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CRITICAL THINKING AND MATHEMATICAL PROBLEM SOLVING SKILLS OF STUDENTS THROUGH SCHOOLOGY-ASSISTED BLENDED LEARNING MODELS

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ABSTRACT

Students' poor critical thinking and mathematical problem-solving abilities are caused by a variety of variables, including teacher-centered learning and an ineffective learning models. In order to increase students' critical thinking skills and mathematical problem solving abilities, it is required to use an appropriate and unique learning strategy. The purpose of this research is to determine the influence of the Blended Learning models, as aided by Schoology Media, on students' critical thinking and mathematical problem-solving abilities. This study used a quasy experimental design as a research method. The population used in this study were all class X students of SMK-SMTI Bandar Lampung. The sample technique employed in this research was cluster random sampling, so that class X KI 4 as the experimental group and class X KI 1 as the control group, each group consisting of 28 students. The instruments used in this study were tests of critical thinking skills, tests of mathematical problem solving Skills, and documentation. Data analysis techniques using descriptive data analysis and inferential analysis. The hypothesis test is in the form of a One-way Multivariate Analysis of Variance (One-way MANOVA) Test. Based on the results of the analysis, 1) There is a difference between the Skills to think critically and the Skills to solve mathematical problems between the two groups of students; 2) There is a difference in the Skills to think critically between the group that is treated with the schoology-assisted Blended Learning model and the group that is given the conventional learning model treatment; 3) There are differences in the Skills to solve mathematical problems between groups that are treated with the schoology-assisted Blended Learning model and the group that is given the conventional learning model treatment; and 4) there is an influence between the Blended Learning learning model on students' critical thinking skills and mathematical problem solving.

Keywords: Blended Learning, Critical Thinking Skills, Mathematical Problem Solving Skills, Schoology Media

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PRELIMINARY

Today, it is critical to learn mathematics. Mathematics is a very fundamental knowledge(Anggraini et al., 2023; Permanasari & Pradana, 2021) and is one of the disciplines that all educational levels must include(Marasabessy et al., 2021). In addition to

supporting science, mathematics also has a very important role in life(Komarudin et al., 2022). Mellawaty & Taufan (2021) said that Mathematics is a very significant science to master at any time because of its many applications in a wide range of fields.

A continuous, dynamic, and active process, mathematics education helps students build logical, thorough, critical, and systematic responses as well as adopt goals and objectives when solving issues(Mendes & da Silva, 2018; Popova et al., 2022). In line with that, Saputra & Zulmaulida (2021) stated that involvement in Mathematical activity is a sort of cognitive activity that may be defined as a distinct pattern, a well-organized pattern of logistical evidence, and the thorough, accurate, and correct use of language. One of the crucial abilities a student in mathematics must learn is the ability to engage in critical thinking as a sort of thinking activity.

Learning maths is the most effective way to develop your critical thinking skills(Samura & Darhim, 2023). The objective of learning mathematics includes critical thinking, which is necessary for problem solving(Saputri & Qohar, 2023). According to Felder & Brent (2016) in Hebebci & Usta (2022), Critical thinking is more than rote learning; Analysis, assessment, introspective, and creative thinking are some of the mental processes that make up critical thinking. Students that possess critical thinking abilities will be more able to reason(Dwyer et al., 2014; Putri et al., 2023; Ulfa, 2020), improve critical analytical skills(Susilawati et al., 2020), Resolve challenging situations in decision-making(Suherman et al., 2020), Analyze every aspect and thoroughly connect to every component(Syarifah, 2017; Yuliati & Lestari, 2018). According to Saputra & Zulmaulida (2021), testing assertions, ideas, and arguments to determine their value is the process of critical thinking. Therefore, critical thinking is a crucial skill that every student needs to possess.(Arisoy & Aybek, 2021).

According to Purwoko et al (2023), critical thinking is the process of applying reasonable and reflective thinking abilities to decide what to believe or do. In interpersonal and social situations, where good judgment and problem-solving abilities are constantly required, critical thinking is especially important(Hage, 2020; Lin et al., 2020; Marzuki et al., 2021). Focus, justifications, inferences, context, circumstance, clarity, and overview are all components of critical thinking(Marasabessy et al., 2021). This demonstrates how critical thinking abilities are crucial for navigating the problems of the twenty-first century. So, Since the capacity to think critically is a quality that students are expected to possess in mathematics, it will be simpler for them to understand the topic(Murni et al., 2022). However, it should be highlighted that teaching and mastering mathematics presents

significant challenges for teachers in terms of motivating students to think critically(Mahmud, 2019; Mahmud et al., 2021), including Indonesia.

The findings of recent studies provide as proof for this, showing that Indonesian students have low mathematical critical thinking skills(Apriliana et al., 2019; Ardianingtyas et al., 2020; Bariroh et al., 2023; Purwoko et al., 2023). Whatever the objective, developing and cultivating this type of thinking in students is a difficult endeavor because it necessitates teachers using a variety of approaches to mathematics learning. Understanding the subject of mathematics will be easier for students who have critical thinking ability since critical thinking skill is one that students are supposed to have in mathematics.

One talent that students should possess is the capacity to solve problems in mathematics, and it is not less significant. Problem solving is an important part of mathematics education because it is at the heart of the subject(Musna et al., 2021) and a key component of mathematical competence(Barana et al., 2022). The capacity of a person to use their knowledge, abilities, and understanding to address problems in unfamiliar contexts is referred to as problem solving skills(Barana et al., 2022; Jannah et al., 2021). To become proficient at solving issues, students need to be exposed to a variety of problems on a regular basis over an extended period of time. Open-ended and non-routine assignments can help students(Rahmawati et al., 2019; Wulandari et al., 2020).

In fact, the two Skills mentioned above are still at a low level. According to the exam results given to students in class X KI, this is what the researchers at SMK-SMTI Bandar Lampung discovered. Following are the test results.

Table 1. Data on The Results of the Critical Thinking Test and Mathematical Problem Solving Material for SPLDV Class X Students

Skills	Class (%)		Average (%)
	X KI 1	X KI 2	
Critical Thinking	55,56	75,00	65,28
Mathematical Problem Solving	44,44	52,78	48,61

Based on table 1 above, the average critical thinking skills and mathematical problem solving Skills of students are still at a low level, where the minimum completeness in SMK-SMTI Bandar Lampung is 70%. The low critical thinking skills and mathematical problem solving skills of students is due to several factors, including teacher-centered learning and the learning model applied by the teacher is not quite right(Lambertus et al., 2023).

The learning process which is still teacher-centered makes it easy for students to forget the material studied before and creates a fear of asking questions. This is reinforced by observations, which reveal that learning is still applied conventionally, with students having a passive role during the learning process. Regarding these problems, it is necessary to adopt an appropriate and innovative to enhance students' capacity for critical thought and for solving problems in mathematics. The use of blended learning models is one innovation that might be the answer to this issue.

According to Darma et al. (2021), ICT in education can help teachers conduct knowledge transfer tasks more swiftly, efficiently, and without being constrained by time or place. The blended learning model absorbs and applies these benefits. Blended learning, a face-to-face learning innovation supported by technology, can make inactive students into active ones. Direct, indirect, computer-assisted, and cooperative learning techniques are all combined in blended learning. (Dangwal, 2017; Mawardi et al., 2023).

With blended learning, students can learn some things on their own at home via video lessons or other learning resources while learning other things in person in a classroom. Teachers may assist anyone who needs it, students can easily access learning resources, and blended learning is more effective and efficient than conventional learning since it is not constrained by time or place. Blended learning satisfies the diverse learning requirements of students by providing the most effective study times.

Various studies on Blended learning have shown its advantages. Research that has been conducted by (Jemakmun, 2022; Kusuma et al., 2023; Nugraha et al., 2019; Pratiwi & Sari, 2022; Sukma & Priatna, 2021; Yanto & Retnawati, 2018) states that the blended learning model has the ability to improve student freedom, learning outcomes, critical and creative thinking, and mathematical concept understanding. Besides that, according to Sulisworo et al. (2020), said that In the case of blended learning, Students who were told to use Schoology as their Learning Management System (LMS) performed better on tests of critical thinking than those who utilized Google Classroom.

In order to make the implemetation of the blended learning model more effective, Schoology media can be used in its implementation. According to Wardono & Mariani (2019), a website called Schoology combines social networking functions with An Learning Management System (LMS). The advantages of Schoology, which are in numerous figures and may be entered into the system, are the same as those of other LMS programs. These numbers include courses, groups, and resources(Darma et al., 2021).

Overall, Schoology's design encourages learners to voluntarily participate in activities both within and outside of the classroom.

According to Wijayanti et al. (2019), incorporating education in the digital age could encourage students to be more engaged in their studies rather than overly depending on traditional teaching and learning methods. This is what is implemented when using schoology media. This is supported by the statement that Schoology media has helped teachers and researchers a lot in improving students' mathematical Skills(Payadnya & Lestari, 2022; Ramdhani, 2020; Resty et al., 2019).

Given these drawbacks, a solution is needed for students' Skills to think critically and solve mathematical problem, given the significance of these two skills for them to learn. As a result, the goal of this research is to determine the impact of the Blended Learning model, as supported by Media Schoology, on the critical thinking and mathematical problem-solving skills of the students.

METHODS

This study employs quantitative research and a descriptive technique. The schoology-assisted blended learning model is the independent variable (X), while critical thinking Skills (Y1) and mathematical problem solving Skills (Y2) are the dependent variable. The research was conducted in October 2021.

Population, Sampling Techniques, and Samples

This study's population consisted entirely of class X students at SMK-SMTI Bandar Lampung in 2021/2022 which consisted of 4 classes with a description in table 2 below:

Table 2. Distribution of Class X Students at SMK-SMTI Bandar Lampung

Class	Number of Students
XKI 1	28
XKI 2	28
XKI 3	28
XKI 4	28
Total	112

In this study, Cluster Random Sampling was used in determining the sample. Based on this technique, it was determined that class X KI 4 served as the experimental class and class X KI 1 served as the control class, each group numbered 28 students. This study used a quasi-experimental design method. The experimental class will be treated with a schoology-assisted blended learning model, while the control class will be treated with face-to-face conventional learning models. The investigation employed a pretest-posttest

control group design using a 2x2 factorial design. For more details, pay attention to table 3 below:

Table 3. The Research Design

Measured Skills (B_i) / Learning Models (A_i)	Critical Thinking Skills (B_1)	Mathematical Problem Solving Skills (B_2)
Schoology-assisted Blended Learning Model (A_1)	(A_1,B_1)	(A_1,B_2)
Conventional Learning Model (A_2)	(A_2,B_1)	(A_2, B_2)

Data Collection Techniques

Tests and documentation are the two main methods used for this study's data collecting. Tests were administered both before and after the treatment. The information gathered is based on experiments that have been conducted and then recorded as tangible proof and outcomes of the research implementation.

Research instruments

Students are tested on their ability to think critically and solve mathematical problems in relation to the subject supplied through the use of essay questions. The scoring of the critical thinking Skills test is divided into 4 indicators, namely interpretation, analysis, evaluation, and inference, while there are four markers for mathematical problem-solving skills, including comprehending the issue, formulating a plan of action, executing the calculation, and reviewing the steps and outcomes. Using the Validity Test, Reliability Test, Difficulty Level Test, and Difference Power Test, existing instruments were first put to the test to see if they were feasible. After passing the feasibility test, the test instrument for measuring students' capacity for critical thought and mathematical problem-solving skills, 8 questions were obtained. Here are the results:

Table 4. Instrument Test Results

No.	Validity Test	Reliability Test	Difficulty Level Test	Difference Power Test	Conclusion
1	Valid	Reliable	Moderate	Good	Used
2	Valid		Moderate	Medium	Used
3	Invalid		Moderate	Poor	Not Used
4	Valid		Hard	Medium	Used
5	Valid		Easy	Medium	Used
6	Valid		Moderate	Medium	Used
7	Valid		Moderate	Good	Used
8	Valid		Hard	Medium	Used
9	Invalid		Moderate	Poor	Not Used
10	Valid		Easy	Good	Used

Data Analysis Technique

N-Gain (Normalized Gain) was employed to evaluate the development of critical thinking abilities and mathematical problem solving between before and after treatments. The following criteria can be used to classify how the N-Gain score was acquired using the N-Gain value:

Table 5. N-Gain Criterion

N-Gain Value	Criteria
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Medium
$g < 0{,}3$	Low

Following the acquisition of instruments that match the four criteria, prerequisite testing in the form of Normality testing and Homogeneity Tests are performed. The Kolmogorv-Smirnov test is used in the Normality test, while Levene's test is used in the Homogeneity of variance test and the Box' M test is used in the Homogeneity of Covariance test. The hypothesis test is carried out when the instrument has satisfied all prerequisites. The one-way multivariate analysis of variance (One-way MANOVA) test is used to examine the validity of the hypothesis..

RESULT AND DISCUSSION

Before being given treatment, To gauge student's early critical thinking abilities and aptitude for solving mathematical problems, a Pretest was first administered. The following are the results of the pretest of these two Skills:

Table 6. Description of Pre-test Results

No.	Statistic	Critical Thinking Skills		Mathematical Problem Solving Skills	
		Experiment	Control	Experiment	Control
1	N	28	28	28	28
2	X_{min}	17	13	25	23
3	X_{max}	75	75	75	78
4	Mean	43,18	43,61	49,25	42,61
5	Std. Deviation	13,747	15,671	12,940	13,093

Based on table 6, for both Skills, it was found that the average value of students' critical thinking skills in the control group was higher than that of the experimental group, whereas in mathematical problem solving abilities, the average scores of the two groups were almost the same. Even so, both the experimental class and the control class had critical thinking skills and mathematical problem solving abilities were still at a low level. See the image below for additional information.

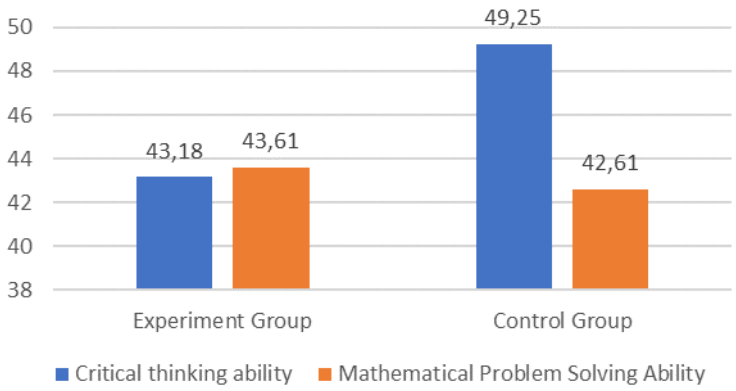

Figure 1. Diagram of Mean Pre-Test Score

In accordance with the results of the mean pre-test score shown in Figure 1 above, treatment was given to the Experimental Group and the Control Group. The control group received conventional face-to-face learning models whereas the experimental group received a blended learning model supported by Schoology. Here are the results:

Table 7. Description of Post-test Results

No.	Statistic	Critical thinking Skills		Mathematical Problem Solving Skills	
		Experiment	Control	Experiment	Control
1	N	28	28	28	28
2	X_{min}	50	39	48	35
3	X_{max}	100	83	100	95
4	Mean	75,11	62,04	73,04	60,32
5	Std. Deviation	11,676	13,065	14,190	14,962

According to table 7, the experimental group's post-test results for critical thinking skills and mathematical problem solving skills were better than the control group's. For more details, consider the figure below.

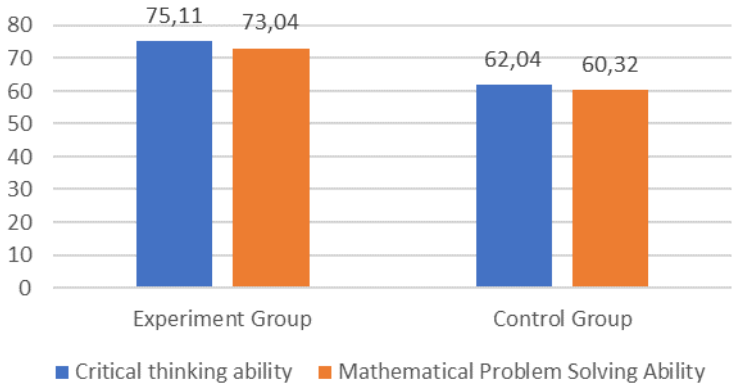

Figure 2. Diagram of Mean Post-Test Score

The Gain category in both the experimental and control groups is analyzed after looking at the pre-test and post-test results in teaching and learning activities. Table 8

below provides the results of the pre-test and post-test gain scores for both groups' critical thinking abilities:

Table 8. Gain Scores for Critical Thinking Skills and Mathematical Problem Solving Skills

Group	Critical thinking Skills		Mathematical Problem Solving Skills	
	Gain Score	Criteria	Gain Score	Criteria
Experiment	0,57	Medium	0,49	Medium
Control	0,33	Medium	0,33	Medium

According to table 8, the growth ratings for both groups on students' critical thinking Skills were in the Medium range. also from table 8 above, it was found that the gain scores for both groups on students' mathematical problem solving Skills were also in the Medium range. It is possible to conclude that the gain scores for both abilities, Both students critical thinking capabilities and their aptitude for solving problems in mathematics are equal.

Before performing the hypothesis test, the preparatory test must be finished. A normality test and a homogeneity test make up the necessary test in this study. The first prerequisite test is the Normality Test. The Kolmogorov-Smirnov test is used to determine normalcy. Table 9 shows the results of the normalcy test:

Table 9. Normality Test Results Using Kolmogorov-Smirnov

Skills	Group	Kolmogorov-Smirnov		
		Statistic	***Df***	***Sig.***
Critical thinking	Experiment	.129	28	.200
	Control	.150	28	.107
Mathematical Problem Solving	Experiment	.136	28	.197
	Control	.142	28	.152

Based on table 9 above, we get a significance value of Gain (Sig.) > 0.05 for all groups for each Skills observed. Thus, it might be claimed that the Gain data on students' critical thinking abilities and aptitude for solving mathematical problems in the experimental and control groups came from populations with regularly distributed data(H_0 is accepted).

The homogeneity test is the second required test. The statistical test employed in homogeneity testing is the Levene's test. The outcomes of Levene's tests are shown in Table 10.

Table 10. Summary of Levene's Homogeneity Test Results

Skills	***Levene Statistic***	***df1***	***df2***	***Sig.***
Critical thinking	.191	1	54	.663
Mathematical Problem Solving	1.702	1	54	.198

It may be seen from table 10 above thatt all significance values (Sig.) > 0.05 for all observed Skills. So it can be concluded that all data have relatively the same variances (homogeneous). The Manova test requires that the variance-covariance matrix must have the same dependent variable. This can be determined using the Box's M test findings. The development of students' critical thinking and mathematical problem-solving skills is the dependent variable in this study. Table 11 summarizes the findings of the Box's M test.

Table 10. Box's M Test Results

Box's M	*Sig.*
10,420	.019

According to the findings in table 11 above, it is discovered that the significance value (Sig.) > 0.05. This shows that the variance-covariance matrix comes from the same dependent variable. After all the necessary assumptions have been completed and all the results are met, the multivariate test can be continued.

The MANOVA Tests of Between-Subjects Effects are used to examine the impact of the blended learning model on critical thinking abilities and mathematical problem solving. The results of MANOVA Table 12 below shows tests between-subjects effects:

Table 12. Summary of MANOVA Test

Source	*Dependent Variable*	*Type III Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*
X	Critical thinking skills	2392.071	1	2392.071	15.584	.000
	mathematical problem solving Skills	2263.143	1	2263.143	10.644	.002

The data analysis findings shown in table 12 above make it evident that the significant value (Sig.) for both Skills is < 0.05 (H_0 is rejected). So, 1) There is a difference between the groups treated with the blended learning with support from the schoolology media and the groups treated with the traditional learning model in terms of the improvement in the score of critical thinking abilities; and 2) There is a difference between the groups treated with the blended learning model with assistance from the schoology and the groups treated with the traditional learning model in terms of the improvement in score for mathematical problem-solving abilities.

Table 13. Summary of Multivariate Tests

Effect	*Value*	*F*	*Hypothesis df*	*Error df*	*Sig.*
Pillai's Trace	.440	20.832	2.000	53.000	.000
Wilks' Lambda	.560	20.832			

Effect	*Value*	*F*	*Hypothesis df*	*Error df*	*Sig.*
Hotelling's Trace	.786	20.832			.
Roy's Largest Root	.786	20.832			

Based on Table 13 results of Multivariate test for growth in mathematical problem-solving ability and critical thinking ability, it is determined that the significance value (Sig.) < 0.05, so H_0 is rejected. On the basis of these results, it is feasible to draw the conclusion that there is an influence between the Blended Learning learning model on students' critical thinking skills and mathematical problem solving.

A blended learning model is a type of learning that mixes online and face-to-face instruction. The blended learning method will work well if it is supported by a Learning Management System (LMS)(Astuti & Bakri, 2022). in accordance with Bervell et al. (2022), for both instructors and students, blended learning with an LMS is now a required choice. In research conducted by Bhadri & Patil (2022), feedback showed that the blended learning model is more adaptable and gives students independent learning chances. The use of technology in teaching and learning has received good comments from more than 82% of the pupils.

Online learning tools are the best way to develop learning conditions at home. Use of Schoology is one of the ideals(Purba et al., 2022). According to Prihandoko (2022), the Schoology platform stimulates students who have adequate online learning readiness to experience their learning positively using Schoology-based blended learning. The LMS, in this case is Schoology contains tools and capabilities for text, graphics, animation, simulation, audio, and video that can be utilized to enhance learning quality, including students' capacity for critical thinking and problem-solving(Siboro et al., 2022). In line with research conducted by Syafriyanti (2022), it was stated that Schoology adoption for online learning significantly improved students' learning results.

The results above are in line with Sulisworo et al. (2020), which states that Students that were instructed to use Schoology as their LMS in the context of blended learning achieved a higher critical thinking Skills score. This is because the information received by students is far more extensive and up-to-date than the material provided by teachers during conventional learning. Apart from that, Nasution et al. (2022) reinforces the results above. They stated that to help students develop their critical thinking abilities, a blended learning model can be utilized in conjunction with a Learning Management System (LMS).

The results of the analysis above are also in line with Noviyanti et al. (2019), which notes an improvement in medium categorization level mathematical problem solving skills. Blended learning model making the learning process more successful and efficient in enhancing students' capacity for solving mathematical problems(Darma et al., 2022). It is conceivable to draw the conclusion that the blended learning models to education is superior to traditional teaching techniques(Marita et al., 2022; Marito & Riani, 2022; Muawanah et al., 2022). Aside from that, it can be claimed that the most crucial abilities that a person must have are the capacity for thinking critically and problem solving (Mellawaty, 2021).

The findings of this investigation also corroborate the claims made by Haeruman et al (2021), in which it is claimed that using a Learning Management System (LMS) makes learning easier for both students and teachers because it can be accessed at any time and from any location, without regard for space or time constraints. Teachers and students can easily access learning with the help of LMS. However, according to Astuti et al. (2019) argues that using a Learning Management System (LMS) for online learning is not any more effective than traditional, face-to-face teaching. She maintains that the conventional approach is still preferred over distant learning since the subject matter is simpler to comprehend and teacher interaction is simpler.

As a result, the blended learning paradigm is available as a solution for both traditional and online learning. In the end, students can develop their critical thinking abilities and learn to solve problems through the experimental approach that has been used. Researchers face a hurdle because of the limited resources and time available to facilitate this learning. This is due to the fact that not all pupils have access to technology that can enhance schoology-based learning. Additionally, researchers must adhere to the academic calendar of the school, and because of the Covid-19 pandemic in the study area, the school must limit treatment time.

CONCLUSION

According to the analysis' findings, it is possible to draw the following conclusion 1) both groups of students experienced an increase in scores; 2) Between the two groups of students, there is a difference in the score gains for critical thinking and quantitative problem-solving abilities; 3) There is a difference in the Skills to think critically between the group that is treated with the schoology-assisted Blended Learning model and the group that is given the conventional learning model; 4) There is a difference in the gain in

the scores of mathematical problem solving Skills between groups that are treated with the schoology-assisted Blended Learning learning model and the group that is given the conventional learning model treatment; and 5) there is an influence between the Blended Learning learning model on students' critical thinking skills and mathematical problem solving.

Based on the conclusions and limitations above, suggestions that can be given include 1) Students must actively participate in learning activities so that the learning process is not only teacher-centered; 2) The Schoology-assisted Blended Learning model can be an option or an alternative for teachers in choosing a learning model that can help students learn; and 3) Researchers hope that other researchers can develop and apply the Schoology-assisted Blended Learning model or other LMS that are more innovative and creative, especially for other math skills.

REFERENCES

Anggraini, L., Rinaldi, A., Syazali, M., & Pradana, K. C. (2023). Analisis Kemampuan Pemahaman Konsep Matematis: Dampak Model Pembelajaran ICM, CRH dan Curiosity. *JMPM: Jurnal Matematika Dan Pendidikan Matematika*, *7*(2), 170–181. https://doi.org//10.26594/jmpm.v7i2.2463

Apriliana, L. P., Handayani, I., & Awalludin, S. A. (2019). The Effect of a Problem Centered Learning on Student's Mathematical Critical Thinking. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *4*(2), 124–133. https://doi.org/10.23917/jramathedu.v4i2.8386

Ardianingtyas, I. R., Sunandar, S., & Dwijayanti, I. (2020). Kemampuan Berpikir Kritis Siswa SMP Ditinjau dari Kemampuan Pemecahan Masalah Matematika. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *2*(5), 401–408. https://doi.org/10.26877/imajiner.v2i5.6661

Arisoy, B., & Aybek, B. (2021). The Effects of Subject-Based Critical Thinking Education in Mathematics on Students' Critical Thinking Skills and Virtues. *Eurasian Journal of Educational Research*, *92*, 99–119. https://doi.org/doi.org/10.14689/ejer.2021.92.6

Astuti, C. C., Sari, H. M. K., & Azizah, N. L. (2019). Perbandingan efektifitas proses pembelajaran menggunakan metode e-learning dan konvensional. *Proceedings of the ICECRS*, *2*(1), 35–40. https://doi.org/10.21070/picecrs.v2i1.2395

Astuti, N. P., & Bakri, R. (2022). Pelatihan Learning Management System (LMS) Untuk Peningkatan Kualitas Pembelajaran Blended Learning Pada Praktikum Perbankan Bagi Dosen Dan Mahasiswa. *LOSARI: Jurnal Pengabdian Kepada Masyarakat*, *4*(1), 41–45. https://doi.org/10.53860/losari.v4i1.90

Barana, A., Boetti, G., & Marchisio, M. (2022). Self-Assessment in the Development of Mathematical Problem-Solving Skills. *Education Sciences*, *12*(2). https://doi.org/10.3390/educsci12020081

Bariroh, N. M., Triyanto, & Fitriana, L. (2023). Critical thinking ability of students at SMPN 2 Kudus with impulsive cognitive style on two variables linear equation system material. *AIP Conference Proceedings*, *2540*(1), 70012. https://doi.org/10.1063/5.0105903

Bervell, B., Umar, I. N., Masood, M., Kumar, J. A., Armah, J. K., & Somuah, B. A. (2022). Promoting Voluntary Use Behavior of Learning Management Systems Among Tutors for Blended Learning in Distance Higher Education. *Contemporary Educational Technology*, *14*(4), 379. https://doi.org/10.30935/cedtech/12193

Bhadri, G. N., & Patil, L. R. (2022). Blended Learning: An effective approach for Online Teaching and Learning. *Journal of Engineering Education Transformations*, *35*(Special issue), 53–60. https://doi.org/10.16920/jeet/2022/v35is1/22008

Dangwal, K. L. (2017). Blended learning: An innovative approach. *Universal Journal of Educational Research*, *5*(1), 129–136. https://doi.org/10.13189/ujer.2017.050116

Darma, I. K., Karma, I. G. M., & Santiana, I. M. A. (2021). Schoology based applied mathematics blended learning model to improve the students' problem-solving ability. *Journal of Physics: Conference Series*, *1810*(1). https://doi.org/10.1088/1742-6596/1810/1/012040

Darma, I. K., Karma, I. G. M., Santiana, I. M. A., & Suastawa, I. W. (2022). Effect Size of Mathematics Blended Learning Design on Increasing Mathematical Problem-Solving Ability of Polytechnic Students in the Covid-19 Pandemic Period. *Logic : Jurnal Rancang Bangun Dan Teknologi*, *22*(1), 43–50. https://doi.org/10.31940/logic.v22i1.43-50

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*, *12*(1), 43–52. https://doi.org/10.1016/j.tsc.2013.12.004.

Felder, R. M., & Brent, R. (2016). *Teaching and learning STEM: A practical guide*. John Wiley & Sons.

Haeruman, L. D., Wijayanti, D. A., & Meidianingsih, Q. (2021). Efektivitas Blended Learning Berbasis LMS dalam Pembelajaran Matematika. *Jurnal Riset Pembelajaran Matematika Sekolah*, *5*(1), 80–84. https://doi.org/10.21009/jrpms.051.10

Hage, G. (2020). The haunting figure of the useless academic: Critical thinking in coronavirus time. *European Journal of Cultural Studies*, *23*(4), 662–666. https://doi.org/10.1177/1367549420926182

Hebebci, M. T., & Usta, E. (2022). The Effects of Integrated STEM Education Practices on Problem Solving Skills, Scientific Creativity, and Critical Thinking Dispositions. *Participatory Educational Research*, *9*(6), 358–379. https://doi.org/10.17275/per.22.143.9.6

Jannah, N., Yerizon, & Arnawa, I. M. (2021). The Effects of Problem Based Learning (PBL) Model on the Improvement of Student's Mathematical Problem-Solving Skill in MAN in Pekanbaru City. *Journal of Physics: Conference Series*, *1742*(1). https://doi.org/10.1088/1742-6596/1742/1/012049

Jemakmun. (2022). Penerapan Pembelajaran Blended Learning Untuk Meningkatkan Hasil Belajar Matematika Siswa Ditinjau Dari Kemampuan Awal Matematika. *AKSIOMA: Jurnal Matematika Dan Pendidikan Matematika*, *11*(4), 2894–2902. https://doi.org/10.24127/ajpm.v11i4.6154

Komarudin, K., Rahmawati, N. D., Anggoro, B. S., Suherman, S., & Arfina, S. (2022). Meningkatkan Kemampuan Metakognitif dan Penalaran Adaptif Matematis: Dampak Model FERA Berbantuan Video Pembelajaran. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(2), 1419–1432. https://doi.org/10.31004/cendekia.v6i2.1268

Kusuma, D. A. C., Sujadi, I., & Slamet, I. (2023). Pengembangan Model Blended Learning Berbasis Etnomatematika Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1), 256–268. https://doi.org/10.24127/ajpm.v12i1.5911

Lambertus, L., Salam, M., Rezkiati, R., Suhar, S., & Hasnawati, H. (2023). Developing Mathematical Creative Thinking (CT) Ability Students Through The Treffinger Learning Model (LM). *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1), 23–35. https://doi.org/10.24127/ajpm.v12i1.5432

Lin, S., Hu, H.-C., & Chiu, C.-K. (2020). Training Practices of Self-Efficacy on Critical Thinking Skills and Literacy: Importance-Performance Matrix Analysis. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(1), 1–10. https://doi.org/10.29333/ejmste/112202

Mahmud, M. S. (2019). The role of wait time in the process of oral questioning in the teaching and learning process of mathematics. *International Journal of Advanced Science and Technology*, *28*(16), 691–697. http://sersc.org/journals/index.php/IJAST/article/view/1942

Mahmud, M. S., Pa, W. A. M. W., Zainal, M. S., & Drus, N. F. M. (2021). Improving Students' Critical Thinking through Oral Questioning in Mathematics Teaching. *International Journal of Learning, Teaching and Educational Research*, *20*(11), 407–421. https://doi.org/10.26803/ijlter.20.11.22

Marasabessy, R., Hasanah, A., & Angkotasan, N. (2021). Efforts to improve students' mathematical critical thinking ability by using Team Assisted Individualization learning model. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012051

Marita, M., Prihatin, I., & Oktaviana, D. (2022). Penerapan Blended Learning Menggunakan Metode Flipped Classroom Berbantuan Google Classroom terhadap Kemampuan Pemecahan Masalah Matematis. *JagoMIPA: Jurnal Pendidikan Matemaika Dan IPA*, *2*(2), 73–83. https://doi.org/10.53299/jagomipa.v2i2.177

Marito, W., & Riani, N. (2022). Efektifitas model pembelajaran blended learning dalam meningkatkan kemampuan berpikir kritis dan kemandirian belajar mahasiswa UPMI pada mata kuliah statistik. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(1), 223–233. https://doi.org/10.31004/cendekia.v6i1.1073

Marzuki, Wahyudin, Cahya, E., & Juandi, D. (2021). Students' critical thinking skills in solving mathematical problems; a systematic procedure of grounded theory study. *International Journal of Instruction*, *14*(4), 529–548. https://doi.org/10.29333/iji.2021.14431a

Mawardi, D. N., Budiningsih, C. A., & Sugiman. (2023). Blended Learning Effect on Mathematical Skills: A Meta-Analysis Study. *Ingénierie Des Systèmes d Information*, *28*(1), 197–204. https://doi.org/10.18280/isi.280122

Mellawaty, M. (2021). Blended Learning: Kemampuan Berpikir Kritis, Self Concept, dan Mathematics Anxiety Pada Mata Kuliah Aljabar Abstrak. *Mathline : Jurnal Matematika Dan Pendidikan Matematika*, *5*(2), 195–204. https://doi.org/10.31943/mathline.v5i2.160

Mellawaty, & Taufan, M. (2021). LMS-Google Classroom Digital Platform: Impact on the Critical Thinking Ability, Self-Concept, and Mathematics Anxiety of Pre-Service Mathematics Teachers during the Covid-19 Pandemic in Indramayu, Indonesia. *Journal of Physics: Conference Series*, *1783*(1). https://doi.org/10.1088/1742-6596/1783/1/012126

Mendes, I. A., & da Silva, C. A. F. (2018). Problematization and research as a method of teaching Mathematics. *International Electronic Journal of Mathematics Education*, *13*(2), 41–55. https://doi.org/10.12973/iejme/2694

Muawanah, N. M. N., Yuzianah, D., & Nugraheni, P. (2022). Efektivitas Model Pembelajaran Blended Learning Terhadap Motivasi dan Kemampuan Pemecahan Masalah pada Materi Peluang. *Jurnal Inovasi Pendidikan Matematika (JIPM)*, *4*(1),

1–9. https://doi.org/10.37729/jipm.v4i1.2162

Murni, A., Marsitin, R., & Fayeldi, T. (2022). Pengembangan Lkpd Berbasis Discovery Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Matematis. *Mathline : Jurnal Matematika Dan Pendidikan Matematika*, *7*(1), 1–18. https://doi.org/10.31943/mathline.v7i1.240

Musna, R. R., Juandi, D., & Jupri, A. (2021). A meta-analysis study of the effect of Problem-Based Learning model on students' mathematical problem solving skills. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012090

Nasution, E. S., Rhamyanti, Y., Lubis, R. U., Harahap, D. G. S., Harahap, A. N., Sara, Y., & Sikumbang, R. S. (2022). The influence of the hybrid learning model using the schoology application in basic physics lectures to improve process skills in the industrial 4.0 period. *Journal of Physics: Conference Series*, *2165*(1). https://doi.org/10.1088/1742-6596/2165/1/012005

Noviyanti, F., Sugiharta, I., & Farida, F. (2019). Analisis Kemampuan Pemecahan Masalah Matematis : Dampak Blended Learning Menggunakan Edmodo. *Desimal: Jurnal Matematika*, *2*(2), 173–180. https://doi.org/10.24042/djm.v2i2.4035

Nugraha, D. G. A. P., Astawa, I. W. P., & Ardana, I. M. (2019). Pengaruh model pembelajaran blended learning terhadap pemahaman konsep dan kelancaran prosedur matematis. *Jurnal Riset Pendidikan Matematika*, *6*(1), 75–86. https://doi.org/10.21831/jrpm.v6i1.20074

Payadnya, I. P. A. A., & Lestari, N. L. P. K. W. (2022). Penerapan Blended Learning Berbantuan E-Worksheet Untuk Meningkatkan Prestasi Belajar Matematika Siswa Kelas VIII.1 Smp Widiatmika. *Jurnal Pendidikan Dan Kebudayaan Missio*, *14*(1), 52–61. https://doi.org/10.36928/jpkm.v14i1.831

Permanasari, L., & Pradana, K. C. (2021). Model Pembelajaran Active Knowledge Sharing Terhadap Hasil Belajar Matematika Siswa SMP. *Ensiklopedia: Jurnal Pendidikan Dan Inovasi Pembelajaran Saburai*, *1*(1), 1–7. https://doi.org/10.24967/esp.v1i01.1327

Popova, Y., Abdualiyeva, M., Torebek, Y., Yelshibekov, N., & Omashova, G. (2022). Improving the effectiveness of senior graders' education based on the development of mathematical intuition and logic: Kazakhstan's experience. *Frontiers in Education*, *7*(986093), 1–13. https://doi.org/10.3389/feduc.2022.986093

Pratiwi, I. R., & Sari, E. M. (2022). Mathematical Creative Thinking Mahasiswa Di Politeknik Menggunakan Blended Learning Dan Lms Moodle. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1105–1115. https://doi.org/10.24127/ajpm.v11i2.4840

Prihandoko, L. A. (2022). Schoology-based Blended Learning in Academic Writing Class during the COVID-19 Pandemic. *JPI (Jurnal Pendidikan Indonesia)*, *11*(1), 51–61. https://doi.org/10.23887/jpi-undiksha.v11i1.33739

Purba, R. A., Munthe, R. G., & Ginting, K. (2022). Learning Model with LMS as an Innovation to Facilitate the Implementation of Learning from Home. *JPI (Jurnal Pendidikan Indonesia)*, *11*(2), 293–301. https://doi.org/10.23887/jpiundiksha.v11i2.38811

Purwoko, R. Y., Kusumaningrum, B., Laila, A. N., & Astuti, E. P. (2023). Development of Open Ended Based Mathematics E-Modules to Enhance Students' Critical Thinking Ability. *Mathline: Jurnal Matematika Dan Pendidikan Matematika*, *8*(1), 194–206. https://doi.org/10.31943/mathline.v8i1.337

Putri, A. S., Prasetyo, Z. K., Purwastuti, L. A., Prodjosantoso, A. K., & Putranta, H. (2023). Effectiveness of STEAM-based blended learning on students' critical and

creative thinking skills. *International Journal of Evaluation and Research in Education*, *12*(1), 44–52. https://doi.org/10.11591/ijere.v12i1.22506

Rahmawati, R., Johar, R., & Hajidin, H. (2019). Tingkat Berpikir Kreatif Siswa dalam Pemecahan dan Pengajuan Masalah Matematika melalui Tipe Soal Open Ended di SMP. *Jurnal Peluang*, *7*(1), 22–30. https://doi.org/10.24815/jp.v7i1.13741

Ramdhani, T. (2020). Pengaruh Model Pembelajaran Hybrid Learning berbantuan Schoology Untuk Meningkatkan Prestasi Belajar Matematika Siswa Kelas XI IPS 1 SMAN 2 Singaraja. *Jurnal Pendidikan Matematika Undiksha*, *11*(2), 62–68. https://doi.org/10.23887/jjpm.v11i2.24967

Resty, Z. N., Muhardjito, M., & Mufti, N. (2019). Discovery Learning Berbantuan Schoology: Upaya Peningkatan Kemampuan Berpikir Kritis. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *4*(2), 267–273. https://doi.org/10.17977/jptpp.v4i2.12040

Samura, A. O., & Darhim. (2023). Improving Mathematics Critical Thinking Skills of Junior High School Students Using Blended Learning Model (BLM) in GeoGebra Assisted Mathematics Learning. *International Journal of Interactive Mobile Technologies*, *17*(2), 101–117. https://doi.org/10.3991/ijim.v17i02.36097

Saputra, E., & Zulmaulida, R. (2021). Implementation of Reflective Thinking Process Approach to Students' Mathematical Critical Thinking. *Journal of Physics: Conference Series*, *2123*(1). https://doi.org/10.1088/1742-6596/2123/1/012033

Saputri, R. R., & Qohar, A. (2023). Students' critical thinking ability in solving combinatoric problems in online learning during Covid-19 pandemic. *The 8th International Conference on Research Implementation and Education of Mathematics and Science (ICRIEMS 2021)*, *2556*, 050005. https://doi.org/10.1063/5.0109922

Siboro, A., Zega, L. Z., & Purba, A. (2022). Pengaruh Model Blended Learning Berbasis LMS (Learning Management System) Terhadap Hasil Belajar Siswa SMA. *Jurnal Penelitian Fisikawan*, *5*(1), 1–8. jurnal.darmaagung.ac.id/index.php/jurnalpenelitianfisikawan/article/view/1325

Suherman, Prananda, M. R., Proboningrum, D. I., Pratama, E. R., Laksono, P., & Amiruddin. (2020). Improving Higher Order Thinking Skills (HOTS) with Project Based Learning (PjBL) Model Assisted by Geogebra. *Journal of Physics: Conference Series*, *1467*(1). https://doi.org/10.1088/1742-6596/1467/1/012027

Sukma, Y., & Priatna, N. (2021). The effectiveness of blended learning on students' critical thinking skills in mathematics education: A literature review. *Journal of Physics: Conference Series*, *1806*(1). https://doi.org/10.1088/1742-6596/1806/1/012071

Sulisworo, D., Ummah, R., Nursolikh, M., & Rahardjo, W. (2020). The analysis of the critical thinking skills between blended learning implementation: Google Classroom and Schoology. *Universal Journal of Educational Research*, *8*(3), 33–40. https://doi.org/10.13189/ujer.2020.081504

Susilawati, E., Agustinasari, A., Samsudin, A., & Siahaan, P. (2020). Analisis Tingkat Keterampilan Berpikir Kritis Siswa SMA. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(1), 11–16.

Syafriyanti, A. (2022). The Effect of Online Learning Using Schoology on Student Learning Outcomes in Momentum and Impulse Matter. *Asian Journal of Science Education*, *4*(2), 10–19. https://doi.org/10.24815/ajse.v4i2.28080

Syarifah, L. L. (2017). Pengaruh pendekatan open ended terhadap kemampuan berpikir kritis matematik siswa. *Jurnal Program Studi Pendidikan Dan Penelitian Matematika*, *6*(1), 91–101.

https://scholar.archive.org/work/ka4usmudvzgavdjh7ppgif2ohy/access/wayback/http://jurnal.umt.ac.id/index.php/prima/article/download/1470/924

Ulfa, F. K. (2020). Kemampuan Koneksi Matematis Dan Berpikir Kritis Siswa Dalam Pembelajaran Matematika Melalui Model Brain-Based Learning. *Jurnal Pendidikan Matematika (JPM)*, *6*(2), 106–116. https://doi.org/10.33474/jpm.v6i2.5537

Wardono, & Mariani, S. (2019). Problem based learning with Indonesian realistic mathematics education approach assisted e-schoology to improve student mathematization. *Journal of Physics: Conference Series*, *1321*(3), 1–7. https://doi.org/10.1088/1742-6596/1321/3/032094

Wijayanti, R. T., Chrisnawati, H. E., & Fitriana, L. (2019). Blended learning with schoology in mathematics: Student's activity and their outcome. *Journal of Physics: Conference Series*, *1318*(1), 1–6. https://doi.org/10.1088/1742-6596/1318/1/012002

Wulandari, N. P. R., Dantes, N., & Antara, P. A. (2020). Pendekatan Pendidikan Matematika Realistik Berbasis Open Ended Terhadap Kemampuan Pemecahan Masalah Matematika Siswa. *Jurnal Ilmiah Sekolah Dasar*, *4*(2), 131–142. https://doi.org/10.23887/jisd.v4i2.25103

Yanto, B., & Retnawati, H. (2018). Dapatkah model blended learning mempengaruhi kemandirian belajar matematika siswa? *AKSIOMA: Jurnal Matematika Dan Pendidikan Matematika*, *7*(3), 324–333. https://doi.org/10.24127/ajpm.v7i3.1559

Yuliati, S. R., & Lestari, I. (2018). Higher-order thinking skills (hots) analysis of students in solving hots question in higher education. *Perspektif Ilmu Pendidikan*, *32*(2), 181–188. https://doi.org/10.21009/pip.322.10