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The Effectiveness of Problem-Based Learning Assisted by Articulate Storyline Interactive Students' Critical Thinking Skills

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Abstract: This study aims to reveal the impact of a problem-based learning model assisted by articulate storyline interactive media on high school biology students' critical thinking skills. This research was conducted in April-July 2023. The research method used was a quasi-experiment with a nonequivalent control group design. The population is all grade X science students (grade X IPA) of SMA Negeri 1 Kawali, West Java in the 2022/2023 school year as many as 6 classes. The sampling technique used was the purposive sampling technique, with grade X IPA 1 class as the experimental class and X IPA 3 as the control class each containing 36 students. The data collecting instrument is a critical thinking skill test consisting of 13 description questions that had gone through validity and reliability tests with the results of the instrument validity test, namely eight significant questions and five very significant questions, and the reliability score r = 0.84 including the high category. The data analysis technique used was the one-way ANOVA test at a significance level of 0.05. The average N-gain score of critical thinking skills of the experimental class is 0.45 (medium) higher than the control class which is 0.19 (low). Based on the results of testing the research hypothesis, it can be concluded that there is an effect of a problem-based learning model assisted by articulate storyline interactive media on critical thinking skills at a significance level of 0.000. The theoretical implication is that critical thinking skills can be improved by using a problem-based learning model assisted by interactive learning media so that the problem-based learning model assisted by articulate storyline interactive media can be used as a teaching method to improve critical thinking skills.

Keywords: articulate storyline, critical thinking skills, problem-based learning

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INTRODUCTION

The 21st-century teaching in Indonesia is implemented in Curriculum 2013 teaching which requires students to have the skills needed for present and future life. According to (Rosnaeni, 2021), in the 21st century, learning is designed to focus on 21st-century skills including critical thinking skills, creative and innovative thinking skills, communication skills, and collaborative skills. Even (Hastuti et al., 2022) state that besides the 4C skills that must be possessed, there are additional new skills, namely character and citizenship.

(Fitri et al., 2020) state that one of the characteristics of 21st-century learning is learning that requires students to have problem-solving skills. Where in learning students must be directed and become accustomed to the ability to formulate problems not just solve problems so that they can train critical thinking skills. (Ennis, 2011) states that critical thinking is reasonable and reflective thinking that focuses on deciding what to believe or do. From this definition, it can be understood that critical thinking is a thinking process that aims to make reasonable and reflective decisions about what we should believe or do. Critical thinking is important because it can make students open-minded, able to

formulate problems clearly and precisely, collect and assess relevant information, determine reasons, and provide appropriate solutions to solve complex problems (Tumanggor, 2021).

In solving problems, students need to examine a concept. In addition to reviewing, the human brain also begins to organize concepts by involving long-term information (long-term memory). (Ubaidah, 2018) explains that long-term memory can be recalled when needed to be rebuilt into new knowledge, for example in the problem-solving process. When students have been able to analyze the concepts they have learned, their thinking skills have been empowered.

Critical thinking skills in ecology are important for students to know to save the ecosystem both now and in the future. According to (Anggriani et al., 2019), this is important to build awareness and understanding of environmental problems. (Zaini, 2019) adds that with critical thinking, solving problems in society such as efforts to protect the environment and making renewable energy can be done to keep the earth sustainable. To find out how the sample profile of students' critical thinking skills, the researchers conducted a preliminary study at one of the public high schools in Ciamis District, namely SMA Negeri 1 Kawali. Based on the results of an interview with one of the biology teachers there, currently, the school is still implementing Curriculum 2013 where the learning model commonly used is the Discovery Learning model with PowerPoint learning media, where the problem-based learning (PBL) model is still rarely used. Unlike the case with schools that have implemented the latest curriculum, namely the Merdeka Curriculum, this PBL learning model has become a learning model that must be used in learning. Previously, the researchers conducted a preliminary study where based on the results of a preliminary study conducted in class X IPA with ecosystem material, and it was found that the critical thinking skills of students were 11.11% in the very high category, 7.41% in the medium category, 22.22% in the low category, and 59.26% in the very low category. Therefore, based on this data, it can be concluded that the category of critical thinking skills of more than 50% of students is still in the very low category.

Based on these problems, it is necessary to improve the teaching process that can train students' critical thinking skills. The problem-based learning model is one of the learning models that can be used to train students' critical thinking skills. (Syamsidah & Suryani, 2018) also explain that the problem-based learning model is a model that involves students trying to solve problems with several stages of the scientific method so that students are expected to be able to learn knowledge related to the problem and at the same time they are expected to have skills in solving problems. (Gani et al., 2021) state that PBL can sharpen students' thinking in real-world problems. So that critical thinking skills can be improved through PBL because the learning approach is on authentic problems, and students are not only asked to understand a problem but also must be able to work together to solve the problem and to stimulate their abilities and skills, especially critical thinking skills (Masrinah et al., 2019). The problem-based learning model is also a constructivism-based learning model that can improve students' problem-solving and memory skills (Widayati et al., 2015).

In research conducted by (Saepuloh et al., 2021), this problem-based learning model can improve critical thinking skills compared to conventional learning models, as indicated by the average post-test score of the experimental class being higher than the control class. This happens because students in the experimental class understand the learning material better. After all, students carry out the discussion process to exchange ideas and information, present the results of the discussion in front of the class, and ask questions so that learning is more active. Whereas in conventional classes, students only listen to teacher lectures, write, and do assignments. (Palinussa et al., 2023) in their research also state that PBL is superior to discovery learning in improving mathematical critical thinking skills because in the PBL model students are involved in authentic problems, where the knowledge possessed by students is used to solve problems so that it requires them to develop knowledge and understanding and apply increased student understanding so that it will produce a solution. So in this study, the PBL model was chosen to be used to improve critical thinking skills.

In addition to using the right learning model, (Nafisa & Wardono, 2019) explain that the presence of learning media is needed because it has a big role in supporting the success of learning objectives. (Caesariani, 2018) states that the implementation of the problem-based learning model requires learning media. This is in line with the results of research from (Agnesa & Rahmadana, 2022) that the PBL model integrated with learning media has a positive impact on critical thinking skills. (Pulungan & Hasanah, 2022) state that in teaching there is a need for teaching media to support the success of the teaching-learning process to clarify the messages conveyed by the teacher. One of the media that can be used and

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integrated into the PBL model is articulate storyline media. (Saski & Sudarwanto, 2021) define articulate storyline as "an e-learning software that functions as an interactive learning content generation tool using tools and displays like using PowerPoint". Articulate storyline media is an interactive multimedia-based learning media that can help students be more active and provide interesting learning experiences to students. When students participate actively in the learning process, they will get meaningful learning and this meaningful learning will be able to improve their critical thinking skills. This is in line with the results of research by (Sa'adah et al., 2020) that the use of interactive multimedia can foster critical thinking skills.

Learning using a problem-based learning model assisted by articulate storyline interactive media is a problem-solving-based learning model that requires students to solve problems using the stages of the scientific method with the help of articulate storyline interactive media. The syntax of the problem-based learning model assisted by articulate storyline interactive media includes 1) orienting students to the problem, 2) organizing students, 3) guiding individual and group investigations, 4) developing and presenting results, and 5) analyzing and evaluating the process and results of problem-solving. The use of articulate storyline media in this PBL model is to assist teachers in conveying learning objectives, problem orientation syntax by providing problems related to learning materials, syntax guiding individual and group investigations by providing information in the form of teaching materials to help students work on student worksheet, and evaluation activities by providing posttest questions in the media.

The use of PBL learning models integrated with interactive learning media was chosen because in the era of increasingly advanced civilization, in the world of education, it is necessary to package new learning models that can stimulate students' thinking skills so that their abilities resulting from the learning process at school can be a provision for them to face concrete problems in life. The use of PBL learning models that use authentic problems in everyday life can be visualized more easily and real with interactive media articulate storyline so that it will help the learning process carried out by teachers and students be easier, more interesting, and more meaningful.

Based on the background that has been described, this study aims to reveal the impact of a problem-based learning model assisted by articulate storyline interactive media on the critical thinking skills of high school biology students.

RESEARCH METHOD

This type of research is quantitative research with a quasi-experiment research method. The research design used is a non-equivalent control group design. The population is all grade X science students (X IPA classes) of SMAN 1 Kawali, Ciamis in the 2022-2023 school year as many as six classes with a total of 211 students. This research was conducted from December 2022 to July 2023. The sample was established using the purposive sampling technique with the criteria that the class used was a class that had the average value of the daily test results relatively the same and was a class with active students in the learning process. Based on these criteria, two classes had the highest average daily test scores and activeness, namely X IPA 1 and X IPA 2 classes each containing 36 students. Meanwhile, for the determination of the experimental and control classes, randomization was carried out by making four rolls of paper containing the writing of the selected class and the writing of the experimental and control class treatments. Then the class roll was put into the first glass, and the treatment roll was put into the second glass. Both were shaken simultaneously and removed simultaneously resulting in the first shuffle of X IPA 1 class as the experimental class and the second shuffle of X IPA 3 as the control class. So the final results obtained X IPA 1 class as the experimental class using the problem-based learning model assisted by articulate storyline interactive media and X IPA 3 class as the control class using the discovery learning model with PowerPoint media.

The data collection was conducted using a test. The test used is a critical thinking test consisting of 13 items in the form of descriptions based on indicators from (Ennis, 1985) which include elementary clarification, basic support, inference, advanced clarification, and strategy and tactics. Before the test was used, validation was carried out through expert judgment and then the test was tested. Furthermore, the test was measured for validity and reliability with the help of ANATES software. Based on the results of the validation of the test, eight questions are in the significant category and five questions are

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in the very significant category. As for reliability, the score of r = 0.84 was obtained, which is in the high category. This critical thinking skill test uses ecosystem material.

Data collection was done twice, namely using pretest and posttest. Then the data were processed to obtain the N-gain score, with the formula :

$$N - Gain = \frac{posttest\ score - pretest\ score}{ideal\ score - \ pretest\ score}$$

Furthermore, the data were interpreted into several categories and then analyzed on each indicator so that the data show an overview of the improvement of critical thinking skills after the treatment of problem-based learning models assisted by articulate storyline interactive media.

The procedure of this study is that students in experimental and control classes took a pretest before participating in the learning process. Furthermore, in each class, students followed the teaching-learning process through the predetermined treatment for three meetings. After the learning process was complete, a posttest was conducted.

The data obtained were then analyzed using descriptive statistics and inferential statistics. Then the data that had been processed were tested for normality and homogeneity with the Kolmogorov-Smirnov test and Levene's test as a prerequisite for analysis to be able to proceed to parametric hypothesis testing. If the data obtained were normally distributed and homogeneous, then it proceeded with parametric hypothesis testing with a one-way ANOVA test using the SPSS application by comparing variances in the average group in the sample to determine the effect of independent variables on the dependent variable.

The implementation of teaching with a problem-based learning model assisted by an articulate storyline interactive media includes the following syntax:

1. Orientation of students to the problem. In this syntax, the teacher explains the learning objectives, the tools and materials used that are needed, and phenomena to students to raise problems using the help of Articulate Storyline media.
2. Organizing students. In this syntax, the teacher divides students into groups and helps them to identify what needs to be known and what needs to be done to solve the problems that have been identified and helps the students to divide roles or tasks to solve the problem.
3. Guiding individual and group investigations. In this syntax, the teacher guides students to collect data/information through various sources of information to solve problems. In this stage, articulate storyline media can be used as a reference source for ecosystem material that already contains various information in the form of text, images, and videos.
4. Developing and presenting results. In this syntax, the teacher guides students to determine the problem-solving that is considered the most appropriate based on the results of studies from various sources of information. Then students complete the student worksheet that has been given to each group and then the results are presented in front of other fellow students.
5. Analyzing and evaluating the process and results of problem-solving. In this syntax, students present the results of problem-solving and the teacher guides and facilitates students to analyze and evaluate the findings of problem-solving, and helps them to reflect and evaluate their investigations and the processes they use through open discussions with other group members. Then at the end of teaching, the teacher provides an evaluation through a posttest related to the material that has been learned using articulate storyline media.

FINDINGS AND DISCUSSION

Data interpretation in Table 1 shows the results of prerequisite analysis testing. Based on the data in Table 1, the significance of pretest and posttest data for normality and homogeneity tests for the experimental class and control class obtained a sig score > 0.05, meaning that all data are normally distributed so that they meet the requirements to proceed to parametric hypothesis testing.

The hypothesis testing carried out used a one-way ANOVA test to see the difference in the average variance of critical thinking skills in experimental and control classes. Based on the data in Table 2, the significance value is 0.000 <0.05 so it can be concluded that there is a significant difference between the experimental class and the control class. This significant difference shows that there is an

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effect of using a problem-based learning model assisted by articulate storyline interactive media on critical thinking skills in biology learning.

Table 1. Normality and Homogeneity Test Result

Data	Class	Normality Test	Homogeneity Test
Pretest	Experiment	Sig. 0.055 > 0.05	Sig. 0.065 > 0.05
	Control	Sig. 0.093 > 0.05	
Posttest	Experiment	Sig. 0.086 > 0.05	
	Control	Sig. 0.200 > 0.05	

Table 2. One-Way ANOVA Test Result

		Sum of Squares	df	Mean Square	F	Sig.
Critical Thinking	Between Groups	7964.467	1	7964.467	44.521	.000
	Within Groups	10375.758	58	178.892		
	Total	18340.225	59			

The results of hypothesis testing that show a significant difference between the experimental class and the control class can be observed from the results of the analysis of the critical thinking skills test of the experimental and control classes in Table 3, which shows an increase in the average score of the experimental class and the control class. The average score of the experimental class is higher than that of the control class. The average score of critical thinking test results per indicator is presented in Table 3. The critical thinking indicators used in this study include basic clarification, basic support, inference, further clarification, and strategy and tactics. The increase in critical thinking skills seen based on the *n*-gain score is higher in the experimental class which is 0.496 compared to that in the control class, which is 0.182. The *n-gain* score of the experimental class is in the medium category, while the control class is in the low category. The difference in *n*-gain scores is evidence that the experimental class is better at improving critical thinking skills compared to the control class. This finding explains that students' critical thinking skills, especially in biology learning, can be improved by using a problem-based learning model assisted by articulate storyline interactive media.

Table 3. Critical Thinking Skills Test Average Score

Critical Thinking Skills Indicator	Experiment		N-Gain	Control		N-Gain
	Pretest	Posttest		Pretest	Posttest	
Elementary clarification	23.75 (very low)	64.125 (medium)	0.54	16.625 (very low)	30 (very low)	0.29
Basic support	30 (very low)	76.75 (high)	0.66	32.5 (very low)	40 (very low)	0.03
Inference	12.74 (very low)	51.08 (low)	0.43	13.33 (very low)	28.08 (very low)	0.16
Advanced clarification	10 (very low)	51.16 (low)	0.48	8.83 (very low)	27.83 (very low)	0.20
Strategy and tactics	13.93 (very low)	44 (low)	0.37	1.18 (very low)	32.41 (very low)	0.23
Average	18.084	57.423	0.496	14.493	31.664	0.182

The improvement of critical thinking skills in the experimental class using the problem-based learning model is supported by (Kusumawati & Adawiyah, 2019) research, that the application of the problem-based learning model affects the improvement of critical thinking skills. The use of articulate storyline media has also been proven to be able to improve student's critical thinking skills in research (Ramadhani et al., 2022). The integration of articulate storyline media in problem-based learning also has a positive effect on the improvement of critical thinking skills, which is in line with what (Agnesa & Rahmadana, 2022) state that the problem-based learning model that uses learning media integration

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has a positive effect on students' critical thinking skills. So it strengthens that the problem-based learning model assisted by articulate storyline media affects students' critical thinking skills.

Based on the average scores of the pretest and posttest, in the experimental class, there has been an increase in critical thinking skills from the pretest score of 18.084, with a very low category, increasing to 57.423 in the posttest to a low category. The highest increase in the average *n*-gain value of critical thinking skills is found in the indicator of building basic skills (basic support), which is 0.66. In this indicator, students have been able to assess the validity of information as stated by (Wahyuni et al., 2021) that students can find and determine evidence of a statement in an information source. This is because, in the problem-based learning process, students must find relevant and credible sources of information to solve and determine the solution to the problem presented. This is in line with what is stated by (Fatmawati et al., 2020) that someone who can think critically is someone who can conclude what he knows and can also find relevant sources of information as support in the problem-solving process. In finding these solutions, of course, the basic ability that must be possessed by students is the ability to distinguish which sources of information are reliable, relevant, and credible to be able to solve problems and produce quality solutions to problems. The use of articulate storyline media also helps students obtain accurate information because the sources of information used in the media come from credible sources and there is a bibliography that can be accessed freely by students.

The lowest increase in the average *n*-gain value is in the indicator of determining strategies and tactics, which is 0.37. (Wahyudi et al., 2020) explain that the low critical thinking skills of students on the strategy and tactics indicator are the impact of weak critical thinking skills on elementary clarification indicators where students cannot write coherently and systematically in answering questions. This can also be observed in the learning process in the experimental class, where students tend to have difficulty in identifying problems and focusing questions during the problem orientation stage because they do not understand the contents of the problem article and are not used to learning models that present problems at the beginning of learning. In problem-based learning, students are trained to work together to develop problem-solving steps. These stages train students to determine the most effective strategies and techniques to find solutions to the problems given at the beginning of learning. The use of articulate storyline media as one of the sources of information by students is part of the steps to solve learning problems.

The indicator of providing a simple explanation (elementary clarification) obtained an increase in the average *n*-gain value of 0.54. In this indicator, students are trained to focus on what questions arise from the problems presented in the learning process. Students identify problems in the articles presented in the articulate storyline media and then focus on questions that will be used as problem formulations to find solutions. The search for sources of information by students trains them to be able to analyze each reading. This is in line with what is stated by (Wahyuni et al., 2021) that students are required to understand reading critically so that after reading activities are complete, they will be able to capture the main ideas in science learning reading.

The indicator of providing advanced clarification obtained an *n*-gain score of 0.48. In this indicator, students define terms assess definitions, and identify what assumptions are the factors that cause the problems presented in learning. The problem given at the beginning of problem-based learning makes students assess whether the event is by existing definitions, concepts, or theories.

The indicator of making an inference obtained an *n*-gain score of 0.43. In this indicator, students are required to be able to make induction, assess the results of induction, and make and assess decisions. In this problem-based learning process, students are trained to draw conclusions from the problems presented in the articulate storyline media, draw conclusions on the results of data collection from various sources, and assess the advantages and disadvantages of the conclusions to draw. The low ability of students in this inference indicator according to (Wahyudi et al., 2020) is possible because they are careless in identifying and explaining the background of the problem presented. However, in the implementation of teaching, the teacher has tried to help students identify problems from the problems presented by providing stimulus in the form of examples of how to identify problems and find the main ideas in the problem articles presented in the articulate storyline media.

The increase in students' critical thinking skills in this study is because students in the experimental class have been trained in critical thinking skills through learning with a problem-based learning model assisted by articulate storyline media. This is supported by (Ardiyanti, 2016) statement that PBL is suitable for training critical thinking competencies because the steps or syntax in PBL have

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the same objectives as critical thinking indicators. (Sanjaya & Ratnasari, 2021) explain that syntax includes problem orientation to train interpretation skills through understanding information from reading. The syntax of organizing students trains students to analyze through identifying concepts. The syntax of guiding individual and group investigations trains students' ability to evaluate and conclude information (inference). The syntax of developing and presenting results trains students to provide questions in the form of arguments and the syntax of analyzing, evaluating, and concluding the results of problem-solving can train students to be skilled in self-regulation by observing one's cognition. (Prasetyo & Kristin, 2020) explain that several factors influence the critical thinking skills of students using the problem-based learning model, one of which is the problems presented in learning related to the environment in everyday life so that students become more trained in identifying, designing, and solving problems. (Legina & Sari, 2022) explain that this interactive learning media can be used by teachers as an innovative learning media and learning resource, so that it can achieve the expected learning objectives, namely increasing students' critical thinking skills.

The results of this study are in line with previous research. In a literature review on several articles, (Agnesa & Rahmadana, 2022) mention that integrating learning media in the learning model has a positive impact on critical thinking skills. Although the results of their study show positive results, in this study the integration of learning media into the learning model together as an independent variable in the learning process can also lead to potential bias whether it is the learning model or learning media that affects the dependent variable of critical thinking or maybe both. In addition, the determination of the sample and the relatively small sample also affect the level of validity of the research results, so further research is needed with different methods so that the results of this study become more valid to produce an effort to improve the quality of learning. In addition, external factors influenced the research, such as the less intensive learning process carried out at school due to constrained internal school activities which also influenced the research results, so obstacles like this in the future need to be anticipated carefully.

Based on the findings in this study, it is expected to provide implications. The use of a problem-based learning model assisted by articulate storyline media can be one of the ways that can be done by teachers to improve students' critical thinking skills, especially in biology learning that uses problem-based materials and other learning subjects that have similar characteristics. The results of this study can also be an input for teachers to always develop teaching methods to achieve superior student competencies and characteristics to be able to face challenges in the 21st century.

CONCLUSION

Based on the research results, hypothesis testing, and discussion, this study concludes that the problem-based learning model assisted by articulate storyline interactive media affects critical thinking skills in biology learning at the significance level of 0.000. The results show that the average *n*-gain score of critical thinking skills of the experimental class is higher than that of the control class. This shows that the PBL learning model assisted by articulate storyline learning media has a positive impact on the improvement of students' critical thinking skills in learning biology. Therefore, PBL integrated with interactive learning media in the future is expected to be used as an alternative model that is suitable for improving students' critical thinking skills in the biology learning process and other learning, so that students can be actively involved in the discussion process and solve problems and thus students can find concepts independently to solve problems and it is expected that independent, critical, and confident students will be formed.

The limitations found by the author in conducting this research include the lack of relevant research references on the topic of experimental research being studied and the use of research methods that are still simple so that they can lead to potential bias in the research results. Therefore, in the future, further research is needed by using better research methods in terms of determining the sample, the sample size, hypothesis testing methods, and the habituation of articulate storyline media to students before the research is carried out. As for the future, this research can be developed by developing a PBL learning model assisted by articulate storyline media in helping to create differentiated learning so that it can create learning that responds to student needs based on their readiness, interests, and potential.

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REFERENCES

Agnesa, O. S., & Rahmadana, A. (2022). Model Problem-Based Learning sebagai Upaya Peningkatan Keterampilan Berpikir Kritis pada Pembelajaran Biologi. *JOTE : Journal On Teacher Education*, *3*(3), 65–81.

Anggriani, F., Karyadi, B., & Ruyani, A. (2019). Kemampuan Berpikir Kritis Siswa Melalui Pembelajaran Berbasis Lingkungan untuk Studi Ekosistem Sungai. *PENDIPA Journal of Science Education*, *3*(2), 100–105. https://doi.org/10.33369/pendipa.v3i2.7701

Ardiyanti, Y. (2016). Berpikir Kritis Siswa Dalam Pembelajaran Berbasis Masalah Berbantuan Kunci Determinasi. *JPI (Jurnal Pendidikan Indonesia)*, *5*(2), 193. https://doi.org/10.23887/jpi-undiksha.v5i2.8544

Caesariani, N. A. (2018). Pemanfaatan Multimedia Interaktif pada Model Problem Based Learning dalam Pembelajaran Matematika. *Jurnal Pendidikan Tambusai*, *4*(11), 832–840.

Ennis, R. H. (1985). A Logical Basis for Measuring Critical Thinking Skills. *Educational Leadership*, 45–48.

Ennis, R. H. (2011). *The Nature of Critical Thinking : An Outline of Critical Thinking Disposition and Abilities* (pp. 1–8).

Fatmawati, I., Darmono, P. B., & Purwoko, R. Y. (2020). Analisis Kemampuan Berpikir Kritis Dalam Pemecahan Masalah Matematika. *Eksakta : Jurnal Penelitian Dan Pembelajaran MIPA*, *5*(2), 196–201.

Fitri, M., Yuanita, P., & Maimunah, M. (2020). Pengembangan Perangkat Pembelajaran Matematika Terintegrasi Keterampilan Abad 21 Melalui Penerapan Model Problem Based Learning (PBL). *Jurnal Gantang*, *5*(1), 77–85. https://doi.org/10.31629/jg.v5i1.1609

Gani, R. A., Anwar, W. S., & Aditiya, S. (2021). Perbedaan Hasil Belajar Melalui Model Discovery Learning dan Problem Based Learning. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, *4*(1), 54–59. https://doi.org/10.55215/jppguseda.v4i1.3192

Hastuti, K. P., Aristin, N. F., & Fani, A. I. M. (2022). Improvement of Six Competency Skills through the Development of Flipped-Case Project in Era of Education 4.0. *Education Quarterly Reviews*, *5*(4), 125–135. https://doi.org/10.31014/aior.1993.05.04.579

Kusumawati, F., & Adawiyah, R. (2019). Pengaruh Model Pembelajaran Problem Based Learning (PBL) terhadap Keterampilan Berpikir Kritis Siswa. *Jurnal Pendidikan Hayati*, *5*(1), 31–38.

Legina, N., & Sari, P. M. (2022). Pengembangan Media Pembelajaran Interaktif Articulate Storyline Berbasis Keterampilan Berpikir Kritis pada Pembelajaran IPA bagi Siswa Sekolah Dasar. *Jurnal Paedagogy*, *9*(3), 375. https://doi.org/10.33394/jp.v9i3.5285

Masrinah, E. N., Aripin, I., & Gaffar, A. A. (2019). Problem Based Learning (PBL) untuk Meningkatkan Keterampilan Berpikir Kritis. *Seminar Nasional Pendidikan*, 924–932.

Nafisa, D., & Wardono. (2019). Model Pembelajaran Discovery Learning Berbantuan Multimedia Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *PRISMA, Prosiding Seminar Nasional Matematika* , *2*, 854–861.

Palinussa, A. L., Lakusa, J. S., & Moma, L. (2023). Comparison of Problem-Based Learning and Discovery Learning To Improve Students' Mathematical Critical Thinking Skills. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *13*(1), 109–122. https://doi.org/10.30998/formatif.v13i1.15205

Prasetyo, F., & Kristin, F. (2020). Pengaruh Model Pembelajaran Problem Based Learning dan Model Pembelajaran Discovery Learning terhadap Kemampuan Berpikir Kritis Siswa Kelas 5 SD. *Didaktika Tauhidi: Jurnal Pendidikan Guru Sekolah Dasar*, *7*(1), 13. https://doi.org/10.30997/dt.v7i1.2645

Pulungan, H., & Hasanah. (2022). Pengembangan Media Pembelajaran IPA Menggunakan Animaker Berbasis Problem Based Learning (PBL) Pada Materi Perubahan Wujud Benda di Kelas IV SD. *Jurnal Penelitian Pendidikan MIPA*, *6*(2), 22–27.

Ramadhani, W. A., Symsurizal, & Afrida. (2022). Multimedia Interaktif Menggunakan Articulate Storyline untuk Meningkatkan Kemampuan Berpikir Kritis Siswa pada Materi Larutan Penyangga. *Hydrogen: Jurnal Kpendidikan Kimia*, *10*(2), 197–208.

Rosnaeni. (2021). Karakteristik dan Asesmen Pembelajaran Abad 21. *Jurnal Basicedu*, *5*(5), 4341–4350. https://doi.org/10.31004/basicedu.v5i5.1548

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

Sa'adah, M., Suryaningsih, S., & Muslim, B. (2020). Pemanfaatan multimedia interaktif pada materi hidrokarbon untuk menumbuhkan keterampilan berpikir kritis siswa. *Jurnal Inovasi Pendidikan IPA*, *6*(2), 184–194. https://doi.org/10.21831/jipi.v6i2.29680

Saepuloh, D., Sabur, A., Lestari, S., & Mukhlishoh, S. U. (2021). Improving Students' Critical Thinking and Self-Efficacy by Learning Higher Order Thinking Skills Through Problem Based Learning Models. *JPI (Jurnal Pendidikan Indonesia)*, *10*(3), 495. https://doi.org/10.23887/jpi-undiksha.v10i3.31029

Sanjaya, W. E., & Ratnasari, E. (2021). Profil dan Kelayakan Teoretis LKPD "Sistem Pencernaan" berbasis Problem Based Learning untuk Melatih Keterampilan Berpikir Kritis. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *10*(2), 403–411. https://doi.org/10.26740/bioedu.v10n2.p403-411

Saski, N. H., & Sudarwanto, T. (2021). Kelayakan Media Pembelajaran Market Learning Berbasis Digital Pada Mata Kuliah Strategi Pemasaran. *Jurnal Pendidikan Tata Niaga (JPTN)*, *9*(1), 1118–1124.

Syamsidah, & Suryani, H. (2018). *Buku Model Problem Based Learning (PBL) Mata Kuliah Pengetahuan Bahan Makanan*. Deepublish.

Tumanggor, M. (2021). *Berpikir Kritis: Cara Jitu Menghadapi Tantangan Pembelajaran Abad 21*. Gracias Logis Kreatif.

Ubaidah. (2018). *Teori Cognitive Flexibility dalam Pembelajaran Konstruktivistik*. Pgsd.Binus.Ac.Id. https://pgsd.binus.ac.id/2018/11/23/teori-cognitive-flexibility-dalam-pembelajaran-konstruktivistik/

Wahyudi, M., Suwatno, & Santoso, B. (2020). Kajian analisis keterampilan berpikir kritis siswa sekolah menengah atas Mauliana. *Jurnal Pendidikan Manajemen Perkantoran*, *5*(1), 67–82. https://doi.org/10.17509/jpm.v4i2.18008

Wahyuni, I. T., Sari, P. M., & Kowiyah. (2021). Identifikasi keterampilan berpikir kritis siswa pada pembelajaran IPA di SDN Gugus 1 Kecamatan Duren Sawit. *JPD: Jurnal Pendidikan Dasar*, 12–22.

Widayati, T. U., Prayitno, B. A., & Ariyanto, J. (2015). Perbedaan Kemampuan Memecahkan Masalah Dan Retensi Menggunakan Model PBL (Problem Based Learning) Dan Ceramah Bervariasi Pada Materi Keanekaragaman Hayati Indonesia Siswa Kelas X Mia Sma Negeri 2 Surakarta Tahun Pelajaran 2014/2015. *Bio-Pedagogi*, *4*(1), 53–38.

Zaini, M. (2019). Keefektifan Lembar Kerja Siswa pada Konsep-Konsep Biologi Jenjang Madrasah Aliyah (Suatu Penelitian Desain Pendidikan) Effectiveness of Students' Worksheet on the Madrasah Students' Biological Conceptual Understanding (An Educational Design ResearH). *BIOEDUKASI: Jurnal Pendidikan Biologi*, *12*(1), 20–29.

ISSN 2406-9205 (print), ISSN 2477-4820 (online)