It means that the value of t count is greater than t table which is 3,086 $>$ 2,312, then H_0 is rejected and H_a is accepted. Thus, there is a significant effect of metacognition on the ability to solve science problems for fifth grade students of SDIT Lhokseumawe City.

Table 4. Hypothesis Testing with T Test

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	65.075	7.486		8.693	0.000	50.023	80.126
Metakognisi	0.317	0.103	0.407	3.086	0.003	0.110	0.523

Discussion

Based on the results of data analysis using SPSS, the t-count value is greater than t-table, which is $3.086 > 2.312$ at the significance level = 0.05, so there is an influence of metacognition with the ability to solve scientific problems. The form of the relationship between metacognition and the ability to solve scientific problems is shown by the regression equation = $65.075 + 0.317X_1$. This shows that if metacognition and science problem solving abilities are measured, then every increase in metacognition score by one unit will be followed by an increase in science problem solving ability score of 0.317, meaning that the higher the metacognition, the higher the problem-solving ability of students. The results of this analysis are relevant to the research conducted by Bahar and colleagues who stated that metacognition is one of the main factors influencing problem solving skills, through scientific activities it was found that there was confidence in problem solving skills, self-control, and metacognitive awareness, all of these components have a positive relationship and strong substantial (Bahar & Aksüt, 2020; Yüksel et al., 2021)

The cognitive processes found in the study refer to the processes used by students to systematically focus their thoughts, feelings, and actions to solve scientific problems given in the form of questions. This finding is relevant to the research that has been done by Siagian and friends who suggest that metacognition is a process where someone considers how they think to design problem solving techniques, in this case students gain experience using the knowledge and skills they already have to solve a given problem, success criteria depend on how students explain solutions (Arianto et al., 2021; Latifah et al., 2020; Siagian et al., 2019). Furthermore, the teacher's role is also important in developing children's ability to solve problems, especially in learning science which can be started from the early grades at the elementary education level. The results obtained that the teacher's role in classroom learning has been able to activate critical and independent thinking skills in dealing with or solving a problem in science learning. Metacognitive thinking skills are essential skills and need to be developed in current learning, through child-centered learning, namely through the role of the teacher by giving instructions to children in the form of giving children autonomy to regulate their own learning, it will positively increase children's ability to solve problems in learning, furthermore, children will be more independent and confident in their abilities (Hendriani et al., 2021; van Loon et al., 2021).

Metacognition skills need to be developed in the learning process in the classroom accompanied by the teacher. In the learning process, metacognitive skills have a significant direct effect on the problem-solving abilities faced by students where it appears that students are more enthusiastic in solving problems correctly through appropriate strategies and logical reasons, it can be concluded that students' perceptions of their performance affect their ability to monitor the learning process (Avargil et al., 2018; Güner & Erbay, 2021). Based on the analysis and research findings, it can be concluded that an increase in students' metacognitive abilities can improve their learning outcomes. The development of cognitive skills in students at the elementary school level is expected to help students solve various difficulties in understanding problems by choosing the right strategy, through the ability to check, detect, and correct errors so that later it will improve the quality of learning for the better.

4. CONCLUSION

The results of hypothesis testing show evidence that there is a positive and significant relationship between metacognition and the ability to solve scientific problems. This shows that students who are able to use the metacognition component well will increase their problem-solving skills in science material. So, it can be concluded that the higher the metacognition, the higher the ability to solve scientific problems. For further research, it is necessary to examine the role of the metacognitive level that is formed based on problem solving abilities.

5. REFERENCES

- Akamatsu, D., Nakaya, M., & Koizumi, R. (2019). Effects of metacognitive strategies on the self-regulated learning process: The mediating effects of self-efficacy. *Behavioral Sciences*, 9(12), 128. <https://doi.org/10.3390/bs9120128>.
- Akben, N. (2020). Effects of the Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education. *Research in Science Education*, 50(3), 1143–1165. <https://doi.org/10.1007/s11165-018-9726-7>.
- Ali, S. S. (2019). Problem Based Learning: A Student-Centered Approach. *English Language Teaching*, 12(5), 73. <https://doi.org/10.5539/elt.v12n5p73>.
- Anthonymsamy, L. (2021). The use of metacognitive strategies for uninterrupted online learning: Preparing university students in the age of pandemic. *Education and Information Technologies*, 26(6), 6881–6899. <https://doi.org/10.1007/s10639-021-10518-y>.
- Arianto, F., Mustaji, & Bachri, B. S. (2021). Metacognitive Strategy and Science Problem-Solving Abilities in Elementary School Students. *International Journal of Social Science and Human Research*, 04(09), 2571–2574. <https://doi.org/10.47191/ijsshr/v4-i9-42>.
- Asy'ari, M., Ikhsan, M., & Muhali. (2019). The effectiveness of inquiry learning model in improving prospective teachers' metacognition knowledge and metacognition awareness. *International Journal of Instruction*, 12(2), 455–470. <https://doi.org/10.29333/iji.2019.12229a>.
- Asy'ari, M., Mirawati, B., Zubaidah, S., & Mahanal, S. (2022). Students' Metacognitive Awareness in Natural Science Learning: An Overview by Gender. *Jurnal Penelitian Pendidikan IPA*, 8(1), 67–72. <https://doi.org/10.29303/jppipa.v8i1.1146>.
- Avargil, S., Lavi, R., & Dori, Y. J. (2018). *Students' Metacognition and Metacognitive Strategies in Science Education*. https://doi.org/10.1007/978-3-319-66659-4_3.
- Bahar, M., & Aksüt, P. (2020). Investigation on the effects of activity-based science teaching practices in the acquisition of problem solving skills for 5-6 year old pre-school children. *Journal of Turkish Science Education*, 17(1), 22–39. <https://doi.org/10.36681/tused.2020.11>.
- Camellia, G. F., Hartono, & Ridlo, S. (2021). The development of HOTS-oriented science supplement book to improve problem solving ability of vocational school students. *Journal of Innovative Science Education*, 10(1), 314–318. <https://journal.unnes.ac.id/sju/index.php/jise/article/view/45313>.
- Cofré, H., Núñez, P., Santibáñez, D., Pavez, J. M., Valencia, M., & Vergara, C. (2019). A Critical Review of Students' and Teachers' Understandings of Nature of Science. *Science and Education*, 28(3–5), 205–248. <https://doi.org/10.1007/s11191-019-00051-3>.
- Dörr, L., & Perels, F. (2019). Improving metacognitive abilities as an important prerequisite for self-regulated learning in preschool children. *International Electronic Journal of Elementary Education*, 11(5), 449–459. <https://doi.org/10.26822/iejee.2019553341>.
- Elita, G. S., Habibi, M., Putra, A., & Ulandari, N. (2019). Pengaruh Pembelajaran Problem Based Learning dengan Pendekatan Metakognisi terhadap Kemampuan Pemecahan Masalah Matematis. *Mosharafa: Jurnal Pendidikan Matematika*, 8(3), 447–458. <https://doi.org/10.31980/mosharafa.v8i3.517>.
- Güner, P., & Erbay, H. N. (2021). Metacognitive Skills and Problem-Solving. *International Journal of Research in Education and Science*, June, 715–734. <https://doi.org/10.46328/ijres.1594>.
- Hadi, S., & Novaliyosi. (2019). TIMSS Indonesia (Trends in International Mathematics and Science Study). *Prosiding Seminar Nasional & Call For Papers Program Studi Magister Pendidikan Matematika Universitas Siliwangi*, 562–569. <http://jurnal.unsil.ac.id/index.php/sncp/article/view/1096>.
- Hastuti, I. D., Surahmat, Sutarto, & Dafik. (2020). Development of collaborative inquiry-based learning model to improve elementary school students' metacognitive ability. *International Journal of Scientific and Technology Research*, 9(2), 1240–1247. <http://repository.unisma.ac.id/handle/123456789/2289>.
- Hendriani, A., Tri Herlambang, Y., Rohayati, E., Ernalis, & Setiawan, D. (2021). Critical Multiliteration: An Alternative Learning Model for Developing Metacognition Skills in Elementary School Students. *Journal of Physics: Conference Series*, 1764(1). <https://doi.org/10.1088/1742-6596/1764/1/012091>.
- Hobri, Ummah, I. K., Yuliati, N., & Dafik. (2020). The effect of jumping task based on creative problem solving on students' problem solving ability. *International Journal of Instruction*, 13(1), 387–406. <https://doi.org/10.29333/iji.2020.13126a>.
- Jin, Q., & Kim, M. (2018). Metacognitive Regulation During Elementary Students' Collaborative Group Work. *Interchange*, 49(2), 263–281. <https://doi.org/10.1007/s10780-018-9327-4>.
- Kalemkus, J., Bayraktar, Ş., & Çiftçi, S. (2021). Comparative Effects of Argumentation and Laboratory Experiments on Metacognition, Attitudes, and Science Process Skills of Primary School Children.

- Journal of Science Learning*, 4(2). <https://doi.org/10.17509/jsl.v4i2.27825>.
- Khairani, S., Suyanti, R. D., & Saragi, D. (2020). The Influence of Problem Based Learning (PBL) Model Collaborative and Learning Motivation Based on Students' Critical Thinking Ability Science Subjects in Class V State Elementary School 105390 Island Image. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 3(3), 1581–1590. <https://doi.org/10.33258/birle.v3i3.1247>.
- Kholid, M. N., Sa'dijah, C., Hidayanto, E., & Permadi, H. (2020). How are students' reflective thinking for problem solving? *Journal for the Education of Gifted Young Scientists*, 8(3), 1135–1146. <https://doi.org/10.17478/JEGYS.688210>.
- Latifah, N., Fauzia, U., & Kelana, J. B. (2020). Natural Science Problem Solving in Elementary School Students Using the Project Based Learning (PjBL) Model. *Jurnal Ilmiah Sekolah Dasar*, 4(4), 596–603. <https://ejournal.undiksha.ac.id/index.php/JISD/article/view/28377>.
- Lestari, W., Pratama, L. D., & Jailani, J. (2019). Metacognitive Skills in Mathematics Problem Solving. *Jurnal Daya Matematis*, 6(3), 286. <https://doi.org/10.26858/jds.v6i3.8537>.
- Lobczowski, N. G., Lyons, K., Greene, J. A., & McLaughlin, J. E. (2021). Socially shared metacognition in a project-based learning environment: A comparative case study. *Learning, Culture and Social Interaction*, 30(PA), 100543. <https://doi.org/10.1016/j.lcsi.2021.100543>.
- Long, N. N., & Khoi, B. H. (2020). The Intention to Study Using Zoom During the SARSCoV-2 Pandemic. *International Journal of Emerging Technologies in Learning*, 15(21), 195–216. <https://doi.org/10.3991/ijet.v15i21.16777>.
- Muhid, A., Amalia, E. R., Hilaliyah, H., Budiana, N., & Wajdi, M. B. N. (2020). The effect of metacognitive strategies implementation on students' reading comprehension achievement. *International Journal of Instruction*, 13(2), 847–862. <https://doi.org/10.29333/iji.2020.13257a>.
- Muncer, G., Higham, P. A., Gosling, C. J., Cortese, S., Wood-Downie, H., & Hadwin, J. A. (2022). A Meta-Analysis Investigating the Association Between Metacognition and Math Performance in Adolescence. In *Educational Psychology Review* (Vol. 34, Issue 1). Educational Psychology Review. <https://doi.org/10.1007/s10648-021-09620-x>.
- Nisa, K., Triwoelandari, R., & Kosim, A. M. (2018). Pengaruh Strategi Metakognitif Terhadap Self-Efficacy Pada Pembelajaran Sains Kelas V SD. *Jurnal Mitra Pendidikan*, 2(10), 1063–1077. <http://ejournalmitrapendidikan.com/index.php/e-jmp/article/view/879>.
- Nunaki, J. H., Damopolii, I., Kandowangko, N. Y., & Nusantari, E. (2019). The effectiveness of inquiry-based learning to train the students' metacognitive skills based on gender differences. *International Journal of Instruction*, 12(2), 505–516. <https://doi.org/10.29333/iji.2019.12232a>.
- Pratiwi, B., & Puspito Hapsari, K. (2020). Analisis Kemampuan Berpikir Tingkat Tinggi Melalui Pemanfaatan YouTube Sebagai Media Pembelajaran Bahasa Indonesia. *Jurnal Ilmiah Sekolah Dasar*, 4(2), 282. <https://doi.org/10.23887/jisd.v4i2.24238>.
- Ramadhanti, D., Ghazali, A. S., Hasanah, M., & Harsiati, T. (2019). Students' metacognitive weaknesses in academic writing: A preliminary research. *International Journal of Emerging Technologies in Learning*, 14(11), 41–57. <https://doi.org/10.3991/IJET.V14I11.10213>.
- Salehi, S., Wang, K. D., Toorawa, R., & Wieman, C. (2020). Can majoring in computer science improve general problem-solving skills? *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, 156–161. <https://doi.org/10.1145/3328778.3366808>.
- Sevgi, S., & Karakaya, M. (2020). Investigation Of Metacognition Awareness Levels And Problem Solving Skills Of Middle School Students. *International Online Journal of Primary Education*, 9(2), 260–270. <https://dergipark.org.tr/en/pub/ijpe/issue/69665/1110850>.
- Siagian, M. V., Saragih, S., & Sinaga, B. (2019). Development of Learning Materials Based on Realistic Mathematics Education Approach to Improve Students' Mathematical Problem Solving Ability and Self-Efficacy. *International Electronic Journal of Mathematics Education*, 14(2), 331–340. <https://eric.ed.gov/?id=EJ1227202>.
- Soeharto, Csapó, B., Sarimanah, E., Dewi, F. I., & Sabri, T. (2019). A review of students' common misconceptions in science and their diagnostic assessment tools. *Jurnal Pendidikan IPA Indonesia*, 8(2), 247–266. <https://doi.org/10.15294/jpii.v8i2.18649>.
- Sukenti, D., Tambak, S., & Charlina. (2020). Developing indonesian language learning assessments: Strengthening the personal competence and islamic psychosocial of teachers. *International Journal of Evaluation and Research in Education*, 9(4), 1079–1087. <https://doi.org/10.11591/ijere.v9i4.20677>.
- Sulaiman, T., Rahim, S. S. A., Yan, W. K., & Subramaniam, P. (2021). Primary science teachers' perspectives about metacognition in science teaching. *European Journal of Educational Research*, 10(1), 75–84. <https://doi.org/10.12973/EU-JER.10.1.75>.

- Sutarto, Dwi Hastuti, I., Fuster-Guillén, D., Palacios Garay, J. P., Hernández, R. M., & Namaziandost, E. (2022). The Effect of Problem-Based Learning on Metacognitive Ability in the Conjecturing Process of Junior High School Students. *Education Research International*, 2022, 1–10. <https://doi.org/10.1155/2022/2313448>.
- Tika, I. N., & Agustiana, I. G. A. T. (2021). The Effect of a Blended Learning Project Based Learning Model on Scientific Attitudes and Science Learning Outcomes. *Jurnal Ilmiah Sekolah Dasar*, 5(4), 557. <https://doi.org/10.23887/jisd.v5i4.39869>.
- Utama, E. G. (2019). Pengaruh Model Pembelajaran POE (Predict, Observe and Explain) Terhadap Keterampilan Proses Sains Siswa SD Kelas V ditinjau dari Keterampilan Metakognitif. *JPDI (Jurnal Pendidikan Dasar Indonesia)*, 4(2), 46. <https://doi.org/10.26737/jpdi.v4i2.1364>.
- van Loon, M. H., Bayard, N. S., Steiner, M., & Roebbers, C. M. (2021). Connecting teachers' classroom instructions with children's metacognition and learning in elementary school. *Metacognition and Learning*, 16(3), 623–650. <https://doi.org/10.1007/s11409-020-09248-2>.
- Yasa, I. K. D., Pudjawan, K., & Agustiana, I. G. A. T. (2020). Peningkatan Efikasi Diri Siswa Pada Mata Pelajaran IPA Kelas IV SD Melalui Model Pembelajaran Numbered Head Together. *Mimbar PGSD Undiksha*, 8(3), 330–341. <https://doi.org/10.23887/jjgsd.v8i3.25351>.
- Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, 9(3), 1281–1295. <https://doi.org/10.12973/eu-jer.9.3.1281>.
- Yüksel, M., Üniversitesi, M., Bölümü, B., Türkiye, İ. /, Üniversitesi, M. S., Harp Okulu, H., & Bilgisi Öz, M. (2021). The Research of The Relationship Between The Problem Solving Skills & Metacognitive Awareness of Middle School Students and The Social Emotional Learning. *Cukurova Üniversitesi Eğitim Fakültesi Dergisi*, 487–506. <https://doi.org/10.14812/cufej.747349>.