JPPIPA 9(4) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of The Problem-Based Learning Model on Critical Thinking Ability and Communication Ability of Prospective Teacher Students in Science Learning

Muhammad Ahyar[1*]

[1] Institut Agama Islam Qomarul Huda Bagu, Lombok Tengah, Indonesia.

Received: February 27, 2023
Revised: April 23, 2023
Accepted: April 25, 2023
Published: April 30, 2023

Corresponding Author:
Muhammad Ahyar
muhammadahyar@iaiqh.ac.id

DOI: 10.29303/jppipa.v9i4.3515

Abstract: This study aims to partially determine the effect of the problem-based learning (PBL) model on prospective teacher students' critical thinking and communication skills in science learning. This research is a quasi-experimental study with a non-equivalent control group design. This research was conducted on third-semester PIAUD students who took PIAUD science learning courses. The sampling technique used saturated samples so that 35 students were obtained. Data collection using tests and non-tests, namely in the form of questions about critical thinking skills and observation sheets of communication skills. Data analysis techniques using descriptive statistics and inferential statistics. The results showed that the use of the PBL learning model in science learning affected the critical thinking and communication skills of PIAUD IAIQH Bagu teacher candidates.

Keywords: Communication ability; Critical thinking ability; PBL; Science learning

Introduction

Early Childhood Islamic Education is one of the study programs that study procedures for teaching, training, guiding, and educating early childhood so that they have good insight, character, and physical development. Islamic Kindergarten (PIAUD) graduate students not only teach drawing and singing but also apply various ways to help children's growth and development in their golden age (Ratnasih et al., 2020; Sidiq et al., 2022).

The implementation of the PIAUD undergraduate program at the Qamarul Huda Bagu Islamic Institute aims to 1) produce teachers who have academic qualifications, pedagogic competence, personality, and social skills; 2) pay serious attention to procuring/preparing educational staff who are professional and have added value; 3) the ability to educate children, namely mastering student characteristics, mastering learning theory, developing curricula, utilizing information and communication technology, conducting learning evaluations, and taking reflective action to improve the quality of AUD learning; and 4) mastering science, developing material creatively and innovatively, as well as developing professionalism in teaching at the AUD level.

The objectives of implementing the PIAUD undergraduate program above are in line with the abilities that prospective teachers must have in the 21st century. Prospective 21st century professional teachers are prospective teachers who are able to become career-long learners to increase the effectiveness of the student learning process in line with environmental developments; able to work with, learn from, and teach colleagues in an effort to deal with the complexities of schooling and teaching challenges (Akın-Sabuncu et al., 2021; Alahmad et al., 2021; Bahtiar & Ibrahim, 2022). The position of the teacher is very urgent in the world of education because the teacher is a person who is given a mandate by the parents of students to educate students to become whole human beings, as

How to Cite:
Ahyar, M. (2023). The Effect of The Problem-Based Learning Model on Critical Thinking Ability and Communication Ability of Prospective Teacher Students in Science Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1727–1733. https://doi.org/10.29303/jppipa.v9i4.3515

someone who is given the mandate, of course, a teacher has a role and function not only as a teacher and educator but also as a parent second for students. The abilities that must be possessed by prospective teachers, in general, consist of 4C, namely creative thinking, collaboration, critical thinking, and communication (Bahtiar, Ibrahim, et al., 2022; Goodwin et al., 2021).

Based on the results of observations and assessments conducted on semester III PIAUD students at Institut Agama Islam Qomarul Huda (IAIQH) Bagu as prospective teachers, it shows that students' critical thinking skills as prospective teachers are still lacking. Student PIAUD teacher candidates still have difficulties in 1) formulating the main issues; 2) revealing existing facts by associating them with everyday life; and 3) providing an explanation regarding the problem presented. The low critical thinking skills of PIAUD teacher candidate students can be seen in the learning process and the results of the tests carried out. Students who usually think critically will be in-depth or dig up information and understand a problem well so that they can make decisions wisely.

In addition to the ability to think critically, communication skills are also one of the skills that must be possessed by prospective PIAUD teacher students. Communication skills are skills or abilities to convey messages, ideas, or thoughts to other people with the aim that other people understand what is meant properly, directly or indirectly (Wahyuni, 2018). Student-teacher candidates with the ability to communicate will become good listeners so that they are able to capture messages without misinformation occurring. This communication ability is of course very important in the world of education because it involves teacher competence as mandated in PERMENDIKBUD Number 3 of 2005 (Wikaningrum et al., 2018). The results of observations made on prospective PIAUD teacher students at IAIQH Bagu show that student communication skills are still relatively low, during learning, there are not many students who are active in commenting, giving ideas, refuting, or expressing opinions related to what is being studied or being discussed. Student-teacher candidates are more silent and only listen to what is conveyed by the lecturer in the learning process.

Based on the description of the problem above, it is necessary to apply a learning model that can help improve the critical thinking skills and communication skills of prospective PIAUD teacher students. One alternative that can be used is the problem-based learning (PBL) model. PBL as a learning model that starts with presenting a problem is designed in a context that is relevant to the material to be studied to encourage students to gain knowledge and understand concepts, achieve critical thinking, have independent learning, participate in group work skills, and communicate skills (Mulyanto et al., 2018; Saputra et al., 2019). Through the PBL learning model, PIAUD prospective teacher students are used to learning from actual and factual problems in everyday life, and students are also used for group study and discussion, as well as studying problems, looking for relevant information, compiling information obtained, reviewing alternative solutions, propose alternative solutions, and develop remedial actions (Ibrahim et al., 2017; Maimun et al., 2022; Siagan et al., 2019).

The application of the PBL learning model in science learning at PIAUD is expected to take place in an interactive, inspirational, fun, challenging, and motivating student teacher candidate to actively participate, and provide sufficient space for initiative, creativity, and independence according to talent, demand, and development of student teacher candidates in critical thinking and communication. The application of the PBL model in PIAUD science learning also provides direct opportunities for prospective PIAUD teacher students to get to know the environment and natural phenomena around them. Student teacher candidates are taught how to feel, experience, and try various natural phenomena according to the topics discussed. Through the application of the PBL model in science learning, it will form student teacher candidates to acquire a deep understanding of the material being taught.

Therefore, based on the description above, the researcher is interested in conducting research to know the effect of applying the PBL learning model on the critical thinking skills and communication skills of prospective PIAUD teacher students at IAIQH Bagu. This research is expected to be the best solution to improving students' abilities to face the challenges of the 21st century.

Method

This research includes quantitative research with a quasi-experimental research type. The research design used was a nonequivalent control group design. This non-equivalent control group design is also known as an untreated control group design with a pretest and posttest. This research design is categorized as a quasi-experimental design. The research design can be seen in Table 1.

This research was conducted in August 2022 with PIAUD students at IAQH Bagu. The sampling technique in this study is probability sampling using saturated samples. This means that all third-semester PIAUD students were used as the research sample. The number of research samples was 35 people, of which 15 students

were male and 20 students were female. The data collection technique used in this study was in the form of critical thinking skills tests using written test questions in the form of descriptions and non-tests in the form of observing students' communication skills using observation sheets during the learning process. Data analysis techniques using descriptive statistics and inferential statistics using homogeneity, normality, and t-tests.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental	O_{11}	PBL	O_{12}
Control	O_{21}	Conversion	O_{22}

Result and Discussion

This study aims to partially determine the effect of the PBL model on the ability to think critically and the communication skills of prospective PIAUD teacher students at IAIQH Bagu.

Critical Thinking Ability

The ability to think critically is a skill that must be possessed by prospective PIAUD teacher students in analyzing or studying an idea or ideas after understanding idea or ideas. Critical thinking skills can help prospective PIAUD teacher students understand how these problems are solved by relating them to existing theories. The critical thinking ability of PIAUD teacher candidate students is known through the critical thinking ability indicator. The indicators of critical thinking skills used in this study are (1) formulating the main issues (KBK-1); (2) disclosing existing facts (KBK-2); (3) choosing logical arguments (KBK-3); (4) detecting bias with different points of view (KBK-4); and (5) draw conclusions (KBK-5). Data on the results of the critical thinking skills of prospective PIAUD teacher students' pretest and posttest in the experimental class and control class can be seen in the Figure 1.

Figure 1 shows that the critical thinking skills of prospective PIAUD teacher students in the experimental class and the control class are different. The critical thinking ability of PIAUD prospective teacher students before implementing the PBL learning model was 46 whereas after the PBL learning model was applied to science learning, the average critical thinking ability of PIAUD prospective teacher students was 84. The high critical thinking ability of PIAUD prospective teacher students was due to the application of the learning model PBL in the science learning process. Through the PBL learning model that is applied, students have many opportunities to formulate problems that they want to solve. In addition, prospective teacher students also have the opportunity to express problems according to what is formulated. The results of this study are in line with research conducted by Mutakinati et al. (2018) and Fuad et al. (2017) which state that critical thinking skills increase after applying a student-centered learning model. Research conducted by Anazifa et al. (2017) and Ulger (2018) states that the application of the PBL learning model is effective in increasing critical thinking skills.

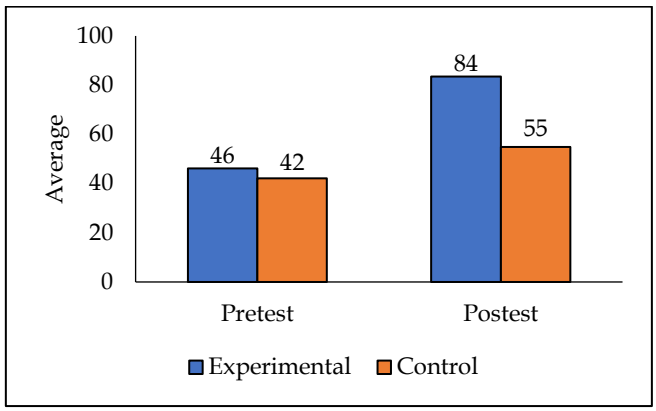

Figure 1. Comparison of critical thinking ability data for PIAUD teacher prospective students

Figure 1 also shows that the average critical thinking skills of PIAUD teacher candidate students in the control class who use the conventional learning model in science learning are 42 and 55. The low critical thinking ability of students in the control class is because prospective teacher students are not facilitated to formulate problems and uncover them. Problems related to everyday life. The use of a lecturer-centered learning model does not have the maximum impact on improving students' critical thinking skills. In addition to analyzing the average grades for each class, the researchers also analyzed the critical thinking skills of prospective PIAUD teacher students for each indicator. The following presents the critical thinking skills of prospective PIAUD teacher students for each indicator.

Figure 2 shows the critical thinking skills of prospective PIAUD teacher students in the experimental class, the indicator for critical thinking skills with the highest percentage is KBK-4 while the indicator with the lowest percentage is KBK-1. The high percentage of KBK-4, namely detecting bias with a different point of view, is caused by student teacher candidates during the learning process getting used to screening and early detection related to solve science problems. The role of the PBL learning model in the science learning process is also the reason for the high KBK-4 indicator. In the control class, a high indicator of the critical thinking ability of prospective PIAUD teacher students was KBK-2. The high level of KBK-2, namely uncovering existing facts, is because the lecturer at the beginning of learning also provides opportunities for students to express facts

related to the problems presented by the lecturer. Stupple et al. (2017) stated that students' critical thinking skills differed for each indicator. Research conducted by Ramdani et al. (2021) and Djamas et al. (2021) also states that the critical thinking skills of students, both male, and female, are different for each indicator.

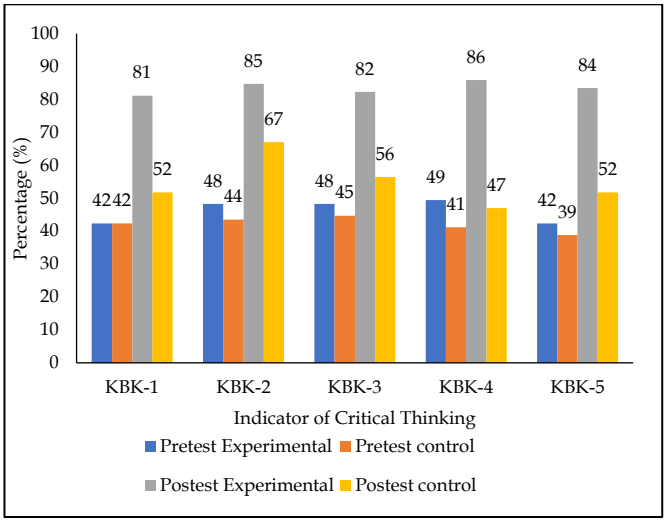

Figure 2. Comparison of students' critical thinking ability based on indicators

To find out whether the application of the learning model affects the critical thinking skills of PIAUD prospective teacher students, the researchers analyzed using inferential statistics using an independent sample t-test. The results of the analysis are presented in the Table 2.

The output table 2 shows that the Significance value of Levene's Test for Equality of Variances is 0.119. This value is greater than 0.05. This indicates that the variance of the data between the experimental class and the control class is homogeneous or the same. The output above also shows that the 2-tailed Significance value is 0.000. This value is less than 0.05, which means that there is a significant difference between the average critical thinking skills of PIAUD teacher-candidate students in the experimental class and the critical thinking skills of PIAUD teacher-candidate students in the control class. This shows that the application of the PBL learning model affects the critical thinking skills of prospective PIAUD teacher students. The results of this study are by the concept of the PBL learning model itself, in which students who are taught using the PBL learning model can improve students' critical thinking skills. Research conducted by Amin et al. (2020), Awan et al. (2017), and Wahyudiati (2022) state that the PBL learning model influences critical thinking skills. Critical thinking skills increased after being taught using the PBL learning model.

Table 2. Output Independent Sample t-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Critical Thinking Ability	Equal variances assumed	2.559	.119	11.259	33	.000	28.418	2.524	23.283	33.553
	Equal variances not assumed			11.145	28.420	.000	28.418	2.550	23.199	33.638

Communication Ability

Communication skills are abilities possessed by prospective PIAUD teacher students in expressing thoughts, feelings, and desires, through verbal communication or non-verbal communication to gain understanding from others. To determine the communication skills of prospective PIAUD teacher students, researchers used indicators of communication skills. The indicators of communication skills used are 1) Respect (respect and appreciation for the communicant) (CMNC-1); 2) Empathy (ability to listen and be perceptive or ready to receive feedback) (CMNC-2); and 3) Audible (messages or information conveyed must be heard) (CMNC-3). Data on the communication skills of prospective PIAUD teacher students were obtained during the learning process. The results of the communication skills of prospective PIAUD teacher students are presented in the Figure 3.

Figure 3 shows that the average communication ability of the experimental class and the control class is different. The experimental class which was taught using the PBL learning model obtained an average score of 86 in communication skills while the control class which was taught using the conventional learning model 48. The high communication skills of prospective PIAUD teacher students in the experimental class were due to the use of the PBL learning model. The steps of the learning model provide opportunities for

prospective teacher students to be skilled in communicating both in small groups and large groups, and when presenting the results of discussions that are being carried out. Saenab et al. (2018), Surya et al. (2018), and Paruntu et al. (2018) stated that the application of the PBL learning model supports students to improve communication skills in the learning process.

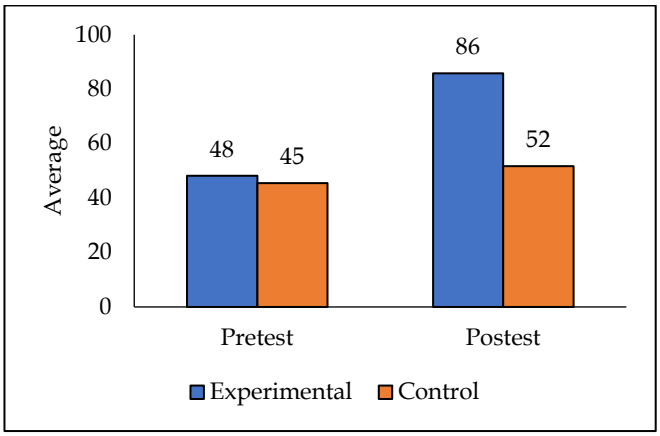

Figure 3. Comparison of communication skills for PIAUD teacher prospective students

In addition to analyzing communication skills in general, researchers also analyzed the communication skills of prospective PIAUD teacher students based on indicators. The following presents the communication skills of prospective PIAUD teacher students based on indicators.

Figure 4 shows that the highest percentage of communication ability indicators is in the experimental class in the form of a CMNC-1 indicator of 88%. The CMNC-1 indicator is a respected indicator. In this case, PIAUD prospective teacher students can respect and appreciate friends and lecturers in learning activities. Interaction between students and lecturers, students and students with attention to colleagues who communicate very well in the learning process of the experimental class that applies the PBL learning model. The highest control class communication ability indicator is the CMNC-2 indicator. The CMNC-2 indicator is an empathy indicator. The empathy indicator is the ability of prospective PIAUD teacher students to listen and be perspective or ready to receive feedback on the material presented by the lecturer. Lordache et al. (2017) state that all indicators of communication skills must be possessed by students in facing the challenges of the 21st century. Research conducted by Pratama et al. (2019) and Oktavia et al. (2020) also states that the implementation of the PBL learning model facilitates the improvement of communication skills for each indicator.

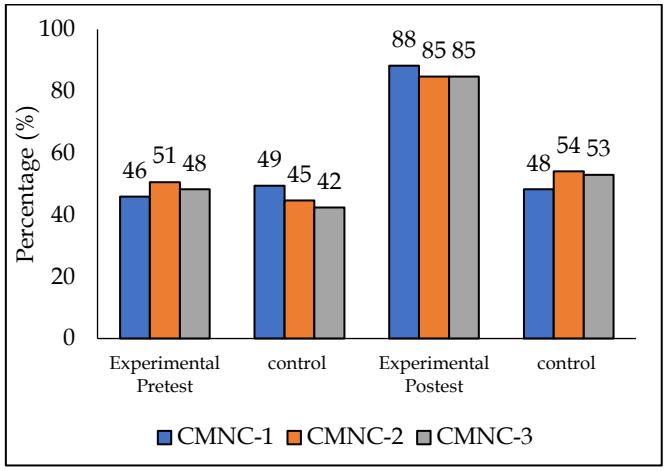

Figure 4. Comparison of communication skills based on indicators

In addition to analyzing descriptively, the researcher also performed inferential statistical analysis using an independent sample t-test. The results of the analysis with the help of SPSS are presented in the table 3.

Table 3. Output Independent Sample t-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Communication Ability	Equal variances assumed	1.289	.264	16.139	33	.000	34.032	2.109	29.742	38.322
	Equal variances not assumed			15.952	27.457	.000	34.032	2.133	29.658	38.406

The output above shows that the Significance value of Levene's Test for Equality of Variances is 0.264. This value is greater than 0.05. This indicates that the variance of the data between the experimental class and the control class is homogeneous or the same. The output above also shows that the 2-tailed Significance value is 0.000. This value is less than 0.05, which means that there is a significant difference between the average

communication skills of prospective PIAUD teacher students in the experimental class and the communication skills of prospective PIAUD teacher students in the control class. This shows that the application of the PBL learning model affects the communication skills of prospective PIAUD teacher students. The results of this study are by the concept of the PBL learning model itself, in which students who are taught using the PBL learning model can improve students communication skills. Research conducted by Deep et al. (2019) states that PBL learning model research is effective for improving communication in class. Research conducted by Hikamah et al. (2021) also shows that the development of virtual learning based on the PBL model during COVID-19 is effective in improving communication skills.

Conclusion

Based on the results of the research and discussion, it can be concluded that the use of the PBL learning model in science learning affects the critical thinking skills and communication skills of PIAUD IAIQH Bagu teacher candidates.

References

Akın-Sabuncu, S., & Ok, A. (2021). Essential qualities for elementary teachers of the 21st century: Voices of key stakeholders. *İlköğretim Online*, *20*(1), 100–120. https://doi.org/10.17051/ilkonline.2021.01.045

Alahmad, A., Stamenkovska, T., & Gyori, J. (2021). Preparing Pre-service Teachers for 21st Century Skills Education. *GiLE Journal of Skills Development*, *1*(1), 67–86. https://doi.org/10.52398/gjsd.2021.v1.i1.pp67-86

Amin, S., Utaya, S., Bachri, S., Sumarmi, S., & Susilo, S. (2020). Effect of Problem Based Learning on Critical Thinking Skill and Enviromental Attitude. *Journal for the Education of Gifted Young Scientists*, *8*(2), 743–755. https://doi.org/10.17478/jegys.650344

Anazifa, R. D., & Djukri. (2017). Project- based learning and problem- based learning: Are they effective to improve student's thinking skills? *Jurnal Pendidikan IPA Indonesia*, *6*(2), 346–355. https://doi.org/10.15294/jpii.v6i2.11100

Awan, R. un N., Hussain, H., & Anwar, N. (2017). Effects of Problem Based Learning on Students' Critical Thinking Skills, Attitudes towards Learning and Achievement. *The Journal of Educational Research*, *20*(2), 28. https://rb.gy/gkbi1

Bahtiar, B., & Ibrahim, I. (2022). The Science Literacy Profile Based on Students' Creative Thinking Skill in the Time of Covid-19 Pandemic Using Blended Learning. *International Conference on Madrasah Reform 2021 (ICMR 2021*, *633*, 102–110. https://doi.org/10.2991/assehr.k.220104.016

Bahtiar, B., Ibrahim, I., & Maimun, M. (2022). Profile of Student Problem Solving Skills Using Discovery Learning Model with Cognitive Conflict Approach. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1340–1349. https://doi.org/10.29303/jppipa.v8i3.1657

Deep, S., Salleh, B. M., & Othman, H. (2019). Study on problem-based learning towards improving soft skills of students in effective communication class. *International Journal of Innovation and Learning*, *25*(1), 17–34. https://doi.org/10.1504/IJIL.2019.096512

Djamas, D., Tinedi, V., & Yohandri. (2021). Development of Interactive Multimedia Learning Materials for Improving Critical Thinking Skills. In *Research Anthology on Developing Critical Thinking Skills in Students* (pp. 507–525). IGI Global. https://doi.org/10.4018/978-1-7998-3022-1.ch026

Fuad, N. M., Zubaidah, S., Mahanal, S., & Suarsini, E. (2017). Improving Junior High Schools' Critical Thinking Skills Based on Test Three Different Models of Learning. *International Journal of Instruction*, *10*(1), 101–116. https://doi.org/10.12973/iji.2017.1017a

Goodwin, A. L., & Low, E. L. (2021). Rethinking conceptualisations of teacher quality in Singapore and Hong Kong: A comparative analysis. *European Journal of Teacher Education*, *44*(3), 365–382. https://doi.org/10.1080/02619768.2021.1913117

Hikamah, S. R., Suhadi, S., Rohman, F., & Kurniawan, N. (2021). Developing Virtual Communication Skills in Online Learning Based on Modified PBL during the COVID-19 Pandemic. *International Journal of Education and Practice*, *9*(2), 323–339. https://doi.org/10.18488/journal.61.2021.92.323.339

Ibrahim, I., Kosim, K., & Gunawan, G. (2017). Pengaruh Model Pembelajaran Conceptual Understanding Procedures (CUPs) Berbantuan LKPD Terhadap Kemampuan Pemecahan Masalah Fisika. *Jurnal Pendidikan Fisika Dan Teknologi*, *3*(1), 14–23. https://doi.org/10.29303/jpft.v3i1.318

Lordache, C., Mariën, I., & Baelden, D. (2017). Developing digital skills and competences: A quick-scan analysis of 13 digital literacy models. *Italian Journal of Sociology of Education*, *9*(1), 6–30. https://doi.org/10.14658/pupj-ijse-2017-1-2

Maimun, M., & Bahtiar, B. (2022). The Effect of Search, Solve, Create, And Share (SSCS) Learning Models Assisted Multimedia Interactive to Improve Creative Thinking Ability and Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1834–1840. https://doi.org/10.29303/jppipa.v8i4.1983

Mulyanto, H., Gunarhadi, G., & Indriayu, M. (2018). The effect of problem based learning model on student mathematics learning outcomes viewed from critical thinking skills. *International Journal of Educational Research Review*, *3*(2), 37–45. https://doi.org/10.24331/ijere.408454

Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through stem education project-based learning. *Jurnal Pendidikan IPA Indonesia*, *7*(1), 54–65. https://doi.org/10.15294/jpii.v7i1.10495

Oktavia, Z., & Ridlo, S. (2020). Critical Thinking Skills Reviewed from Communication Skills of the Primary School Students in STEM-Based Project-Based Learning Model. *Journal of Primary Education*, *9*(3), 311–320. https://doi.org/10.15294/jpe.v9i3.27573

Paruntu, P. E., Sukestiyarno, Y. L., Priyono, A., & Prasetyo, B. (2018). Analysis of Mathematical Communication Ability and Curiosity Through Project Based Learning Models With Scaffolding. *Unnes Journal of Mathematics Education Research*, *7*(1), 26–34. https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/21864

Pratama, M. A. R., Cahyono, E., & Aggraito, Y. U. (2019). Implementation of problem based learning model to measure communication skills and critical thinking skills of Junior High School Students. *Journal of Innovative Science Education*, *8*(3), 324–331. https://doi.org/10.15294/jise.v8i1.30788

Ramdani, A., Jufri, A. W., Gunawan, G., Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of Students' Critical Thinking Skills in terms of Gender Using Science Teaching Materials Based on The 5E Learning Cycle Integrated with Local Wisdom. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 187–199. https://doi.org/10.15294/jpii.v10i2.29956

Ratnasih, T., & Garnasih, T. (2020). Conceptual Model of Early Childhood Islamic Learning in Islamic Kindergarten. *International Journal of Psychosocial Rehabilitation*, *24*(9), 1158–1167. https://rb.gy/gos5k

Saenab, S., Yunus, S. R., Saleh, A. R., Virninda, A. N., L, H., & Sofyan, N. A. (2018). Project-based Learning as the Atmoshphere for Promoting Students' Communication Skills. *Journal of Physics: Conference Series*, *1028*(1), 012026. https://doi.org/10.1088/1742-6596/1028/1/012026

Saputra, M. D., Joyoatmojo, S., Wardani, D. K., & Sangka, K. B. (2019). Developing critical-thinking skills through the collaboration of jigsaw model with problem-based learning model. *International Journal of Instruction*, *12*(1), 1077–1094. https://doi.org/10.29333/iji.2019.12169a

Siagan, M. V, Saragih, S., & Sinaga, B. (2019). Development of Learning Materials Oriented on Problem-Based Learning Model to Improve Students' Mathematical Problem Solving Ability and Metacognition Ability. *International Electronic Journal of Mathematics Education*, *14*(2), 331–340. https://doi.org/10.29333/iejme/5717

Sidiq, A. M., & Al Muairi, M. (2022). Social Development of Early Children in Online Learning in the Time of the Covid-19 Pandemic. *Indonesian Journal of Early Childhood Education Studies*, *11*(2), 146–156. https://doi.org/10.15294/ijeces.v11i2.57676

Stupple, E. J. N., Maratos, F. A., Elander, J., Hunt, T. E., Cheung, K. Y. F., & Aubeeluck, A. V. (2017). Development of the Critical Thinking Toolkit (CriTT): A measure of student attitudes and beliefs about critical thinking. *Thinking Skills and Creativity*, *23*, 91–100. https://doi.org/10.1016/j.tsc.2016.11.007

Surya, E., Syahputra, E., & Juniati, N. (2018). Effect of Problem Based Learning Toward MathematicalCommunication Ability and Self-Regulated Learning. *Journal of Education and Practice*, *9*(6), 14–23. www.iiste.org

Ulger, K. (2018). The Effect of Problem-Based Learning on the Creative Thinking and Critical Thinking Disposition of Students in Visual Arts Education. *Interdisciplinary Journal of Problem-Based Learning*, *12*(1). https://doi.org/10.7771/1541-5015.1649

Wahyudiati, D. (2022). Critical Thinking Skills and Scientific Attitudes of Pre-Service Chemistry Teachers Through the Implementation of Problem-Based Learning Model. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 216–221. https://doi.org/10.29303/jppipa.v8i1.1278

Wahyuni, A. (2018). The power of verbal and nonverbal communication in learning. *1st International Conference on Intellectuals' Global Responsibility (ICIGR 2017*, 80–83. https://doi.org/10.2991/icigr-17.2018.19

Wikaningrum, T., & Yuniawan, A. (2018). The relationships among leadership styles, communication skills, and employee satisfaction: A study on equal employment opportunity in leadership. *Journal of Business and Retail Management Research*, *13*(1), 105–120. https://doi.org/10.24052/JBRMR/V13IS01/ART-14