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ORIGINAL

Effectiveness of Interactive Lecture Demonstration (ILD) Model-Based Website in Improving Critical Thinking Skills of Elementary School Teacher Education Study Program (PGSD) Students

Eficacia de un sitio web basado en el modelo de demostración de conferencias interactivas (ILD) para mejorar las habilidades de pensamiento crítico de los estudiantes del Programa de Estudios de Formación Docente de Escuela Primaria (PGSD)

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ABSTRACT

This research aims to evaluate the effectiveness of a learning website based on the Interactive Lecture Demonstration (ILD) model in improving students' critical thinking skills in the Primary School Teacher Education Study Program (PGSD). The research method used was an experiment with a pretest-posttest design and involved two groups, namely the experimental class and the control class, each consisting of 76 Primagraha University students. The experimental class received learning through an ILD-based website, while the control class used conventional methods. The analysis showed that the experimental class's average posttest score (81,86) was higher than the control class's (74,00). The N-Gain value for the experimental class reached 0,62 (62 %) with the interpretation of "quite effective", while the control class was only 0,34 (34 %), which was classified as "not effective". The independent sample t-test produced a significance value (Sig. 2-tailed) of 0,003 < 0,05, which shows a significant difference between the two groups. The ILD website was developed based on Mayer's multimedia theory and is equipped with interactive features such as animation, video and reflective activities that can encourage active student participation. This research concludes that the use of ILD-based websites is not only relevant to 21st century learning needs, but is also able to improve critical thinking skills significantly. This website is an alternative innovative learning solution that can be applied in the context of higher education, especially in the PGSD program.

Keywords: Learning Website; Interactive Lecture Demonstration; Critical Thinking; PGSD; Educational Technology.

RESUMEN

Esta investigación busca evaluar la efectividad de un sitio web de aprendizaje basado en el modelo de Demostración de Clases Interactivas (DCL) para mejorar las habilidades de pensamiento crítico de los estudiantes del Programa de Estudios de Formación del Profesorado de Primaria (PEFP). El método de investigación empleado fue un experimento con un diseño pretest-postest, que involucró a dos grupos: la clase experimental y la clase de control, cada una compuesta por 76 estudiantes de la Universidad de Primagraha. La clase experimental recibió aprendizaje a través de un sitio web basado en DCL, mientras que la clase de control utilizó métodos convencionales. El análisis mostró que la puntuación promedio de la clase experimental en la prueba posterior (81,86) fue superior a la de la clase de control (74,00). El valor de N-Gain para la clase experimental alcanzó 0,62 (62 %), con la interpretación de "bastante efectiva", mientras que la

clase de control fue de tan solo 0,34 (34 %), la cual se clasificó como "no efectiva". La prueba t de muestras independientes arrojó un valor de significancia (Sig. bilateral) de 0,003 < 0,05, lo que indica una diferencia significativa entre los dos grupos. El sitio web de ILD se desarrolló con base en la teoría multimedia de Mayer y cuenta con funciones interactivas como animación, video y actividades reflexivas que fomentan la participación activa del alumnado. Esta investigación concluye que el uso de sitios web basados en ILD no solo es relevante para las necesidades de aprendizaje del siglo XXI, sino que también puede mejorar significativamente las habilidades de pensamiento crítico. Este sitio web es una solución de aprendizaje innovadora y alternativa que puede aplicarse en el contexto de la educación superior, especialmente en el programa de Desarrollo Universitario Preuniversitario (PGSD).

Palabras clave: Sitio Web de Aprendizaje; Demostración de Clase Interactiva; Pensamiento Crítico; PGSD; Tecnología Educativa.

INTRODUCTION

In the 21st century, globalization and technological advances have significantly transformed human lifestyles. The rapid development of science and technology requires education systems to adapt, especially in preparing students with essential 21st-century skills such as critical thinking, creativity, communication, collaboration, and technological literacy.[1,2,3]

Scientists study natural phenomena and the physical world.[4] Science places emphasis on direct experience to scientifically investigate and understand the patterns and beauty of nature, allowing for a deeper understanding of the surrounding environment. Science learning is directed at developing a learning domain that reaches a high level of understanding, enabling students to hone skills related to natural phenomena in a comprehensive manner.[4] One very important skill is the ability to think, which includes the ability to think critically, creatively, and the ability to solve problems.[5] Wallace[6] defines critical thinking skills as a way to carefully consider subjects, content or problems to improve the quality of responsible decision making. Meanwhile, according to Yilamaz[7], critical thinking skills are the ability to test assumptions, identify hidden values, evaluate evidence, and assess conclusions. In this context,[8] emphasizes that critical thinking activities can be improved through effective problem solving, which allows understanding a problem from concrete knowledge concepts to a more contextual understanding. This helps increase students' experience and ability to think more advanced, critically, creatively, and have a strong drive to face developments in science and technology in the 21st century.[9]

In science learning, many researchers measure students' critical thinking skills. According to research conducted by [10], there is a lack of training in the critical thinking process provided by the lessons, evaluations and curriculum used. Apart from that, there is a similar opinion,[11] which states that students' lack of ability to evaluate conclusions is the cause of their low critical thinking abilities. In addition, Pradana[12] and Azizah et al.[13] state that educators fail to create effective learning strategies to improve students' critical thinking skills and only focus on the teacher without encouraging students.[12,13] Furthermore, [14] explains that the low level of critical thinking skills is also caused by science learning methods or models that cannot develop these skills.

Learning model Interactive Lecture Demonstration (ILD) is expected to increase student participation in learning.[15] In this model, the teacher carries out demonstrations with certain tools and materials, so that students can see and feel the concepts being studied directly.[16] Apart from that, the website-based ILD learning model can be developed to be more interactive and dynamic by adding web-based technology. In this model, students can access learning materials through an attractive website platform. Websites can be used to provide additional material, explain concepts in more depth, and provide opportunities for students to participate actively in learning.[17] Websites also provide students with opportunities to participate in educational content and activities as they become active participants in learning, positively influencing their performance. According to Aljraiwi[18], building cooperative relationships and positive communication between participants results in the exchange of experiences, problem-solving skills, critical thinking, learning independence, and competitiveness.

ILD which is an abbreviation of Interactive Lecture Demonstration, is a learning method that focuses on an approach to understanding scientific concepts through visual demonstrations and aims to help students believe that the concepts being studied can be explained and proven by Wijanarka et al.[19]. The ILD model is a learning approach that is based on general principles of understanding and involves inquiry methods, where teachers/lecturers use interactive demonstrations, encourage collaboration in small groups, and emphasize interaction in class such as discussions so that it is suitable for application in higher education, namely for students.[20] 1) Observation, 2) Explanation, and 3) Reflection are the stages of the ILD learning model which are based on common sense. In the first stage of learning, students observe the teacher/lecturer demonstrating a problem.

In the next stage, students are given problems that arise from observations and are asked to explain the solution. In the final stage, the teacher/lecturer guides students to draw conclusions based on the relationship between the observed phenomena and the concepts that have been studied.

In the context of higher education, developing students' critical thinking skills is one of the main focuses, especially in the Elementary School Teacher Education (PGSD) study program. Although much research has been done on effective teaching methods, there is still a lack of understanding of how the model Interactive Lecture Demonstration (ILD) can be optimally integrated in online learning to improve students' critical thinking skills.[21,22] This research aims to fill this gap by exploring the effectiveness of ILD-based websites in the PGSD context.

The urgency of this research is increasing along with the development of information technology which influences the way students learn. Websites designed with the ILD model can provide interactive and interesting learning experiences, which are expected to encourage students to be more active in the learning process and improve their critical thinking skills.[23] However, there is still little research that specifically examines the impact of using ILD-based websites on increasing critical thinking among PGSD students. Thus, this research not only contributes to the development of educational theory, but also provides practical implications for teaching in PGSD. It is hoped that the results of this research will provide new insights for educators and curriculum developers in designing learning strategies that are more effective and relevant to student needs in the digital era.[24]

The aim of this research is to explore and analyze the effectiveness of model-based websites Interactive Lecture Demonstration (ILD) in improving the critical thinking skills of students in the Elementary School Teacher Education Study Program (PGSD). This research aims to identify the extent to which the use of the ILD website can facilitate student interaction and involvement in the learning process, as well as to evaluate its impact on improving their critical thinking skills. With this approach, it is hoped that more innovative and effective learning strategies can be found that can be applied in the context of higher education.

The novelty of this research lies in the integration of the ILD model with an online learning platform specifically designed for PGSD students. Although the ILD model has been proven effective in face-to-face learning contexts, this research will provide a new perspective by adapting the model to a digital format. In addition, this research will present empirical data that supports the effectiveness of using ILD-based websites in improving critical thinking, which is still rarely discussed in educational literature. Thus, this research not only contributes to the development of educational theory, but also offers practical solutions that are relevant to educational needs in the digital era.

METHOD

The method used in this research is an Research & Development (R&D). exspecially experimental design with a pretest-posttest approach to measure the effectiveness of model-based websites Interactive Lecture Demonstration (ILD) in improving the critical thinking skills of students in the Elementary School Teacher Education Study Program (PGSD). This research will involve two groups, namely an experimental group that will use the ILD website and a control group that will take part in conventional learning.

The research stage began by conducting a pretest to measure students' critical thinking abilities before the intervention. After that, the experimental group will be given treatment using an ILD-based website for a certain period, while the control group will follow traditional learning methods. After the intervention is complete, a posttest will be conducted to measure students' critical thinking abilities again. The difference between the pretest and posttest scores will be calculated to obtain a gain score, which is defined as:

$$\text{Gain Score} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Possible Score} - \text{Pretest Score}}$$

The data was analysed using the t test to compare the average gain score between the experimental and control groups. The t-test was chosen because it can determine whether there are significant differences between two independent groups.[25,26] Apart from that, gain score analysis will also be carried out to evaluate the effectiveness of the intervention, referring to the method developed by Hake[21], which classifies gain scores into low, medium, and high categories. Thus, it is hoped that this research can provide empirical evidence regarding the effectiveness of using ILD-based websites in improving PGSD students' critical thinking skills.

RESULTS

The effectiveness test of a learning website is a series of research and development processes to produce a science-based learning website.*ILD* which is representative for use in learning. This stage is also called field trials (*field try-out)*. An example of the appearance of the website being developed can be seen in figure 1.

Figure 1. Example of an ILD-based science learning website display

This activity is designed in the form of experimental research where there is an experimental class and a control class. The number of students involved in the field trial was 76 students.

Table 1. Number of Students in Learning Website Effectiveness Test

Institution Name	Number of Students		Total
	Experimental Class	Control Class	
Primagraha University	76	76	152

The field trial was carried out over eight meetings, namely pre-test, implementation of science learning in the experimental class and control class and post-test. The results of testing the effectiveness of using the learning website are translated into pre-test, post-test and results data N-Gain critical thinking skills.

Pretest and Posttest Results of Critical Thinking Skills in Students

The results of the pre-test and post-test of critical thinking skills in this research will be described as follows:

Pretest Results of Critical Thinking Skills in Students

This pretest was carried out to determine the initial state or extent of critical thinking skills possessed by students in both the experimental and control classes before using the science-based learning website. *ILD*. After obtaining the pretest results, data processing is then carried out and the average, smallest score, largest score and standard deviation are obtained. The data can be visualized in the following table:

Table 2. Pretest Average of Critical Thinking Skills for Experimental and Control Classes

Class	Number of Students	Rather Ideal	Smallest Score	Biggest Score	Rate-rate	Standard Deviation
Experiment	76	100	34	66	50,25	8,36
Control	76	100	28	74	59,54	10,99

Based on the table above, the average pretest score for critical thinking skills in the experimental class is higher than that of the control class for students.

Posttest Results of Critical Thinking Skills in Students

This post-test was carried out to determine the extent of critical thinking skills possessed by students in both the experimental and control classes after receiving treatment using a science-based learning website. ILD. After obtaining the data from the post-test of critical thinking skills, data processing and average, smallest score, largest score, and standard deviation were carried out. The data can be visualized in the following table:

Table 3. Posttest Average Critical Thinking Skills of Experimental and Control Classes

Class	Number of Students	Rather Ideal	Smallest Score	Biggest Score	Rate-rate	Standard Deviation
Experiment	76	100	74	95	81,86	4,77
Control	76	100	50	86	74,00	6,38

The table above shows that the average post-test score for critical thinking skills in the experimental class is higher than the control class.

Test Results of Differences in Mean Pretest and Posttest Experimental and Control Classes

After the researcher knows the average of the pre-test and post-test results, the next step is to find out the effectiveness of the learning website in improving critical thinking skills, a test is carried out using N-Gain as well as the T test using an independent sample t test. As for the test results N-Gain score obtained as follows:

Table 4. Test Results N-Gain Score

No	Class	N-Gain Score	N-Gain Percent	Interpretation
1	Experiment	0,62	62	Quite Effective
2	Control	0,34	34	Ineffective

The table above shows that the N-Gain percent in the experimental class is 62 with the interpretation being quite effective. This means that the use of science learning websites in experimental classes is quite effective in improving students' critical thinking skills. The N-Gain percent in the control class is 34, with the interpretation being ineffective.

This means that the use of media that lecturers usually give to students in control classes is not effective in improving students' critical thinking skills. Thus, it can be concluded that the use of science-based learning websites, ILD, is quite effective in improving the critical thinking skills of class V students in higher education.

Next, a test is carried out independent sample t test to determine if the average difference is significant. Before carrying out this test, the data must first be tested for analysis requirements, namely the normality test and homogeneity test. The normality test and homogeneity test calculation process uses IBM SPSS 25. The normality test results are as follows:

Table 5. Normality Test Results N-Gain Critical Thinking Skills in Experimental and Control Classes among Students

		Tests of Normality					
	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Say.	Statistic	df	Say.
N_GAIN	Experiment	0,096	76	0,080	0,975	76	0,137
	Control	0,091	76	0,186	0,935	76	0,001

Note: a. Lilliefors Significance Correction

The table above shows that the experimental class's N-Gain critical thinking skills have a significant value of 0,08 > 0,05 and the control class has a significant value of 0,186 > 0,05, so the hypothesis is accepted. This shows that the N-Gain of critical thinking skills in the experimental and control classes is normally distributed.

Furthermore, the results of the N-Gain pretest and posttest score homogeneity test for critical thinking skills in the experimental class and control class for students can be explained in the table below:

Table 6. Homogeneity Test Results of Pretest and Posttest Scores for Critical Thinking Skills in Experimental and Control Classes for Students

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Say.
N_GAIN	Based on Mean	1,343	1	150	0,248
	Based on Median	1,566	1	150	0,213
	Based on Median and with adjusted df	1,566	1	149,040	0,213
	Based on trimmed mean	1,487	1	150	0,225

Based on the table above, a significant value is obtained (*P Value)* > 0,05, it can be concluded that the distribution of N-Gain critical thinking skills in the experimental and control classes among students is homogeneous.

Thus, the N-Gain critical thinking skills of the experimental and control classes in students are normally distributed and homogeneous. Furthermore, the researcher conducted a test of the average difference. This test uses a one-sample independent t-test with a significance level of 0,05. The results of the N-Gain average difference test for critical thinking skills are as follows:

Table 7. Average Difference Test Results N-Gain Critical Thinking Skills

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Say.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95 % Confidence Interval of the Difference	
									Lower	Upper
N_GAIN	Equal variances assumed	0,743	0,392	3,063	58	0,003	0,08767	0,02862	0,03037	0,14496
	Equal variances not assumed			3,063	55,960	0,003	0,08767	0,02862	0,03033	0,14500

Based on the table above, it is known that the value, Sig. (2-tailed), is 0,003 < 0,05. This shows that there is a significant average difference between the experimental class and the control class. Thus, it can be concluded that the use of ILD-based science learning websites has proven to be quite effective in improving students' critical thinking skills.

In testing product effectiveness, research is designed as experimental research with an experimental class and a control class. The universities involved in the effectiveness test were Primagraha University students. The number of students involved in the field trial was 60 students. The independent sample t test shows a difference in the average N-Gain of critical thinking skills between the experimental and control classes. In addition, the N-Gain test results show that the use of science learning websites has proven to be effective in improving students' critical thinking skills. From this, it can be explained that science learning websites can improve students' critical thinking skills. This is proven by the test results, which show an increase between before and after implementing learning using the science learning website. Thus, the science learning website

is based ILD developed by researchers can be a solution to the problems of lecturers and students in the field in terms of science learning.[27]

In essence, this learning website product was developed based on needs in the field, and the development process was adapted to suggestions and input from experts and practitioners. An attractive display accompanied by interactive video animations makes students happy and more enthusiastic about learning. This learning website is based on main theory.[28] In this theory, a website must have components such as; (1) text, as a basic element, (2) images, (3) animation, (4) video, (5) audio, and (6) interactivity. According to Clark et al.[27] students can learn better from animation and voiced narration than animation and text on a screen display. The same images and words presented visually (i.e. as animation and text) will cause the visual channel to be overloaded while the auditory/verbal channel is not utilized. Therefore, in website development, visual and auditory channels are used equally.

In addition, the learning website developed by researchers has shown an interaction between the website and the cognitive process during learning. This interaction is known as the cognitive theory model of learning websites developed by Mayer. Meaningful learning requires student participation in the cognitive process during learning, but the capacity of students to use their cognitive processes is limited. To overcome this, lecturers must create recognition through the use of websites, the use of learning websites has sensitivity to the burden of students' cognitive processes during learning.[28]

Several studies have proven that learning websites can improve critical thinking skills. In the research of Lai et al.[29] shows that website-based augmented reality can improve students' critical thinking skills. The existence of this website can make it easier to understand concepts, analyze data, and make it easier for them to relate concepts to the material contained in the media. Furthermore, Oktaweri et al.[30] have carried out field needs analysis research on website-based learning. Research findings show that website based learning games needs to be developed based on several factors, namely: a) High Order Thinking Skills (HOTS) students are still lacking. b) creativity, innovation, and student activity in learning Physics are still far from ideal. c) Physics learning conditions are not optimal in the use of ICT-based teaching materials. d) Need to develop learning website teaching materials assisted by games. The results of a preliminary study conducted by Oktaweri et al.[30] show that learning websites have the potential to improve the ability High Order Thinking Skills (HOTS) student. Furthermore, a study shows that websites can improve students' critical thinking skills in terms of analyzing data, making conjectures, verifying, drawing conclusions, and testing the validity of arguments. Students' responsiveness and learning motivation are also positive because the website has interactive video displays and complete materials, while students feel that the learning process is not limited by space and time. Of course, this shows the superiority of the website itself for students. Research by Gandri et al.[31]; Hanggara et al.[32]; Saputrı et al.[33] have also proven that the use of websites in learning can improve students' critical thinking.

Several studies state that the integration of text, graphics, images, sound and animation can stimulate students' problem-solving skills.[34,35,36,37] In addition, this research proves that learning websites can increase students' conceptual understanding and learning motivation. This is because students can independently construct concepts through the learning steps contained on the website.

Integration ILD The learning website aims to provide students with experience in entering the scientific process. ILD chosen because it aims to train students' abilities in researching, explaining phenomena, and solving problems scientifically.[27,38] On a website based ILD, Students will be invited to carry out various scientific methods or inquiry processes to discover a concept using inductive thinking. This activity will challenge students' abilities in analyzing concepts and solving problems. If students are used to carrying out the inquiry process correctly, their critical thinking skills will begin to develop.

In line with the statement[39] someone who thinks critically is able to make analyzes and evaluate data or information and is able to solve a problem they face. Use of learning-based websites ILD designed to involve students in truly original research problems by exposing students to areas of investigation, helping students identify conceptual or methodological problems in those fields, and inviting students to design ways to overcome these problems. Through a science-based learning website ILD can stimulate and improve students' critical thinking skills.

On integration ILD into the website is operationalized into learning activities consisting of "let's ask, let's explore, let's analyze, and let's evaluate". This learning activity is designed to involve students in truly original research problems by confronting students with the field of investigation, helping students identify conceptual or methodological problems in the field, and inviting students to be able to design ways to overcome these problems. Thus, students can find out how knowledge is created and constructed.

Next, after going through several activities, ILD students are faced with reflection activities. This is where students will appreciate knowledge due to a challenging process and may also learn to overcome the problems, limitations and obstacles they experience. Indirectly based learning ILD can stimulate students' critical thinking abilities. Through several structured learning activities, learning becomes meaningful. In line with Ausubel's

theory, learning can be categorized into two dimensions. The first dimension is related to the way information or material is presented to students through reception or discovery. Then the second dimension is related to how students can link this information to existing cognitive structures, which include facts, concepts and generalizations that students have learned and remembered.[40,41] With the entire learning process on the website, students will get meaningful learning.

In this case, the advantages of a science learning website based on...ILD among others, (1) this learning website covers science material for 1 semester so that it has a long contribution in helping lecturers facilitate student learning, especially for class V first semester students, (2) this learning website is not like websites in general but has a unique feature, namely that the steps for learning activities on the website are integrated with ILD. This makes students use the website and actively explore to find concepts or solve problems critically independently, (3) this science website also motivates students to study individually and in groups. In analyzing activities, some tasks are projects with worksheets in them. This can motivate students to study in groups. Apart from that, other activities have clear learning instructions which can also motivate individual student learning, and (4) this science learning website trains students to reason and think critically. Every learning activity on this website is based on a thought process starting from let's ask, let's explore, let's analyze, and evaluate. Apart from that, all the learning activities in it also motivate students to learn to analyze information, classify data, evaluate information, and solve problems.

CONCLUSIONS

Based on the results of the study, it can be concluded that the use of a science learning website based on Interactive Lecture Demonstration (ILD) has proven to be quite effective in improving critical thinking skills of PGSD students. This is shown by an increase in the average posttest score in the experimental class of 81,86, compared to the control class which only reached 74,00. In addition, the N-Gain value in the experimental class of 0,62 (62 %) is categorized as quite effective, while the control class only obtained an N-Gain of 0,34 (34 %) with an ineffective category.

The results of the independent sample t-test showed a significance value of 0,003 <0,05, indicating a significant difference in the average between the experimental group and the control group. This confirms that the use of ILD-based websites statistically has a significant effect on improving students' critical thinking skills.

This website is designed interactively by referring to Mayer's multimedia theory, equipped with text, animation, video, audio and reflective activity features such as "let's ask", "let's explore" and "let's analyze". These features have been proven to increase active participation and in-depth understanding of concepts. Thus, an ILD-based science learning website can be used as an innovative and applicable solution to improve the quality of higher education, especially to equip students with 21st century critical thinking skills.

BIBLIOGRAPHIC REFERENCES

1. Andrian Y, Rusman R. Implementasi pembelajaran abad 21 dalam kurikulum 2013. J Penelit Ilmu Pendidik. 2019;12(1):14–23.

2. Redhana IW. Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. J Inov Pendidik Kim. 2019;13(1).

3. Handayani R, Wulandari D. Modern assessment dalam menyongsong pembelajaran abad 21 dan hambatan di negara berkembang. J Pendidik Edutama. 2021;8(1):13.

4. Rahayuni G. Hubungan keterampilan berpikir kritis dan literasi sains pada pembelajaran IPA terpadu dengan model PBM dan STM. J Penelit dan Pembelajaran IPA. 2016;2(2):131–46.

5. Syofyan H, Amir TL. Penerapan literasi sains dalam pembelajaran IPA untuk calon guru SD. J Pendidik Dasar. 2019;

6. Ramdani A, Jufri AW, Jamaluddin J, ... Kemampuan berpikir kritis dan penguasaan konsep dasar IPA peserta didik. J Penelit …. 2020;

7. Rachamatika T, Sumantri MS, ... Pengaruh Model Pembelajaran Dan Kemandirian Belajar Terhadap Kemampuan Berpikir Kritis IPA Siswa Kelas V SDN Di Jakarta Timur. … Pendidik J …. 2021;

8. Susanti E. Penerapan model pembelajaran probing-prompting untuk meningkatkan kemampuan berpikir kritis Matematis siswa kelas XI. IPA MAN 1 Kota Bengkulu. J Pendidik Mat Raflesia. 2017;

9. Jannah DRN, Atmojo IRW. Media Digital dalam Memberdayakan Kemampuan Berpikir Kritis Abad 21 pada Pembelajaran IPA di Sekolah Dasar. J Basicedu. 2022;

10. Rahayu R. Pengembangan desain pembelajaran IPA untuk meningkatkan karakter pelajar Pancasila pada aspek bernalar kritis dan kreatif di SMPIT Ihsanul Fikri Kota Magelang. J Inov Pembelajaran Biol. 2022;3(2):88–109.

11. Nadeak B. The effectiveness of distance learning using social media during the pandemic period of COVID-19: A case in Universitas Kristen Indonesia. Int J Adv Sci Technol. 2020;29(7):1764–72.

12. Pradana DBP. Pengaruh penerapan tools google classroom pada model pembelajaran project based learning terhadap hasil belajar siswa. IT-Edu J Inf Technol Educ. 2017;2(1).

13. Azizah IN, Widjajanti DB. Keefektifan pembelajaran berbasis proyek ditinjau dari prestasi belajar, kemampuan berpikir kritis, dan kepercayaan diri siswa. J Ris Pendidik Mat. 2019;6(2):233–43.

14. Anisa A. Meningkatkan keterampilan berpikir kritis peserta didik melalui pembelajaran IPA berbasis potensi lokal Jepara. J Inov Pendidik IPA. 2017;

15. Taufiq B. Identifikasi nilai-nilai pendidikan Islam dalam pemberdayaan masyarakat pada PNPM Mandiri. J Penelit. 2017;11(1):69–90.

16. Maryani M, Nisak MS, Supriadi B. Implementasi media pembelajaran berbasis web Google Sites untuk meningkatkan kemampuan memecahkan masalah siswa SMA pokok bahasan gelombang bunyi. J Penelit Pendidik IPA. 2022;8(4):2136–44.

17. Rohmani N, Andriani R. Correlation between academic self-efficacy and burnout originating from distance learning among nursing students in Indonesia during the coronavirus disease 2019 pandemic. J Educ Eval Health Prof. 2021;18.

18. Aljraiwi S. Effectiveness of gamification of web-based learning in improving academic achievement and creative thinking among primary school students. Int J Educ Pract. 2019;7(3):242–57.

19. Wijanarka BS, Sukardi T, Rahdiyanta D, Ngadiyono Y. Evaluation of implementation of health and safety in industry and vocational school in Yogyakarta Special Region. In: Journal of Physics: Conference Series. IOP Publishing; 2019. p. 12063.

20. Marwanti E, Wardani K, Megawati I. Pengembangan modul digital berbasis team learning pada virtual classroom konsep dasar ips sd. TRIHAYU J Pendidik Ke-SD-an. 2022;8(2):1383–91.

21. Hake RR. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am J Phys [Internet]. 1998;66(1):64–74. Available from: http://aapt.scitation.org/doi/10.1119/1.18809

22. Prince M. Does active learning work? A review of the research. J Eng Educ. 2004;93(3):223–31.

23. Bishop J, Verleger M. Testing the flipped classroom with model-eliciting activities and video lectures in a mid-level undergraduate engineering course. In: 2013 IEEE Frontiers in Education Conference (FIE). IEEE; 2013. p. 161–3.

24. Garrison DR, Anderson T, Archer W. A theory of critical inquiry in online distance education. Handb distance Educ. 2003;1(4):113–27.

25. Field A. Discovering statistics using IBM SPSS statistics. Sage publications limited; 2024.

26. Field A. Discovering statistic using SPSS. 3rd ed. London: Sage Publication; 2009.

27. Clark RC, Mayer RE. E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. john Wiley & sons; 2023.

28. Mayer RE, Moreno R. A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. J Educ Psychol. 1998;90(2):312.

29. Lai Y, Saab N, Admiraal W. Learning strategies in self-directed language learning using mobile technology in higher education: A systematic scoping review. Educ Inf Technol. 2022;27(6):7749–80.

30. Oktaweri S, Djamas D. Curriculum analysis in developing interactive multimedia teaching materials scientific model assisted games for physics learning. In: Journal of Physics: Conference Series. IOP Publishing; 2019. p. 12118.

31. Gandri M, Djamas D. Preliminary analysis of Problem Based Learning model implementation in the development of module assisted multimedia interactive game for improving critical thinking skill learners. In: Journal of Physics: Conference Series. IOP Publishing; 2019. p. 12140.

32. Hanggara A, Suhaeti Y. Improving Students' Critical Thinking Skills through Multimedia Based Economic Learning (Research and development on Ten Grade Students of Senior High Schools in Kuningan, West Java). In: 1st International Conference on Economics, Business, Entrepreneurship, and Finance (ICEBEF 2018). Atlantis Press; 2019. p. 511–3.

33. Saputrı DY, Rukayah R, Indrıayu M. Need assessment of interactive multimedia based on game in elementary school: A challenge into learning in 21st century. Int J Educ Res Rev. 2018;3(3):1–8.

34. Adhitama I. Pengembangan Multimedia Pembelajaran Interaktif Model Discovery Learning pada Materi Pokok Teorema Pythagoras untuk Siswa Kelas VIII MTs Al-Furqon Kabupaten Bantul Tahun Ajaran 2017/2018. UNS (Sebelas Maret University); 2018.

35. Husein S, Harjono A, Wahyuni S. Problem-based learning with interactive multimedia to improve students' understanding of thermodynamic concepts. In: Journal of Physics: Conference Series. IOP Publishing; 2019. p. 12028.

36. Prabowo A, Anggoro RP, Adiyanto R, Rahmawati U. Interactive multimedia-based teaching material for trigonometry. In: Journal of Physics: Conference Series. IOP Publishing; 2018. p. 12138.

37. Wiana W, Barliana MS, Riyanto AA. The Effectiveness of Using Interactive Multimedia Based on Motion Graphic in Concept Mastering Enhancement and Fashion Designing Skill in Digital Format. Int J Emerg Technol Learn. 2018;13(2).

38. Prunckun H. Handbook of scientific methods of inquiry for intelligence analysis. Scarecrow Press; 2010.

39. Ennis RH. Critical thinking across the curriculum: A vision. Topoi. 2018;37:165–84.

40. Abdullah S, Hendon S. Transforming Science Teaching Environment for the 21st Century Primary School Pupils. Malaysian Online J Educ Technol. 2016;4(4):68–76.

41. Skuballa IT, Dammert A, Renkl A. Two kinds of meaningful multimedia learning: Is cognitive activity alone as good as combined behavioral and cognitive activity? Learn Instr. 2018;54:35–46.

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