



The Effectiveness of DISTAD Learning Model on Metabolism Material for Critical Thinking Ability of High School Students

Siwi Pratiwi Prabandari, Siti Alimah¹✉

Biology Department, FMIPA, Universitas Negeri Semarang, Indonesia

Info Article

History Article:

Received : July 2023

Accepted : July 2023

Published : November 2023

Keywords:

DISTAD Learning, critical thinking skills

Abstract

Metabolic material has its own level of difficulty compared to other materials, because the material is difficult for the eye to perceive directly and involves a long process of enzymatic reactions. Metabolism learning at SMA Negeri 1 Karangobar is less interactive causing students to be less critical in understanding material concepts. One alternative to improve critical thinking skills is the DISTAD Learning model (integration of the Discovery Learning model and the Student Teams Achievement Division model). The purpose of this study was to analyze the effectiveness of the DISTAD Learning model on metabolic material on high school students' critical thinking skills. This research is a quantitative research with the type of experimental research using the Pre-Experimental Design in the form of one group pretest-posttest design. The population of this study were students of class XII MIPA 1 to XII MIPA 5 SMA Negeri 1 Karangobar for the academic year 2022/2023. Sampling was carried out using saturated sampling technique. The data collection technique used the test method and the students' critical thinking skills were tested with the One Sample T-test. The increase in students' critical thinking skills was seen from the average student score after participating in the DISTAD Learning model learning of 78.6 which was included in the high category with 76% of students obtaining grades \geq KKM. Based on the calculation of the N-Gain test, there was an increase in three aspects of students' critical thinking skills, namely the aspect of giving simple explanations of 0.54, the aspect of making conclusions by 0.38, and the aspect of making further explanations of 0.61, where in the third This aspect shows the moderate category. In the analysis of the One Samples T-test showed a significance value of 0.000 (<0.05). The conclusion of this study is that the application of the DISTAD Learning model is effective in increasing the critical thinking skills of high school students.

© 2023 Universitas Negeri Semarang

✉ Correspondence:
D6 Building 1st Floor Jl Raya Sekaran Gunungpati Semarang
E-mail: siti_alimah@mail.unnes.ac.id

INTRODUCTION

Metabolism material has its own level of difficulty compared to other materials, because the material is difficult to sense directly with the eye. Metabolism material is divided into 2 sub-materials, namely catabolism and anabolism, both of which require enzymatic reactions with long processes and involve chemical compounds, so that students tend to have difficulty understanding the material (Adji, 2021). Characteristics of metabolic material that requires in-depth understanding, so learning must be carried out by strengthening students' understanding of concepts. Students' ability to understand concepts is closely related to students' critical thinking skills (Putri *et al.*, 2019). Aspects of critical thinking that are used include the ability to provide simple explanations (*elementary clarification*), make conclusions (*inference*), and make further explanations (*advanced clarification*), because these aspects are relevant for metabolic material.

Based on the results of interviews with biology teachers at SMA Negeri 1 Karangobar, Banjarnegara Regency, problems were found regarding the implementation of biology learning, especially on metabolism material. Students must understand a long process with many terms to remember. Teaching materials that are often used by teachers are textbooks and student worksheets. The lesson plan used as a learning guide for metabolism material, the core of learning is more dominant in student activities that pay attention to the teacher's explanation. This causes the process of conveying information to only rely on one direction, namely the teacher, without discussions with students so that students are less critical in understanding the material, and students will easily forget the material that has been presented.

Students' critical thinking skills can be improved by learning innovations (Agnafi, 2019). Learning innovations can be applied by using relevant and interesting learning media, for example by using learning media crossword puzzles. Learning media using crossword puzzles have a positive effect on students' critical thinking skills in biology learning (Eriska, 2018). The use of learning media can be supported by learning innovations, one of which is by applying the Discovery Learning learning model. Yachsan *et al.* (2016) stated that the application of the Discovery Learning learning model improved students' critical thinking skills, which was indicated by an increase in students' cognitive learning outcomes in the coordination system material. This is because in the application of the Discovery Learning learning model, students are given the freedom to build their own knowledge about metabolic material, so that learning activities can be more meaningful for students.

Meaningful learning for students can be done by applying the cooperative learning model of the Student Teams Achievement Division (STAD) type. The advantage of the STAD model is that there is cooperation between group members so that they can motivate and assist each other in understanding the material so as to trigger better learning outcomes (Hanggara & Wajubaidah, 2015).

Based on the explanation above, it is necessary to conduct research on learning model innovation by integrating Discovery Learning and STAD learning models. The Discovery Learning learning model has the characteristics of building students' understanding through their own observations, so that students can be trained to think critically (Khaeruddin, 2017). To support Discovery Learning, a STAD learning model is needed that refers to group activities, so that students can work together and help each other in developing critical thinking skills on metabolic material. The use of 3D metabolism crossword puzzles makes it easier for students to realize their understanding and remember the material, thereby helping students understand the complexities of metabolism material.

Research on the integration between Discovery Learning and STAD assisted 3D metabolism crossword puzzle learning models called DISTAD Learning has never been done before. DISTAD Learning directs students to solve problems regarding metabolic processes, so that it will lead to students' critical thinking skills that are relevant to the demands of 21st century education. Changes in 21st century education are marked by a learning orientation that leads to the learning process so that teachers must be able to provide stimulus, guidance, direction, and encouragement to students so that a process of forming knowledge occurs through their cognitive performance (Mardhiyah *et al.*, 2021). This challenge requires teachers as teachers to be able to make learning more innovative and effective (Tarihoran, 2019).

RESEARCH METHOD

This type of research is experimental research using the Pre-Experimental Design in the form of one group pretest-posttest design. The population in this study were all class XII MIPA students at SMA Negeri 1 Karangobar for the 2022/2023 academic year. Sampling was carried out using a saturated sampling technique consisting of 5 classes, namely class XII MIPA 1, XII MIPA 2, XII MIPA 3, XII MIPA 4, and XII MIPA 5. Test instruments to measure critical thinking skills in the aspect of ability to provide simple explanations (*basic clarification*), make conclusions (*inference*), and make further explanations (*advanced clarification*). The test instrument was arranged using multiple choice questions consisting of 25 questions. The effectiveness in this study was determined by the increase or difference in the average student score with the Standard of Minimum Completeness (KKM) score set in Biology learning at SMA Negeri 1 Karangobar. The technique of analyzing the effectiveness of the DISTAD Learning model is determined from the following criteria:

1. 75% of students score \geq KKM or \geq 70
2. The N-Gain value is in the medium to high category
3. The significance of student scores $>$ 70 with the One Sample T-Test.

RESULTS

This research was conducted at SMA Negeri 1 Karangobar Banjarnegara with a sample of all XII MIPA classes at SMA Negeri 1 Karangobar, totaling five classes, namely class XII MIPA 1, XII MIPA 2, XII MIPA 3, XII MIPA 4, and XII MIPA 5. The variable that was measured in this study was students' critical thinking skills. Students' critical thinking skills before and after learning are measured by working on pre-test and post-test questions.

Table 1 Results of Pretest and Post-test Descriptive Analysis of Students' Critical Thinking Ability

Information	Pretest	Post-test
Maximum Value	76	100
Minimum Value	24	60
Average Value	49.58	78.6

Based on Table 1, it shows that the experimental class before and after being treated with the DISTAD Learning model experienced an increase in critical thinking skills. Students' initial ability to think critically before participating in metabolic learning using the DISTAD Learning model shows an average of 49.58 which is a low-level critical thinking category. Whereas after participating in metabolism learning using the DISTAD Learning model it showed an increase in the average score to 78.67 which is included in the high category. The results of students' critical thinking skills showed an increase due to the application of the DISTAD Learning model.

The effectiveness of the DISTAD Learning model is determined by the following criteria:

1. 75% of students score \geq KKM or \geq 70
2. The N-Gain value is in the medium to high category
3. The significance of student scores $>$ 70 with the One Sample T-Test.

Table 2 Post-test Results of Students' Critical Thinking Ability

Class	Class Intervals	Frequency	Relative Frequency (%)
1	60-64	24	14
2	65-69	17	10
3	70-74	21	12
4	75-79	22	13
5	80-84	43	25
6	85-89	14	8
7	90-94	17	10
8	95-99	9	5
9	100-104	5	3
Sum		172	100

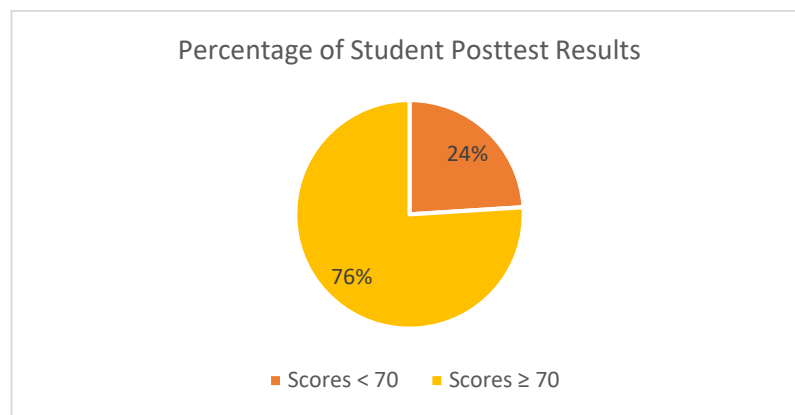


Figure 1 Percentage of Student Post-test Results

Table 2 and Figure 1 show the Minimum Completeness Criteria (KKM) after carrying out metabolic learning with the DISTAD Learning model, 76% of students scored ≥ 70 . This shows that most students have succeeded in achieving the predetermined competencies.

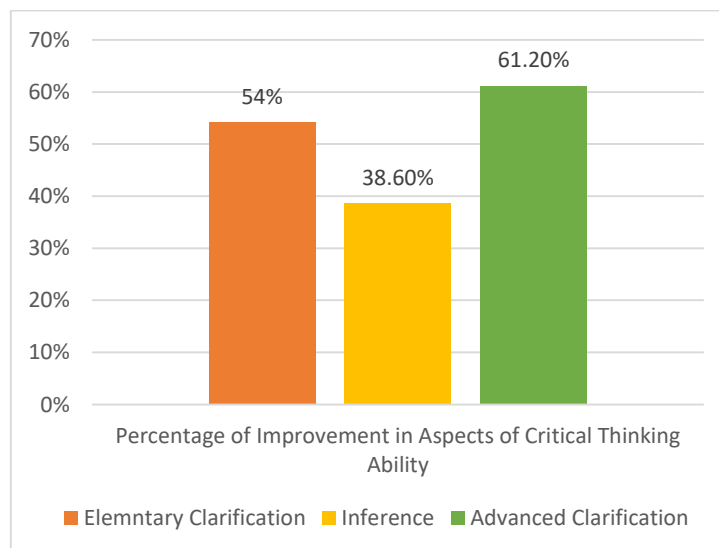


Figure 2 Percentage of Increasing Students' Critical Thinking Ability Per Aspect of Critical Thinking

Figure 2 shows the criteria for the N-Gain test to determine the increase in students' critical thinking skills in three aspects of critical thinking. Aspects of critical thinking used include aspects of providing simple

explanations (elementary clarifications), making conclusions (inferences), and making further explanations (advanced clarifications) showing an increase in all aspects. The N-Gain test results on the aspect of providing a simple explanation (elementary clarification) of 0.54, on the aspect of making conclusions (inference) of 0.38, and on the aspect of making further explanation (advanced clarification) of 0.61, where the three aspects it shows the medium category.

Table 3 Results of Significance Analysis of Student Values Using One Sample T-test

One-Sample Tes						
Tes Value = 70						
95% Confidence Interval of the Difference						
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Post-test	8.876	172	.000	8.220	6.39	10.05

Table 3 shows the results of the One Sample T-test, namely the effectiveness of the DISTAD Learning model is the significance of student scores > 70 using the One Sample T-Test. The One Sample T-test was used to compare students' average scores with the KKM scores set in Biology learning at SMA Negeri 1 Karangobar.

In the analysis of One Samples T-test showed a significance value of 0.000 (< 0.05) which means that the average value of learning metabolism with the DISTAD Learning model is greater than 70 or the DISTAD Learning model is effective in increasing students' critical thinking skills. Based on the comparison of the values of t_{count} and t_{table} , it is stated that the t_{count} obtained is 8,876 with t_{table} 1,973 so that $t_{\text{count}} > t_{\text{table}}$, which means that the average value of learning metabolism with the DISTAD Learning model is not the same as the value of 70.

DISCUSSION

Based on Table 1 shows an increase in the average score to 78.67 which is included in the category of high-level critical thinking after learning using the DISTAD Learning model. The results of students' critical thinking skills showed an increase due to the application of the DISTAD Learning model. The syntax contained in the DISTAD Learning model includes *Stimulation*, *Analyze*, *Evaluation*, and *Synthesis*. The *Stimulation* syntax can stimulate students so that students can be encouraged to take part in learning. Sudarti (2019) states that giving a stimulus before learning can increase student interest in learning. Followed by the *Analyze* syntax, where this syntax students will work in groups to solve existing problems both in practicum activities and discussion activities. Group learning can make it easier for students to solve problems, thereby training students to solve problems independently (Rostika & Junita, 2017). The next syntax is *Evaluation* which includes test and quiz activities. Test activities students work on individual description questions to check understanding based on the learning that has been done while in quiz activities students complete 3D metabolism crossword puzzles in groups, so they can work together in realizing their knowledge in real terms. The last syntax is *Synthesis*, where in this syntax students can prove existing hypotheses and make conclusions from the learning outcomes that have been implemented. All the syntaxes in the DISTAD Learning model are mutually sustainable so that students can build their critical thinking skills gradually.

Based on Table 2 and Figure 1, it shows that 76% of students scored ≥ 70 , which means that most students have succeeded in achieving the predetermined competencies. These results indicate that the DISTAD Learning model can develop students' critical thinking skills. The application of the DISTAD Learning model is carried out in groups, so that students can collaborate and work together in building their critical thinking skills. Students can collaborate in solving a problem by combining the perceptions or understandings of each group member (Wela *et al.*, 2020). Differences in perceptions in understanding a concept can direct students to think critically and creatively by communicating to reach the most appropriate conclusion (Bambang *et al.*, 2017). Supena *et al.*, (2021) stated that in collaborative learning the students had to be grouped, so they could interact and discuss it with their friends, have a strong willingness to teach other friends, and gain the benefits of collaborative learning.

Based on Figure 2, it shows that the three aspects of critical thinking show an increase in the medium category. The highest increase is in the aspect of making advanced explanations (*advance clarification*) with an

N-Gain value of 0.61 which is included in the medium category. In the DISTAD Learning model there is an *Evaluation* syntax in which there are test and quiz activities. This test activity students work on questions in the form of descriptions. Essay questions have the advantage of being able to measure students' deeper critical thinking skills, in the form of the ability to classify, integrate, analyze, and evaluate information (Fraenkel & Wallen, 2009 in Setiawan, 2019). In test activities students are trained to analyze and provide detailed explanations of the material that has been studied, so that students are accustomed to giving further explanations. This causes an increase in the average highest score on the aspect of making further explanations.

The results of student achievement in the aspect of providing simple explanations (*elementary clarification*) also increased by 0.54 which is included in the medium category. This aspect refers to students' ability to understand questions, analyze questions, and answer questions pertanyaan (Ennis, 1985 in Arfianawati *et al.*, 2014). This ability directs students to identify a question, which then considers the right answer. In the *Evaluation* syntax there are test and quiz activities. The quiz activity was carried out with the help of a 3D metabolism crossword puzzle by placing simple answers in the boxes provided. This allows students to remember simple explanations of the material that has been discussed. This is in line with the information processing theory put forward by Gagne. This theory states that a person's cognitive learning abilities describe processing, storing, and recalling existing understandings (Gagne, 1975 in Kusaeri, 2018). According to Hitipiew (2009) in Kusaeri (2018) this theory emphasizes the process, where information is easier to remember if someone connects the stimulus to the sensory memory and then selects which information given special attention will enter short term memory. When the information is often repeated (rehearsal), the information will be entered in long term memory (long term memory), and it will be easier to retrieve the information (retrieval).

In the aspect of drawing conclusions (*inference*), a percentage increase of 0.38 is obtained which is included in the medium category. In this aspect, students are trained to consider facts, present alternatives, and end by drawing conclusions (Pritananda & Yusmin, 2016). In the DISTAD Learning model, each sub-material is carried out in a practicum, the aim is for students to be able to build their own real understanding through their own observations, related to the material being discussed. This supports students' critical thinking skills in the aspect of drawing conclusions. Practicum activities carried out by students can also improve their ability to remember which takes longer compared to ordinary learning activities (Sapitri *et al.*, 2020). For students, the implementation of practicum learning can also help them to enjoy new experiences to observe, to try, to use tools, and to do experiments. Therefore, practicum activities in biology learning are important (Duda *et al.*, 2019). In practicum activities, there is an *Analyze* syntax that allows students to analyze the objectives of each stage of the practicum which is supported by discussion activities for each group.

Implementation of the DISTAD Learning model on metabolism material is carried out 3 times practicum, namely catalase enzyme practicum as an introduction to enzyme material, fermentation practicum in anaerobic respiration as an introduction to catabolism material, and finally photosynthesis practicum as an introduction to learning anabolism material. Practicum activities can lead to an active attitude of students in solving a problem, thus triggering students' critical thinking skills (Lestari *et al.*, 2018). After the practicum activities, it is continued with the implementation of *Synthesis* syntax. In this syntax students draw conclusions and demonstrate the results of the practicum that has been implemented. Each group can exchange opinions in connecting the practicum results with existing theory. The activity of demonstrating the results of observations also aims to train students' abilities to implement concepts in the context of the observations (Al-yafasy *et al.*, 2018). Based on practicum activities and demonstrating the results of the practicum, students are accustomed to drawing conclusions (*inference*) from the learning that has been carried out.

Based on Table 3, the One Sample T-test shows a significance value of 0.000 (<0.05), which means that the average metabolic value of learning with the DISTAD learning model is greater than 70 or the DISTAD learning model is effective in improving students' critical thinking skills. The results of the analysis showed that there was a difference between the average value of the DISTAD Learning metabolism learning model and the KKM applied at SMA Negeri 1 Karangobar, which was 70, which means that the DISTAD Learning model was effective in increasing students' critical thinking skills. This is because the application of the DISTAD Learning model uses the help of 3D metabolism crossword puzzle media. Audie (2019) states that learning media innovation supports the effectiveness and efficiency of learning. The use of 3D metabolism crossword puzzle media helps students to be directly involved in the learning process. Students directly do real things in the form of assembling

3D metabolism crossword puzzle pieces based on the questions that have been provided. The preparation of 3D metabolism crossword puzzle pieces also involves the senses of sight, hearing, feeling, smell, and touch, so that students can realize critical thinking skills in a real way. This is supported by the theory of Edgar Dale. Edgar Dale classifies learning experiences from the most concrete (bottom) to the most abstract (top), or known as the cone of experience (Dale E, 1969 in P. Sari, 2019). This cone of experience explains the link between learning theory and the learning media used (Lubis & Rambe, 2021). Edgar Dale (1969) in Lubis & Rambe (2021) states "learning outcomes are obtained from concrete things in the form of direct experience from the environment then in the form of artificial objects, to abstract things in the form of verbal symbols. The higher the peak, the more abstract the medium for delivering the message. The learning process and interaction do not have to be from direct experience, but starting from the experience that best suits the needs and abilities of students according to the learning situation. Direct experience can provide information from what has been experienced, so that it involves the senses of sight, hearing, feeling, smell and touch.

Based on the three criteria used in determining the effectiveness of the DISTAD Learning model, it can be concluded that the DISTAD Learning models are effective in increasing the critical thinking skills of SMA Negeri 1 Karangobar students. Apart from this, there were still obstacles during the implementation of the research, namely often there is a reduction in learning hours due to several activities that must be followed by all class XII students of SMA Negeri 1 Karangobar, so that some syntaxes are not carried out optimally and the lack of DISTAD Learning syntax implementation instruments that can be used by all students as a guide for learning activities.

CONCLUSION

Based on the results of the analysis and discussion that has been done, it can be concluded that the application of the DISTAD Learning model is effective in increasing high school students' critical thinking skills in metabolic material.

REFERENCES

- Adji, G. B. (2021). *Pengembangan E-Modul Interaktif Berbasis Web Pada Materi Metabolisme Kelas Xii. 06*, 6–9.
- Agnafi, D. N. (2019). Analisis Kemampuan Berpikir Kritis Siswa dalam Pembelajaran Biologi. *Florea*, 6(1), 45–53.
- Al-yafasy, K. N., Akman, & Hidayati. (2018). Pengaruh Penerapan LKS Berorientasi Pendekatan Demonstrasi Interaktif Untuk Meningkatkan Kompetensi IPA Fisika Siswa Kelas VIII SMPN 3 Lembah Gumanti. *Pillar of Physics Education*, 11(3), 161–168. <http://103.216.87.80/students/index.php/pfis/article/view/3310/2581>
- Arfianawati, S., Sudarmin, & Sumarn, W. (2014). *Model Pembelajaran Kimia Berbasis Etnosains [Mpkbe] Untuk Mengembangkan Literasi Sains Siswa*. 83–90.
- Audie, N. (2019). Peran Media Pembelajaran Meningkatkan Hasil Belajar Peserta Didik. *Prosiding Seminar Nasional Pendidikan FKIP*, 2(1), 589–590.
- Bambang, A., Munzil, & Arif, H. (2017). Pengaruh Collaborative Learning Dengan Teknik Jumping Task Terhadap Keterampilan Berpikir kritis dan hasil belajar. *Jurnal Pembelajaran Sains*, 1(2), 15–25. <http://dx.doi.org/10.17977/um033v1i2p15-25>
- Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, 12(1), 1207–1222. <https://doi.org/10.29333/iji.2019.12177a>
- ERISKA, E. V. I. (2018). *Pengaruh Media Crossword Puzzle Terhadap Berpikir Kritis Siswa Pada Pembelajaran Biologi Sma Muhammadiyah 1 Palembang*. <http://repository.radenfatah.ac.id/2915/>
- Hanggara, Y., & Wajubaidah. (2015). Eksperimentasi Model Pembelajaran Kooperatif Tipe Jigsaw Dan Stad Terhadap Hasil Belajar Matematika Ditinjau Dari Motivasi Belajar Siswa Kelas Vii Smpn 50 Batam Tahun Pelajaran 2015/2016. *Pythagoras: Jurnal Program Studi Pendidikan Matematika*, 5(2), 131–138. <http://journal.unrika.ac.id/index.php/jurnalpythagoras/article/view/465>
- Khaeruddin. (2017). Model Pembelajaran Fisika Berbasis Keterampilan Proses Sains Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. In *Evaluasi Pembelajaran*. https://scholar.google.com/citations?view_op=view_citation&hl=en&user=KLNgC7sAAAAJ&pagesize=100&citation_for_view=KLNgC7sAAAAJ:L8Ckcad2t8MC

- Kusaeri, K. (2018). Proses Berpikir Siswa dalam Menyelesaikan Masalah Matematika Berdasarkan Teori Pemrosesan Informasi. *Suska Journal of Mathematics Education*, 4(2), 125. <https://doi.org/10.24014/sjme.v4i2.6098>
- Lestari, S., Mursali, S., & Royani, I. (2018). Pengaruh Model Pembelajaran Langsung Berbasis Praktikum Terhadap Keterampilan Proses Sains Dan Kemampuan Berpikir Kritis Siswa. *Jurnal Ilmiah Biologi*, 6(1), 67–79. https://www.researchgate.net/publication/339683402_Pengaruh_Model_Pembelajaran_Langsung_Berbasis_Praktikum_Terhadap_Keterampilan_Proses_Sains_Dan_Kemampuan_Berpikir_Kritis_Siswa
- Lubis, R. R., & Rambe, N. (2021). Pelatihan Pembuatan Media Pembelajaran Berbasis Multimedia Interaktif Pada Guru Sd Swasta Pab 10 Sampali. *Jurnal Pengabdian Kepada Masyarakat (JPKM)*, 2(2), 86–94.
- Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. 71(1), 63–71.
- Pritananda, R., & Yusmin, E. (2016). [3] Kemampuan Berpikir Kritis Siswa Pada Aspek Inference Dalam. 1–8.
- Putri, N. K. I. P., Murda, N., & Sudana, D. N. (2019). Pengaruh Model Pembelajaran Group Investigation Berbantuan Media Questions Card Terhadap Pemahaman Konsep \ dan Keterampilan Berpikir Kritis IPA. *Thinking Skills and Creativity Journal*, 1(2), 46. <https://doi.org/10.23887/tscj.v1i2.20492>
- Rostika, D., & Junita, H. (2017). Sd Dalam Pembelajaran Matematika Dengan Model Diskursus Multy Representation (Dmr). *Jurnal Pendidikan Dasar*, 9(1), 35–46.
- Sapitri, R. D., Hadisaputra, S., & Junaidi, E. (2020). Pengaruh penerapan praktikum berbasis kearifan lokal terhadap keterampilan literasi sains dan hasil belajar. *Jurnal Pijar Mipa*, 15(2), 122–129. <https://doi.org/10.29303/jpm.v15i2.1342>
- Sari, P. (2019). Analisis Terhadap Kerucut Pengalaman Edgar Dale Dan Keragaman Dalam Memilih Media. *Jurnal Manajemen Pendidikan*, 1(1), 42–57.
- Setiawan, A. R. (2019). Menyusun Instrumen Penilaian Untuk Pembelajaran Ekologi Berorientasi Literasi Saintifik. *Prosiding Seminar Nasional Dan Workshop Biologi-IPA Dan Pembelajarannya Ke-4*, 241–249.
- Sudarti, D. O. (2019). Kajian teori behavioristik stimulus dan respon dalam meningkatkan minat belajar siswa. *Tarbawi: Jurnal Pendidikan Islam*, 16(2), 55–72. <https://ejournal.unisnu.ac.id/JPIT/article/view/1173>
- Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence of Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, 14(3), 873–892.
- Tarihoran, E. (2019). Guru Dalam Pengajaran Abad 21. *SAPA - Jurnal Kateketik Dan Pastoral*, 4(1), 46–58. <https://doi.org/10.53544/sapa.v4i1.68>
- Wela, G. S., Sundaygara, C., & Yuli Pratiwi, H. (2020). Pbl Dengan Pendekatan Multiple Representation Terhadap Kemampuan Berpikir Kritis Ditinjau Dari Kemampuan Kolaborasi. *RAINSTEK : Jurnal Terapan Sains & Teknologi*, 2(3), 209–220. <https://doi.org/10.21067/jtst.v2i3.4711>
- Yachsan, S., Aziz, A. A., & Junda, M. (2016). Pengaruh Model Pembelajaran Discovery Learning terhadap Keterampilan Berpikir Kritis dan Hasil Belajar Kognitif Biologi Peserta Didik pada Materi Sistem Koordinasi. *Prosiding Seminar Nasional Biologi VI: Harmonisasi Pembelajaran Biologi Pada Era Revolusi 4.0*, 674–679. <https://ojs.unm.ac.id/semnasbio/article/view/10636>