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Improving students' problem-solving skills through RIAS model in science classes

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ABSTRACT

Learning has indisputably been hampered throughout the Coronavirus 2019 pandemic, as perceived in undesirable observed phenomena such as students' ennui, learning loss, poor engagement, poor problem analysis skill, and inability to properly provide solutions to various predicaments. In view of this, the present study aimed to examine the effect of the Reading, Identification, Analysis, and Self-reflection (RIAS) learning model implemented in online learning to improve students' problem-solving skills. It was quasi-experimental research with a pretest and posttest control group design involving 60 undergraduate students in a general biology course. They were divided into two groups each of which consisted of 30 students, as the control and experimental class. The control class harnessed the lecture method while the experimental one executed the RIAS model. To collect the data, this study used an essay test consisting of 20 items with a reliability level of 0.886, and the figures were later scrutinized by means of descriptive and ANCOVA analysis. The results revealed that the RIAS model with reading, identification, analysis, and self-reflection techniques had a considerable impact on problem-solving skills, as evidenced by the mean score difference of 33.06 (low) and 66.33 (very high) between the lecturing and RIAS groups. The findings recommend that educators should simulate the RIAS model before online learning so that the learning activities can run as planned and that students can be more focused on the discussions of the learning topics. A further study could improve the quality of student activities at each stage of learning and develop teaching materials to support the RIAS learning model for a more qualified teaching-learning process and outcome.

Keywords: problem solving skills, RIAS model

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INTRODUCTION

Learning is an activity of teaching and learning for teachers and learners with the aim to facilitate learners to develop their cognitive, affective, and psychomotor skills. The eventual goal of learning is for students to be able to overcome problems that occur in their daily lives (Kurnianto & Haryani, 2020; Makhrus & Hidayatullah, 2021). Difficulties in everyday life, however, are certainly unpredictable, therefore hands-on and useful skills are needed in the current era.

Currently, the world has entered the industrial revolution 5.0 era marked by the internet of think, cloud computing, and cognitive computing. Other skills that must be mastered in the 5.0 revolution era, consequently, include data literacy and human literacy (Demir et al., 2019; Ellitan, 2020). These three challenges would be easily handled to meet human needs provided that humans have problem excellent solving skills. These skills can be defined as a set of competencies that can be used by a person to solve problems and make decisions as to the best solution. Problem-solving skills involve one's knowledge in connecting long-standing information with the new one in solving problems (Sari et al., 2020; Nirwana et al., 2021).

Skills in resolving problems are imperative for students to cultivate because they will

contribute to their motivation and a better cognitive level (Astuti et al., 2021). People who are unable to understand problems will not be able to find out and use the appropriate strategy for coping with problems they face (Arıkan & Ünal, 2015). Problem-solving skills, hence, should be trained to students throughout the learning process in order to create superior human resources who can solve any confronting challenges.

Currently, education has changed due to the Coronavirus 2019. It transforms face-to-face classrooms into online learning via virtual such as Zoom Meeting, Google Meeting, and learning management systems (LMS). These learning aids can properly function only if they are directed by lecturers and students to achieve their learning objectives. Based on a survey conducted by the authors on students at one of the universities in Indonesia with 303 participating students, it was found that most students perceive learning loss during the online learning process. It indicated that 75.9 % of the students were tired of learning; 67.3 % felt learning loss, and 61.1% underwent disoriented skills. Based on this preliminary study, students were bored with online learning, feel lost in learning, and feel lost in learning skills. This is supported by similar investigations that revealed that learning in the pandemic era partakes no progress for learners who employed the study-from-home learning scheme (Engzell et al., 2021; Kisno et al., 2021). Besides, students' solving skills were possibly at the low level as seen on the observations in the learning process, that students were passive, less capable to analyze problems, and are less qualified in providing solutions to a problem given by the lecturer.

To respond to this, learning innovation is needed, especially during online learning to avoid students' boredom and to develop the students' skills in solving daily problems. Currently, online learning has been carried out by lecturing through Zoom meetings, and techniques that require students to be active were also not carried out properly. Hence, this situation likely makes students feel that they have lost the skills needed. One of the learning innovations that is expected to improve student activities is the RIAS learning model which consists of the main steps of Reading, Identification, Analysis, and Self Reflection (Muhlisin et al., 2020). It is consistent with the constructivism theory that learners construct and create their knowledge according to what they have learned (Bhattacharjee, 2015; Bada & Olusegun, 2015; Fernando & Marikar, 2017). It also facilitates activities for the creation of a solution to problems being learned. The learning activity in this model is started from reading that can be conducted before the learning or the online learning is started; hence, discussion activities in the step of identification, analysis, and self-reflection conducted during the online learning could attract learners' interest, improve learners' activities, and enhance problem-solving.

This research is deemed important since it is an alternative for online science learning during the pandemic for activating students to learn and develop problem-solving skills through learning. As suggested, learning experiences that activate students during the learning process can improve problem-solving skills (Shieh & Chang, 2014), and there is a relationship between problem-solving skills and learning objectives to be achieved properly as the learning outcome. Assuming that someone can solve problems, students' cognitive knowledge will be linked to thinking activities. They can decide the best solution to solve problems (Becker & Park, 2011; Surya et al., 2017; Suparno et al., 2018). Reflecting on the emerging challenges and the benefits of the aforementioned model, therefore, this investigation aimed to examine the effect of the RIAS learning model in online learning through Zoom meetings to improve problem-solving skills. The essential findings of the study are expected to provide considerations for teachers and lecturers to use the RIAS learning model learning framework (reading, identification, analysis, and self-reflection) through Zoom meetings as an alternative to science learning to improve problem-solving skills to reduce learning loss.

METHOD

Design

This research was carried out in the Science Education Study Program in the General Biology Course with the topics of (1) microorganisms and their role in life; (2) the role of plants in life; (3) imbalance factors in the ecosystem; (4) structure, function, and process as well as abnormalities/diseases that occur in organ systems of living things; and (5) factors affecting metabolic processes in living things. The objectives of these topics require students to identify and solve problems faced in daily life. Conducted in 14 meetings in one cycle from March 2021 to August 2021, the class could cover all topics whether in the control or experiment group, since

this research employed a quasi-experimental design with a pre-test and post-test control group design with a total of 60 students. The research design can be seen in Table 1.

Table 1. Quasi experiment with pre-test post-test control group design

Pre-test	Treatment	Pos-test
Pre-test scores	RIAS Model in Online Learning*	Post-test score
Pre-test scores	Lecturing model in online learning	Post-test score

*Note: *The online learning referred to in this study is teaching and learning activities using Zoom meetings*

Learning activities conducted in both classes had the same duration of 100 minutes for each meeting. While learning activities with the lecturing model in online learning comprise three phases, namely introduction, core activities, and closing. Table 2 presents the detailed stages, duration for each phase, and examples of activities implemented in the class.

Table 2. Learning stages of the lecturing model

No	Phase	Activity	Duration (In minute)
1.	Introduction	Lecturer checked the students' attendance	10
2.	Core Activities	• Students presented their topic in groups	40
		• Students listened as the lecturer explained the materials using PowerPointslides	40
		• Students asked questions	5
3.	Closing	The students and lecturer concluded what they learned	5

Based on Table 2, the learning process in the control group was conducted via the lecturing method with groups alternately made presentations based on the agreed schedule via Zoom meetings. The learning process, however, was more about the lecturer's explanation compared to students' activities. Next, the learning steps of the RIAS Model applied in the online learning can be seen in Table 3.

Table 3. Learning steps of RIAS model in the online class

No	Phase	Step	Example of Activity	Duration (In minute)
1.	Reading	Students read information related to the topic being studied	Before the class, students read some information from the internet related to the concept of photosynthesis in plants.	-
			At the beginning of the class, students re-read the materials.	15
2.	Identification	Students in groups identify phenomena or problems found in the material they have read	Students identified via group discussions various kinds of problems that occur in photosynthesis in the breakout room of zoom meetings.	35
3.	Analysis	Students in groups analyze and provide several options to solve the problem	Students analyzed via group discussions the factors that affect photosynthesis accompanied by arguments based on valid data and references. Students also suggested solutions to cope with problems in photosynthesis.	40
4.	Self-reflection	Students conduct self-evaluation individually regarding the solution as a priority choice in solving problems	Students evaluated individually various solutions from group discussion results to choose the most appropriate solution to overcome problems in photosynthesis. Furthermore, students convey the results of their evaluations to all students so that conclusions can be drawn classically.	10

Table 3 indicates that the learning process was conducted online via zoom meetings using RIAS learning model steps has the same duration as the previous learning model. The learning activities facilitate students to be active in learning to identify problems and solve them in groups. Through these activities, students are expected to acquire skills needed in everyday life.

Sampling

The subjects in this study were 60 students who took General Biology courses at Science Education Study Program, Universitas Tidar. They were divided into two classes consisting of 30 students for each. The control class applied the lecturing method in online learning, while the experimental class applied the RIAS Model. All classes were done synchronously.

Instrument

The instrument used in this research was an essay test with 20 questions. Each question employed 1-4 assessment rubrics resulting in a maximum score of 80 and a minimum score of 20. The scores would be a basis for creating interval ranges for the determination of score categories, namely criteria of 20 – 35 is low, 36 – 50 is fair, 51 – 65 is a high category, and 66 – 80 is a very high category. This test was used in pretest and posttest in both RIAS Model and lecturing model in the online learning. An essay test was used to measure problem-solving skills in which each question was integrated with problem skill indicators consisting of problem identification, problem analysis, solution identification, solution evaluation, and defending the solution (Zubaidah, 2018; Muhlisin et al., 2020). Based on the result of the Pearson Correlation Product moment validity test, and the help of SPSS 23, all questions were deemed valid with a 0.886 reliability score. The rubric was used to measure students' problem-solving skills according to the results of the learning previously conducted. The problem-solving skills rubric can be seen in Table 4.

Table 4. Assessment rubric in measuring problem solving skills

Problem Solving Skill Indicators	Score 4	3	2	1
Problem identification	The answer can clearly describe the problem and relate it with conditions supported with some data	The answer can describe the basics of the problem with some supporting data and information	The answer can explain some problems but have trouble in understanding all parts of the problems	The answer is having trouble in identifying and explaining parts of the problem
Problem analysis	The answer can identify key issues, set priorities, and see unwritten implications. The answer shows complex ideas from multiple perspectives	The answer can identify and understand the main problem, but the rationale assessment has not been developed yet	The answer can describe the main problem but is unclear. The answer is unable to look at the problem wisely and objectively	The answer shows that the writer needs help in understanding problems and drawing simple conclusions
Solution identification	The answer has at least 4 viable solutions and describes them clearly	The answer offers two or three reasonable solutions	The answer explains one or two possible solutions	The answer cannot give any solution
Solution evaluation	The answer can evaluate and analyze all possible solution options before deciding on the most feasible solution	The answer can make a reasonable judgment about the choice of solutions and take one that makes sense	The answer can compare the options and choose one to use	The questions may be answered, but it may not be a good choice.
Defending the solution	The answer can analyze all solutions and choose the one that shows the understanding of the problem and the solution	The answer can evaluate solutions and choose one that seems feasible	The answer can give a simple explanation for one reasonable choice	The answer cannot explain a solution. It was just thought randomly

Sources: Modified from Zubaidah (2018) & Muhlisin et al. (2020)

Before this essay test was used, it was preliminarily tested on 20 students who had taken a General Biology course to determine the validity and reliability of the items. The validity of the questions used the Pearson Correlation product-moment validity test and SPSS 23, gaining a validity value of 0.886. It means that the test questions are declared valid. Furthermore, the questions were tested for reliability with Cronbach's Alpha test of 0.886>0.60, meaning that the questions were declared reliable to measure problem-solving skills.

The implementation of the RIAS model class in online learning was evaluated as supporting data that the influence of problem-solving skills is the result of good implementation of the learning process activities. The measurement of the learning implementation used an observation instrument assessed by two observers in the learning steps that were consistent with the planned learning process. Aspects observed in the implementation of learning include 1) the introduction that can be seen from providing motivation and arousing students' curiosity about the studied material; 2) reading steps; 3) problem identification step; 4) problem analysis step; 5) self-evaluation step; and 6) steps to conclude and provide reinforcement to the implemented learning process. Scores used to assess each activity consisted of 0 (not implemented), 1 (poor), 2 (fair), (good), and 4 (very good) (Ismirawati et al., 2015).

Research procedure

The research procedure consists of several steps, i.e., 1) surveys related to learning activities and student responses in learning; 2) review of references; 3) determining the trial subject and research design; 4) instrument development and instrument test; 5) treatment of the test subject; 6) data collection and analysis; and 7) conclusion and recommendation (Sugiyono, 2017).

Data analysis

The data in this study were analyzed through the ANCOVA test with the pretest as a covariate (Zubaidah et al., 2018) carried out as a requirement for the ANCOVA test by testing the normality and homogeneity of the data through the SPSS 23 program. The results of the normality and homogeneity tests were concluded to be normally distributed and homogeneous. Detailed results can be seen in Table 5.

Table 5. Normality and Homogeneity Test Results

Test	df	P-value	Criteria	Conclusion
Test of Normality	60	0.304	$P \geq 0.05$	Normal
Test of Homogeneity of Variances	60	0.724	$P \geq 0.05$	Homogeneous

Based on Table 5, the normality test for the pre-test in the experimental class and the control class gained a p-value of 0.304≥0.05 which can be concluded that the data is normally distributed. Furthermore, the data were tested for homogeneity with a p-value of 0.724 ≥0.05 which proved that the data were homogeneous.

FINDING AND DISCUSSION

Finding

The research aimed to examine the effect of the RIAS learning model implemented in online classes through Zoom meetings in improving learners' problem-solving skills. The data were collected from pretest and posttest essay questions administered to students applying both the RIAS model and lecturing method. Responses to essay questions were used as data to test the effect of the implementation of the learning model in online learning. Overall, the mean score for problem-solving skills can be seen in Figure 2.

The values obtained were grouped according to the category intervals, namely value of 20 – 35 is Low category, 36 – 50 is Fair category, 51 – 65 is High category, and 66 – 80 is Very High category. Based on Figure 2 it is obtained that the mean score of the pre-test in the lecturing model and that of the RIAS model shows no significant difference in which both are low, 33.10 and

33.56 consecutively. On the other hand, the mean score of the post-test indicates a significant difference between the control and experiment class as seen from the comparison of the mean score of 33.06 (Low) and 66.33 (Very High). Furthermore, the results of problem-solving skills were grouped based on indicators of problem identification, problem analysis, identification of solutions, evaluation of solutions, and defending solutions. In detail, the improvement of problem-solving skills for each indicator can be seen in Table 6.

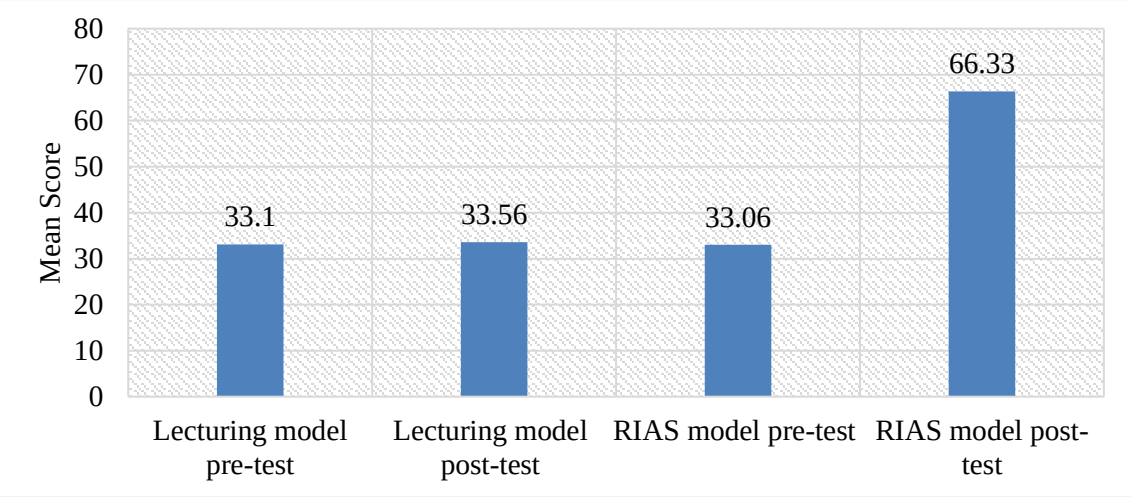

Figure 2. Mean Score of Problem-Solving Skills

Table 6. Recapitulation of problem-solving skills' improvement of each indicator

Problem Solving Skills Indicators	Lecturing model in online learning		Improvement Value	RIAS Model in online learning		Improvement Value
	Mean score of pre-tests	Mean score of post-tests		Mean score of pre-tests	Mean score of post-tests	
Identification of Problem	1.42	1.44	0.02	1.42	2.72	1.30
Problem analysis	1.37	1.37	0.00	1.37	2.63	1.26
Identify solutions	1.29	1.30	0.01	1.28	2.64	1.36
Solution evaluation	1.29	1.34	0.05	1.29	2.66	1.37
Defending solution	1.24	1.27	0.03	1.24	2.60	1.36
Mean			0.02			1.33

Table 6 displays that the increase of mean score in the RIAS Model in online learning (0.02) is higher than that in the lecturing model in online learning (1.33). It can be concluded that the implementation of the RIAS model in online learning is relatively more effective for improving problem skills than the lecturing model in online learning. Furthermore, data on the implementation of the RIAS model in online learning were gathered as evaluated by using an observation instrument by two observers. The results of such observation are presented in Table 7.

Table 7 demonstrate that the implementation of each step of the RIAS model learning in online learning is in the Very Good category. It indicates that all learning steps in the class of RIAS model in online learning from the beginning of learning to the end of learning can activate students to achieve predetermined learning goals. Referring to the observers' findings, however, the learning activities at the beginning of learning using the RIAS model faced obstacles, namely inappropriate time for the specified activities and a lack of discussion focus on the determined topics. Moreover, to see the effect of the implementation of the learning model, the ANCOVA test was carried out with the pretest as a covariate. ANCOVA test results can be seen in Table 8.

Table 7. Recapitulation of the mean score of the learning process implementation on the RIAS model in online learning

No	Aspect	Mean
1.	Introduction: motivating students and arousing students' curiosity about the study material	4.00
2.	Reading step	4.00
3.	Problem identification step	3.50
4.	Problem analysis step	3.50
5.	Self-evaluation step	4.00
6.	Concluding learning and reinforcing the implemented learning process	4.00

Table 8. ANCOVA test results of the learning model implementation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16112.288[a]	2	8056.144	230.226	0.000
Intercept	1113.825	1	1113.825	31.831	0.000
Pre-test	7.471	1	7.471	0.214	0.646
Learning Model	16108.081	1	16108.081	460.332	0.000
Error	1994.562	57	34.992		
Total	167807.000	60			
Corrected Total	18106.850	59			

From the results of the ANCOVA test in Table 8 information that the source of the learning model p is smaller than α 0.05 ($p \leq 0.05$) with sig. 0,000 was gained. It indicates that there are differences in problem-solving skills between students who studied with the RIAS model in online learning and those with online lecturing. Therefore, it can be concluded that there is an effect of the RIAS model in online learning on students' problem-solving skills.

Discussion

The results of the analysis show that the implementation of the RIAS model in online learning has a higher influence than that of the lecturing model in online learning on students' problem-solving skills. This, however, can be influenced by several factors. The improvement of problem-solving skills in the RIAS model in online learning can be induced by the learning process that facilitates students to be able to construct knowledge used in solving problems. This is in line with the idea that learning which facilitates students in constructing knowledge can improve problem-solving (Wu & Wang, 2012; Özden & Yenice, 2020; Ilma et al., 2020).

In the Student activities in constructing knowledge as the basis for problem-solving were carried out by students at the reading stage. Reading activities have the advantage for students to seek a variety of knowledge from various learning sources, and this can increase students' curiosity about the study material being studied. Reading activities mean that students are in a critical thinking process so that students can understand the content of the reading, and identify the main ideas (Samani et al., 2019; Setiawati & Corebima, 2017; Mokhtari et al., 2018). A reading technique that is often used by students to understand a reading or find important information is underlining or circling the information in the text to help them to remember the information (Küçükoğlu, 2013; Solak & Altay, 2014). This is supported by research that applies reading activities in learning to improve problem-solving skills (Özsoy et al., 2015; Nicolas & Emata, 2018).

The knowledge or information that has been built by students is then used as a basis for carrying out problem identification in accordance with the materials studied by students. Problem identification activities were carried out in heterogeneous groups by describing the problem and relating it with conditions accompanied by some supporting data based on valid information. In problem identification activities, the students were facilitated to think based on data and evidence (Oliveras et al., 2013; Setiawati & Corebima, 2017). This is supported by research that states that problem identification activities are one of the skills in the scientific method that can improve

problem-solving skills (Mukhopadhyay, 2013; Reddy & Panacharoensawad, 2017; Batlolona et al., 2018).

The description of the problem accompanied by valid data and information was then used by students to carry out problem analysis activities. In this activity, students identified major problems and understand complex ideas from multiple perspectives. This activity facilitates students to practice understanding the main problem to improve problem-solving (Prahani et al., 2020); (Astuti et al., 2021). The ability to understand the main problem and to express ideas from various points of view is used to provide several solutions and to set priorities in solving the problem. This is in accordance with research which supports the idea to set priority solutions (Apriyani et al., 2019; Hidayati & Wagiran, 2020; Cho & Kim, 2020).

Besides, heterogeneous group activities facilitated in learning activities at the stage of problem identification and analysis facilitated active students to exchange ideas and solve problems together. Group discussion activities are able to straddle students who are less active to become active so that there is an even distribution of understanding among group members (Rachmawati, 2018; Muhlisin et al., 2020). Group problem-solving activities, therefore, can improve group solving skills (Hagemann & Kluge, 2017; Anggraini & Amin Fauzi, 2017).

The final step of the RIAS learning model that facilitates students to improve problem-solving skills is independent evaluation activity. Independent evaluation activities focus on a priority choice solution in solving problems. This activity means that students think comprehensively starting from data, identification, analysis, and the advantages and disadvantages of the solutions that have been set. Evaluating the advantages and disadvantages of a solution can improve problem-solving skills (Klegeris et al., 2013; Cheng et al., 2018). Previous investigations shos that students who can evaluate predetermined solutions are able to improve problem-solving skills (Sivaci, 2017; Sudirman et al., 2017).

In general, the learning process was carried out well according to the results presented in Table 7. The obstacle found in the research that has been carried out includes that student were not accustomed to conducting group discussion activities in online learning via Zoom meetings. It takes more time because they had to go in and out of the provided room for online learning and it took more time. The solution to overcome this was emphasizing the main discussion and providing direction about the agreed time in the lesson plan to be carried out properly.

CONCLUSION

The research to examine the influence of the RIAS learning model in online learning has been proven capable to improve students' problem-solving skills. BESIDES, the learning process in the RIAS model in online learning could be well implemented and activate students' learning activities. As the scientific contribution, the results of this study confirm that problem-solving skills can be improved through a learning process that facilitates the scientific process of identifying problems, analyzing problems, and providing solutions. Practically, this research is an alternative learning innovation during the pandemic with a framework in compliance with steps of reading, problem identification, problem analysis, and self-reflection. Further research could improve the quality of student activities for each step of learning and develop teaching materials that implement the RIAS learning model for the implementation of the learning process to become more qualified. The findings of the present study also recommend that educators should give simulation of the RIAS model before online learning and train students to focus more on the discussion topics so that learning activities can run within the specified time.

REFERENCES

Anggraini, L., & Amin Fauzi, K. M. (2017). Implementation of group investigation learning model to improve problem solving ability in class VIII SMP Negeri 11 Medan. *Inspiratif: Jurnal Pendidikan Matematika*, *3*(3), 72–81. https://doi.org/10.24114/jpmi.v3i3.8978

Apriyani, R., Ramalis, T. R., & Suwarma, I. R. (2019). Analyzing student's problem-solving abilities of direct current electricity in STEM-based learning. *Journal of Science Learning*, *2*(3), 85–91. https://doi.org/10.17509/jsl.v2i3.17559

Arıkan, E. E., & Ünal, H. (2015). Investigation of problem-solving and problem-posing abilities of seventh-grade students. *Kuram ve Uygulamada Egitim Bilimleri*, *15*(5), 1403–1416. https://doi.org/10.12738/estp.2015.5.2678

Astuti, N. H., Rusilowati, A., & Subali, B. (2021). STEM-Based learning analysis to improve students' problem-solving abilities in science subject: A literature review. *Journal of Innovative Science Education*, *9*(3), 79–86. https://doi.org/10.15294/jise.v9i2.38505.

Bada & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *IOSR Journal of Research & Method in Education (IOSR-JRME), 5(6), 66-70.*

Batlolona, J. R., Baskar, C., Kurnaz, M. A., & Leasa, M. (2018). The improvement of problem-solving skills and physics concept mastery on temperature and heat topic. *Jurnal Pendidikan IPA Indonesia*, *7*(3), 273–279. https://doi.org/10.15294/jpii.v7i3.12432

Becker, K., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary. *Journal of STEM Education*, *12*(5), 23–38. file:///Users/ruthsc/Downloads/out (1).pdf

Bhattacharjee, J. (2015). Constructivist approach to learning-an effective approach of teaching learning. *International Research Journal of Interdisciplinary & Multidisciplinary Studies (IRJIMS), 1(7), 65-74.*

Cheng, S. C., She, H. C., & Huang, L. Y. (2018). The impact of problem-solving instruction on middle school students' physical science learning: Interplays of knowledge, reasoning, and problem solving. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(3), 731–743. https://doi.org/10.12973/ejmste/80902

Cho, M. K., & Kim, M. K. (2020). Investigating elementary students' problem solving and teacher scaffolding in solving an Ill-structured problem. *International Journal of Education in Mathematics, Science and Technology*, *8*(4), 274–289. https://doi.org/10.46328/IJEMST.V8I4.1148

Demir, K. A., Döven, G., & Sezen, B. (2019). Industry 5.0 and human-robot co-working. *Procedia Computer Science*, *158*, 688–695. https://doi.org/10.1016/j.procs.2019.09.104

Ellitan, L. (2020). Competing in the era of industrial revolution 4.0 and society 5.0. *Jurnal Maksipreneur: Manajemen, Koperasi, dan Entrepreneurship*, *10*(1), 1. https://doi.org/10.30588/jmp.v10i1.657

Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(17). https://doi.org/10.1073/PNAS.2022376118

Fernando, S., & Marikar, F. (2017). Constructivist teaching/learning theory and participatory teaching methods. *Journal of Curriculum and Teaching, 6(1), 110-122.*

Hagemann, V., & Kluge, A. (2017). Complex problem solving in teams: The impact of collective orientation on team process demands. *Frontiers in Psychology*, *8*(SEP), 1–17. https://doi.org/10.3389/fpsyg.2017.01730

Hidayati, R. M., & Wagiran, W. (2020). Implementation of problem-based learning to improve problem-solving skills in vocational high school. *Jurnal Pendidikan Vokasi*, *10*(2), 177–187. https://doi.org/10.21831/jpv.v10i2.31210

Ilma, S., Al-Muhdhar, M. H. I., Rohman, F., & Saptasari, M. (2020). The correlation between science process skills and biology cognitive learning outcome of senior high school

students. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *6*(1), 55–64. https://doi.org/10.22219/jpbi.v6i1.10794

Ismirawati, N., Corebima, A., Zubaidah, S., & Syamsuri, I. (2015). Prototipe model pembelajaran ercore (elicitation, restructuring, confirmation, reflection) untuk memberdayakan keterampilan metakognisi. SNPS V, 227-239.

Kisno et al. (2021). *Teachers' learning loss diminution through self-phased learning with guru binar*. *24*(1), 17–26.

Klegeris, A., Bahniwal, M., & Hurren, H. (2013). Improvement in generic problem-solving abilities of students by use of tutor-less problem-based learning in a large classroom setting. *CBE Life Sciences Education*, *12*(1), 73–79. https://doi.org/10.1187/cbe.12-06-0081

Küçükoğlu, H. (2013). Improving reading skills through effective reading strategies. *Procedia - Social and Behavioral Sciences*, *70*, 709–714. https://doi.org/10.1016/j.sbspro.2013.01.113

Kurnianto, B., & Haryani, S. (2020). Critical thinking skills and learning outcomes by improving motivation in the model of flipped classroom. *Journal of Primary Education*, *8*(6), 282–291.

Makhrus, M., & Hidayatullah, Z. (2021). The role of cognitive conflict approach to improving critical thinking skills and conceptual understanding in mechanical waves. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *11*(1), 63–70.

Mokhtari, K., Dimitrov, D. M., & Reichard, C. A. (2018). Revising the metacognitive awareness of reading strategies inventory (MARSI) and testing for factorial invariance. *Studies in Second Language Learning and Teaching*, *8*(2 Special Issue), 219–246. https://doi.org/10.14746/ssllt.2018.8.2.3

Muhlisin, A., Siswanto, S., Singgih, S., Dewantari, N., & Mohtar, L. E. (2020). Integration PBL with RMS: Improving problem solving skills on environmental education. *Biosfer*, *13*(2), 155–166. https://doi.org/10.21009/biosferjpb.v13n2.155-166

Mukhopadhyay, D. R. (2013). Problem solving in science learning - some important considerations of a teacher. *IOSR Journal of Humanities and Social Science*, *8*(6), 21–25. https://doi.org/10.9790/0837-0862125

Nicolas, C. A. T., & Emata, C. Y. (2018). An integrative approach through reading comprehension to enhance problem- Solving skills of Grade 7 mathematics students. *International Journal of Innovation in Science and Mathematics Education*, *26*(3), 40–64.

Nirwana, M., Mohamad Nur, & Budi Jatmiko. (2021). The problem-solving skills profile of tsanawiyah islamic school students in the vibration, wave, and sound learning Materials. *IJORER: International Journal of Recent Educational Research*, *2*(2), 158–170. https://doi.org/10.46245/ijorer.v2i2.86

Oliveras, B., Márquez, C., & Sanmartí, N. (2013). The use of newspaper articles as a tool to develop critical thinking in science classes. *International Journal of Science Education*, *35*(6), 885–905. https://doi.org/10.1080/09500693.2011.586736

Özden, B., & Yenice, N. (2020). The effect of common knowledge construction model-based teaching on the cognitive and psychomotor learning of 7th grade students. *Journal of Science Learning*, *4*(1), 31–40. https://doi.org/10.17509/jsl.v4i1.25607

Özsoy, G., Kuruyer, H. G., & Çakiroğlu, A. (2015). Evaluation of students' mathematical problem-solving skills in relation to their reading levels. *International Electronic Journal of Elementary Education*, *8*(1), 581–600.

Prahani, B. K., Ramadani, A. H., Kusumawati, D. H., Suprapto, N., Madlazim, M., Jatmiko, B., Supardi, Z. A. I., Mubarok, H., Safitri, S., & Deta, U. A. (2020). ORNE Learning model to

improve problem-solving skills of physics bachelor candidates: An alternative learning in the Covid-19 pandemic. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, *10*(1), 71. https://doi.org/10.26740/jpfa.v10n1.p71-80

Rachmawati, R. I. (2018). Pengaruh penerapan metode problem solving dan metode group investigation terhadap kemampuan berpikir kritis siswa dilihat dari kemampuan awal. *Indonesian Journal of Economic Education (IJEE)*, *1*(1), 85–102. https://doi.org/10.17509/jurnal

Reddy, M. V. B., & Panacharoensawad, B. (2017). Students problem-solving difficulties and implications in physics: An empirical study on influencing factors. *Journal of Education and Practice*, *8*(14), 59–62.

Samani, M., Sunwinarti, S., Putra, B. A. W., Rahmadian, R., & Rohman, J. N. (2019). Learning strategy to develop critical thinking, creativity, and problem-solving skills for vocational school students. *Jurnal Pendidikan Teknologi dan Kejuruan*, *25*(1), 36–42. https://doi.org/10.21831/jptk.v25i1.22574

Sari, A. N., Rosidin, U., & Abdurrahman, A. (2020). Developing an instrument of performance assessment to measure problem-solving skills of senior high school students in physics inquiry-based learning. *Scientiae Educatia*, *9*(1), 1. https://doi.org/10.24235/sc.educatia.v9i1.5654

Setiawati & Corebima. (2017). Empowering critical thinking skills of the students having different academic ability in biology learning of senior high school through PQ4R - TPS strategy. *The International Journal of Social Sciences and Humanities Invention*, *4*(5), 3521–3526. https://doi.org/10.18535/ijsshi/v4i5.09

Shieh, R. S., & Chang, W. (2014). Fostering student's creative and problem-solving skills through a hands-on activity. *Journal of Baltic Science Education*, *13*(5), 650–661.

Sivaci, S. Y. (2017). The relationship between reflective thinking tendencies and social problem-solving abilities of pre-service teachers. *Journal of Education and Training Studies*, *5*(11), 21. https://doi.org/10.11114/jets.v5i11.2273

Solak, E., & Altay, F. (2014). *The reading strategies used by prospective english teachers in Turkish ELT context*. *1*(3), 78–89.

Sugiyono. (2017). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Sudirman, M., Fatimah, S., & Jupri, A. (2017). Improving problem solving skill and self regulated learning of senior high school students through scientific approach using quantum learning strategy. *International Journal of Science and Applied Science: Conference Series*, *2*(1), 249. https://doi.org/10.20961/ijsascs.v2i1.16720

Suparno et al. (2018). Student learning achievement in the concrete. *Applying The Problem-Solving Method to Improve Student Learning Achievement in the Concrete Construction 1 Course*, *201*(Aptekindo), 234–238.

Surya, E., Putri, F. A., & Mukhtar. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education*, *8*(1), 85–94. https://doi.org/10.22342/jme.8.1.3324.85-94

Wu, B., & Wang, M. (2012). Integrating problem solving and knowledge construction through dual mapping. *Knowledge Management and E-Learning*, *4*(3), 248–257. https://doi.org/10.34105/j.kmel.2012.04.021

Zubaidah et al. (2018). Using remap-TmPS learning to improve low-ability students' critical thinking skills. *Asia-Pacific Forum on Science Learning and Teaching*, 19(1), 2-29.