

AljabarMath: The way to foster critical thinking ability

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Abstract

Critical thinking ability are important for facing challenges in the 21st century. There are ways to foster critical thinking ability, one of which is through mathematics using learning media. This paper provides an overview of how to foster critical thinking ability, especially among students who used to learn media AljabarMath. This study aims to describe the level of students' critical thinking ability in mathematics especially algebra subject grades VII SMP Negeri 10 Pontianak by using the AljabarMath. The method used is quantitative descriptive research. Data analysis was done to determine the percentage of critical thinking ability achieved based on indicators measured following the use of AljabarMath. The findings show that: 1) 68% of students were able to comprehend and articulate the purpose of a problem by identifying what was known and asked; 2) 64% of students were able to make a mathematical model in order to identify the relationship between statements, questions, and concepts given in the questions indicated.; 3) students who demonstrated the ability to assess the veracity of statements using the appropriate technique by 64%; and 4) students who demonstrated the ability to make accurate conclusions by taking into account pertinent information and the implications of a problem based on the available data by 62%. The utilization of AljabarMath can enhance students' critical thinking ability in algebra classes, according to the study's findings.

Keywords: AljabarMath, critical thinking ability, learning media

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INTRODUCTION

The ability to think critically is very important for life and educational processes (Chen & Chuang, 2020; Lau, 2011; Khasanah & Ayu, 2017). According to Paul and Elder (2007), a person who thinks critically can raise vital questions and problems and formulate them clearly and precisely. Critical thinking is one of the higher-order thinking skills (HOTS) that must be possessed and instilled in students' ways of thinking (Wahyudi et al., 2020). This is because with good critical thinking ability, students are able to uncover information, choose things that are important or necessary, prioritize or not, change the truth of a problem, and solve mathematical problems that are abstract and systematic, such as algebra (Ulva, 2018). Mathematics and critical thinking is very closely related (Damarjati & Miatun, 2021). Therefore, critical thinking ability need to be developed by students to deal with problems, especially math.

Critical thinking ability are very important for students, but in reality, students in this country do not properly teach this kind of things. The results of PISA 2018 and TIMSS 2015 show the same; namely the ability of students, especially in mathematics in Indonesia, is still at the level of understanding until

application and has not reached the aspect of critical thinking ability (Nizam, 2016; Agus & Purnama, 2022). Based on the results of previous research by researchers at SMP Negeri 10 Pontianak in class VIIB, the level of students' critical thinking ability remains relatively low. Only approximately 38% of students were able to interpret information from the questions, as many as 42% of students were able to make mathematical models, and only 22% of students were able to assess questions and provide appropriate conclusions. Learning does not involve students in discussions and the teacher only explains the material on the blackboard and asks students to solve problems in the books provided. That is, the learning process that is carried out does not train students to deal with mathematical problems that require them to develop higher-order thinking ability, so that they are less trained in critical thinking ability (Putri et al. 2020). According to Chukwuyenum (2013), that critical thinking is a complicated idea that requires both cognitive abilities and self-assurance. Teachers' use of a variety of instructional strategies can have an impact on students' development of critical thinking ability. Critical thinking ability can be foster in students through a learning process directed at solving problems as an approach to learning mathematics (Andriani, 2015; Wahyudi et al. 2020). One branch of mathematics that requires critical thinking ability is the algebra.

Algebra is closely related to generalization processes, problem-solving, critical thinking ability (NCTM, 2008; Fridanianti et al. 2018). Learning algebra requires the ability to think critically in order to promote pattern recognition and analysis, reasoning and problem-solving ability, and generalizing arithmetic operations through symbol representation (Rahardjoni et al., 2020). However, some students find it challenging to understand the algebraic material due to the high level of abstraction in the subject (Rahardjoni et al., 2020). As a result, in order for students to build their own understanding of the teacher's lessons, we need to adopt a more student-centered teaching approach.

The research results of Karim and Normaya (2015) found that in the learning process, the teacher still predominantly used the lecture method and did not use instructional media, so it did not help students understand the learning material well. The use of learning media is a solution for student learning using higher-order thinking ability by making it easier for students to understand and deepen algebra learning material (Khalil & Wardana, 2022).

One of the learning media that is considered capable of improving the quality of learning and student abilities is interactive media (Syawaludin et al., 2019). One popular form of digital technology is interactive media, which uses various software programs to engage students in a variety of learning activities (Hung, Hwang, & Huang, 2012). One application that can be used to develop interactive media is scratch. Scratch is a developer application that can be used to create interactive media to help students understand algebraic material (Yulianisa & Sudiartinih, 2022). Research conducted by Yulianisa et al (2022) stated that the development of math learning media for algebraic multiplication materials based on scratch applications was very useful because it was interactive and helped in the learning process.

Several studies on the application of learning media have shown positive results in towards improving students' critical thinking ability. The study of Aulia et al. (2021) states that the use of scratch applications in learning mathematics can have a positive impact, namely increasing student interest in learning. Besides the use of interactive media developed using scratch can train and stimulate students to think critically (Yulhendri, 2022; Gretter & Yadav, 2016). Supported by research conducted by Khalil et al. (2022), which stated

that the development of mathematics learning media using scratch applications can improve high-level abilities (HOTS) in students. The media developed in this research is called AljabarMath.

AljabarMath is a media created with several menus such as subjects' material, quizzes, games and learning competencies. This media is containing with an attractive appearance with a colourful background and images tailored to students. So, it can be attract by student. This media was chosen and created by following current developments to make it easier for students to learn algebra and develop their critical thinking ability by providing a fun and joy sensation for learning and playing. AljbarMath is equipped with a combination of several menus in it, namely subjects material, quizzes and games, making this media able to make it easier for students to develop critical thinking ability while also being able to measure their critical thinking abilities after studying the materials.

According to earlier studies, learning materials created from scratch have been widely utilized to support the learning process, raise student interest in learning, and increase HOTS. The use of AljabarMath learning resources, which were created with Scratch, to encourage students' critical thinking skills, particularly with regard to junior high school algebra curriculum, is what makes this study unique.

Fostering critical thinking ability

The capacity to notice, comprehend, evaluate, and synthesize information in order to draw valid conclusions and take appropriate action in problem-solving is known as critical thinking (Khasanah et al, 2017). In keeping with the assertion made by Prihatini, Lestari, and Saputri (2018) that critical thinking is the capacity to comprehend, dissect, and assess concepts and claims. These expert viewpoints lead to the conclusion that critical thinking ability include the capacity to identify pertinent information sources, derive conclusions from the data gathered, use the data to solve problems, and make sound decisions and judgments.

Students can be considered to possess critical thinking ability if they exhibit certain traits, as these characteristics serve as indications of critical thinking ability. The critical thinking ability indicators interpretation, analysis, evaluation, inference, explanation, and self- regulation that were employed were taken from Facione (2015). However, as explanation and self-regulation indicators are only explanations of critical thinking processes that lead to conclusions at the point of inference, this study only employed indicators for interpretation, analysis, evaluation, and inference. According to Karim et al (2015), the self-regulating and explanatory indicators already mean the same thing when it comes to elucidating the arguments made in support of the indicator conclusions.

The term "foster" assigns pupils a more engaged and meaningful role, or it requires them to be able to develop values that they already possess (Munawaroh, 2009). According to this perspective, developing the critical thinking ability mentioned in this study is an attempt to develop students' potential for critical thinking so they can advance to the category of quite critical.

The goal of this study is to use AljabarMath media to assess students' critical thinking skills in terms of critical thinking proficiency. The use of AljabarMath, a learning tool created with Scratch, is what makes this study novel. Each instructor is thought to be able to choose the best learning model

or technique for the students after learning the qualities of critical thinking ability.

The AljabarMath media has a display with a play button (Figure 1a). There are four menus in AljabarMath, such as content material, quizzes, games, and competent learning (Figure 1b). By using this media, students can study algebra material on the material menu, find out indicators of critical thinking ability and learning objectives on the competent learning menu and practice critical thinking ability on the quiz and game menus. On the games menu (Figure 1c), students are accustomed to carrying out several critical thinking activities such as determining known and asked information, determining mathematical models, and carrying out calculations with the strategy to determine the correct conclusions (Figure 1d).

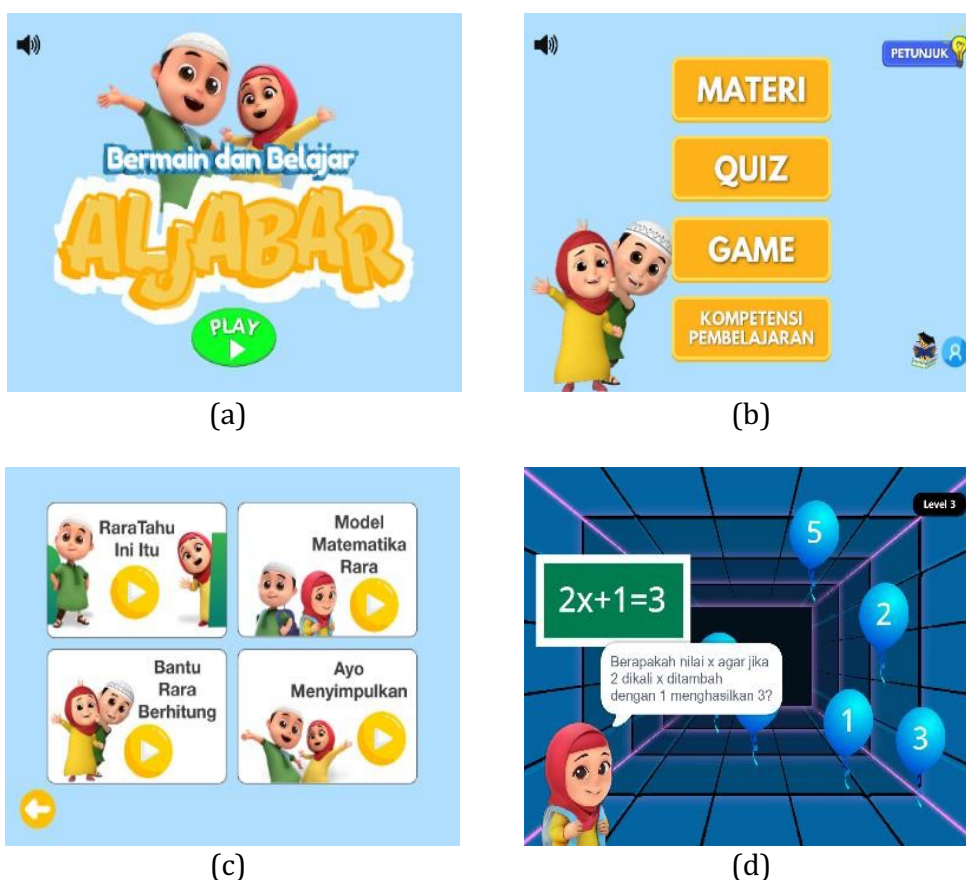


Figure 2. The display of AljabarMath media (a); AljabarMath game for foster critical thinking ability (b); AljabarMath game menus per indicator of critical thinking ability (c); and AljabarMath game for foster critical thinking ability (d).

RESEARCH METHOD

The research methodology used for this study was quantitative descriptive research. According to Sugiyono (2016), descriptive quantitative methods make an effort to explain and interpret data in a descriptive and numerical format. The purpose of this study was to evaluate students' critical thinking skills after using AljabarMath to learn algebraic content. In this investigation, cluster random sampling was the sample method employed. The sample was classified as class VII B, with 30 students.

The research instrument is a measurement tool for social and natural phenomena that have been observed (Sugiyono, 2016). This study's instrument was a test instrument. To acquire data on students' critical thinking ability, the researcher made a test sheet in the form of a description that consisted of one question and included four questions. The exam questions were designed to measure critical thinking skills and were based on algebraic content. Table 1 displays the critical thinking ability indicators.

Table 1. Indicators of critical thinking ability

Indicators	Description
Interpretation	The ability to understand the problem is shown by writing what is known and asking about the problem.
Analysis	The capacity to build a mathematical model that shows the relationship between the concepts, questions, and statements presented in the problems.
Evaluation	The capacity to assess a statement's credibility by applying the appropriate technique.
Inference	The capacity to make accurate decisions by taking into account relevant information about an issue and its effects based on data that is currently available.

Adaptation of Facione (Karim et al, 2015).

Two phases of the study were carried out: (1) AljabarMath media treatment and (2) a critical thinking ability assessment. A test measuring the students' capacity for critical thought was administered at the end of the learning exercise. The test had four questions with the highest possible score, and a total score of 16 for the entire test.

The data analysis method used in this study was a descriptive qualitative research analysis. In order to facilitate the assessment of students' critical thinking ability, the final step involves calculating a percentage of their critical thinking ability. This can be achieved by using the following calculation formula:

$$\text{Percentage of critical thinking ability (P)} = \frac{\text{score}}{\text{maximum score}} \times 100\%$$

Classifying the percentage of students' critical thinking ability achievement following their use of the learning materials created using the original algebraic material was the next step after the data were presented. Table 2 lists the requirements for the critical thinking ability category.

Table 2. Criteria for critical thinking ability

Percentage of critical thinking ability (%)	Category
$89 < P \leq 100$	Very Critical
$78 < P \leq 89$	Critical
$64 < P \leq 78$	Quite Critical
$55 < P \leq 64$	Less Critical
$0 < P \leq 55$	Not Critical

RESULTS AND DISCUSSION

Following the use of AljabarMath, the research findings from the assessments of students' critical thinking ability in algebraic material were conducted. Students' critical thinking abilities grow by a good percentage. Class VII students at SMP Negeri 10 Pontianak's critical thinking ability test was divided into five general categories based on their scores: very critical, critical, quite critical, less critical, and not critical. Table 3 displays the categorization of students' critical thinking ability test results.

Table 3. Data on students' critical thinking ability test results

Category	The Number of Students	Percentage (%)
Very Critical	4	13.4
Critical	16	53.3
Quite Critical	10	33.3
Less Critical	0	0
Not Critical	0	0
Sum	30	100

Table 3 indicates that four students possess a high degree of critical thinking. This is evident from the four students' average score of 98.5, or from the range of scores between 93,75 and 100, which shows how critical the four students are. The study's findings also demonstrated that no pupils lacked the capacity for critical thought. This data is presented in a way that should make it easier for readers and future researchers to compare the findings of their research and comprehend the proportion of students who possess critical thinking ability.

The following shows one of the answers from students who have very critical (Figure 2).

1.a. • Informasi yang diketahui :

- 1) Tinggi tower I yaitu 21 m.
Terdiri dari 3 bangun persegi panjang dan 3 bangun segi enam
- 2) Tinggi tower II yaitu 19 m.
Terdiri dari 2 bangun persegi panjang dan 3 bangun segi enam
- 3) Tinggi tower III terdiri dari 2 bangun persegi panjang dan 1 bangun segi enam

• Informasi yang belum diketahui :
Tinggi tower III

(a)

1.b. Misalkan : Tinggi bangun persegi panjang = a
Tinggi bangun segi enam = b

Maka,

- Tinggi tower I = $3a + 3b$
- Tinggi tower II = $2a + 3b$
- Tinggi tower III = $a + 2b$

(b)

1.c. Kesimpulan : Tidak tepat
karena berdasarkan selisih tower I dan tower II
maka tinggi persegi panjang adalah 2 m.
Tinggi tower 3 : $a + 2b = 5 + 2(2)$
 $= 5 + 4$
 $= 9$ m
yang berarti tinggi tower III adalah 9 m bukan 10 m.

(c)

1.d. Kesimpulan : Ya
Ya, karena kedua bangun memiliki kelipatan yang sama yaitu 10 m.
• Tinggi tower persegi panjang : $2 \text{ m} \times 5 = 10 \text{ m}$.
• Tinggi tower segi enam : $5 \text{ m} \times 2 = 10 \text{ m}$.
Maka, kedua tower dapat memiliki ketinggian yang sama pada ketinggian 10 m.

(d)

Figure 2. Interpretation indicator by student's correct answer (a); Analysis Indicator by student's correct answer (b); Evaluation Indicator by student's correct answer (c); and Inference Indicator by student's correct answer (d).

Based on the results of the answers of students who have very high critical thinking ability, this achievement is due to the interactive AljabarMath media.

On the interpretation indicator (Figure 2a), students show that they can think critically by writing down what they know and asking questions about the issue. As per Hikmah, N. & Kartika (2022), pupils possessing a strong critical thinking aptitude can recognize the concepts employed in the given problems. At this point, the subject can apply what he has learned to all situations, ask questions about any issues that arise, and perform accurate and precise calculations. By building a mathematical model to show the relationships between the statements, questions, and concepts presented in the problems, students are said to possess the critical thinking ability on the analysis indicator (Figure 2b). Karim et al (2015) states that in order to form analytical ability in critical thinking, students were asked to make a mathematical model because in making a mathematical model students had to think critically in analyzing to the context of the problem. Students are said to have the critical thinking ability on the evaluation indicator indicated by the use of the right strategy to determine the credibility of a statement (Figure 2c). Karim et al (2015) states that evaluating abilities can be formed by familiarizing students with solving questions with the right strategy. Based on available data, students are considered to have the critical thinking ability on the inference indicator when they are able to correctly draw conclusions from information related to a problem and its implications (Figure 2d). According to Karim et al. (2015), students' high critical thinking ability on inference indicators can be attributed to the presentation of their problem-solving and proposal-making process outcomes, which enable them to draw conclusions about the given problems.

The findings of the research by Khalil et al. (2022) indicate that using media whose content is tailored to the indicators of critical thinking ability can help people develop and become accustomed to using critical thinking skills. This is made possible by the AljabarMath media, which gives students the chance to comprehend problems by presenting information that is known and requested, recognizing the connections between statements, questions, and the idea of a problem by creating a mathematical model, assessing the veracity of a statement using the appropriate technique, and drawing the appropriate conclusions by taking into account relevant information about a problem and its implications based on available data. According to the result of Agung, Amalia, Faizah and Ardiansyah research (2022) that using scratch media in learning mathematics can improve critical thinking ability. Scratch learning media have a positive impact to improve students' critical thinking (Jiang & Li, 2021).

The overall test results reviewed for each critical thinking ability indicator are listed in Table 4.

Table 4. Students' critical thinking ability per indicators

Indicators of Critical Thinking Ability	Average Per Indicator	Percentage (%) Per Indicator
Interpretation	3,4	68
Analysis	3,2	64
Evaluation	3,2	64
Inference	3,1	62
Average	3.225	64.5

Table 4 clearly shows that critical thinking ability generally produced an average total of 3.225 with a proportion of 64.5%. The interpretation indicator, which has the highest average score of 3.4 with a proportion of 68%, indicates that students should be able to comprehend the problems presented by writing what is known and asked in the questions. This is evident from the results of proportions based on indicators. Additionally, 3.2 with a proportion of 64% was the ability to recognize the relationship between statements, questions, and concepts provided in the questions for threat analysis indicators. Evaluation metrics for the capacity to employ the best approach to assess bank credibility also received an average score of 3.2, or 64% of the possible points. The least understandable indicator for students is the inference indicator, which asks them to make accurate conclusions by taking into account relevant information about a problem and its effects based on available data. With a percentage of 62%, this inference indicator displayed an average score of 3.1.

Learning mathematics, particularly in algebraic materials, can help students develop their critical thinking skills, according to the above research's findings. This is consistent with the idea that algebraic problem-solving skills and critical thinking abilities are closely related (Sukmawati, 2015). Students' critical thinking skills are also thought to be enhanced by the learning materials that were created using the foundation. This result supports the notion that using scratch in mathematics learning materials can raise students' HOTS (Ropii, Hardyanto & Ellianawati, 2019). One of the higher-order thinking skills is critical thinking (HOTS). Higher-order thinking skills include the capacity for critical and creative thought as well as the ability to solve problems and make decisions, according to Nurhatmanti, Lian, and Dedy (2021). Thus, it is anticipated that educators will be able to use scratch learning materials when teaching algebra.

CONCLUSION

AljabarMath media that is made from scratch and modified based on measures of critical thinking proficiency yields excellent outcomes. After utilizing learning materials created from scratch, students' critical thinking skills in algebraic material were rated as critical with a proportion of 80.35%. This demonstrates how teachers in schools can support students' development of critical thinking skills by using media that is well-designed and tailored to critical thinking indicators. Utilizing this media is thought to be more pertinent to technological advancements in the age of accelerating globalization. In terms of the total number of students who attained each category level, 13.4% of students were able to place themselves in the very critical category, and 53.3% were able to place themselves in the critical category. Thirty-three percent of the students fell into the category of quite critical. Students who receive the most requests (68%) among the four critical thinking ability indicators are able to reach the interpretation indicator.

The high critical thinking ability of students in interpreting indicators is due to the mathematical algebra media facilitating the presentation of material and games in the form of questions that encourage students to become used to choosing information that is known and information that is not yet known from problems. This shows that the use of AljabarMath learning media developed using scratch is complicate with the combination of several menus in it, namely subjects material, quizzes and games, makes this media easier for students to develop critical thinking ability while also being able to measure their critical thinking ability after studying the materials. It is hoped that the research can

be developed further so that the use of media to foster critical thinking ability can have an even better positive impact.

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REFERENCES

- Agung, G. H., Amalia, I. R., Faizah, N. A., & Ardiansyah A. S. (2022). Problem based learning berbantuan scratch bernuansa etnomatematika cagar budaya kota semarang terhadap kemampuan berpikir kritis siswa. *PRISMA Prosiding Seminar Nasional Matematika* (pp. 670-675). Semarang State University.
- Agus, I. & Purnama, A. N. (2022). Kemampuan berpikir kritis matematika siswa: studi pada siswa smpn satu atap. *Jurnal Pendidikan Matematika Raflesia*, 7(1), 65-74. <https://doi.org/10.33369/jpmr.v7i1.20143>
- Andriani, P. (2015). Penalaran aljabar dalam pembelajaran matematika. *Beta Jurnal Pendidikan Matematika*, 8(1), 1-13.
- Aulia, S., Zetriuslita, Amelia S., Qudsi, R. (2021). Analisis minat belajar matematika siswa dalam menggunakan aplikasi scratch pada materi trigonometri. *Juring: Journal for Research in Mathematics Learning*, 4(3), 205-214. <http://dx.doi.org/10.24014/juring.v4i3.13128>
- Chen, H. L. & Chuang, Y. C. (2020). The effects of digital storytelling games on high school students' critical thinking skills. *Journal of Computer Assisted Learning*, 37(1), 265-274. <https://doi.org/10.1111/jcal.12487>
- Chukwuyenum, A. N. (2013). Impact of critical thinking on performance in mathematics among senior secondary school students in Lagos State. *IOSR Journal of Research & Method in Education*, 3(5), 18-25. <http://dx.doi.org/10.9790/7388-0351825>
- Damarjati, S. & Miatun, A. (2021). Pengembangan game edukasi berbasis android sebagai media pembelajaran berorientasi pada kemampuan berpikir kritis. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, 4(2), 2615-4072. <https://doi.org/10.24176/anargya.v4i2.6442>
- Facione, P. A. (2011). Critical thinking: What it is and why it counts. *Insight Assessment*, 1(1), 1-23.
- Fridanianti, A., Purwati, H., & Murtianto, Y. H. (2018). Analisis kemampuan berpikir kritis dalam menyelesaikan soal aljabar kelas VII SMP Negeri 2 Pangkah ditinjau dari gaya kognitif reflektif dan kognitif impulsif. *Jurnal Aksioma*, 9(1), 11-20. <https://doi.org/10.26877/aks.v9i1.2221>
- Gretter, S., & Yadav, A. (2016). 'Computational thinking and media & information literacy: an integrated approach to teaching twenty first century skills. *TechTrends*, 60, 510-516. Springer. <https://doi.org/10.1007/s11528-016-0098-4>
- Hikmah, N. & Kartika (2022). Analisis kemampuan berpikir kritis matematis siswa pada materi pecahan. *Journal of Mathematics Education and Applied*, 4(1), 88-94. <https://doi.org/10.36655/sepren.v4i1>
- Hung, C.M., Hwang, G.J., & Huang, I. (2012). A project-based digital storytelling approach for improving students' learning motivation, problem-solving

- competence and learning achievement. *Educational Technology & Society*, 15(4), 368–379.
- Jiang, B., & Li, Z. (2021). Effect of Scratch on computational thinking skills of Chinese primary school students. *Journal of Computers in Education*, 8(4), 505–525. <https://doi.org/10.1007/s40692-021-00190-z>
- Karim & Normaya (2022). Kemampuan berpikir kritis siswa dalam pembelajaran matematika dengan menggunakan model jucama di sekolah menengah pertama. *EDU-MAT: Jurnal Pendidikan Matematika*, 3(1), 92–104. <http://dx.doi.org/10.20527/edumat.v3i1.634>
- Khalil, N. A. & Wardana, M. R. (2022). Pengembangan media pembelajaran matematika menggunakan aplikasi scratch untuk meningkatkan higher order thinking skill siswa sekolah dasar. *Jurnal Kiprah Pendidikan*, 1(3), 121–130. <https://doi.org/10.33578/kpd.v1i3.45>
- Khasanah, B. A. & Ayu, I. D. (2018). Kemampuan berpikir kritis siswa melalui penerapan model pembelajaran brain based learning. *Jurnal Eksponen*, 7(2), 46–53. <https://doi.org/10.47637/eksponen.v7i2.148>
- Lau, J. Y. F. (2011). *An introduction to critical thinking and creativity: Think more, think better*. John Wiley & Sons. <http://dx.doi.org/10.1002/9781118033449>
- Munawaroh, I. (2009). Menumbuhkan keterampilan berpikir kritis siswa sd melalui penerapan pembelajaran tematik. *Jurnal Majalah Ilmiah Pembelajaran*, 2(6), 220.
- NCTM (2008). *Principles and Standar of School Mathematics*. The National Council of Teacher of Mathematics.
- Nizam. (2016). *Ringkasan Hasil-hasil Asesmen Belajar dari Hasil UN, PISA, TIMSS, INAP*. Puspendik Balitbang Kemdikbud.
- Nurhatmanti, R., Lian B., & Dedy A. (2021). Analysis of students' higher order thinking skills (HOTS) in science subject Class V at SD Negeri 76 Palembang. *Indonesian Journal of Primary Education*, 5(2), 208–213. <https://doi.org/10.17509/ijpe.v5i2.37107>
- Paul, R. and L. Elder. (2007). *The Miniature Guide to Critical Thinking Concepts and Tools*. Foundation for Critical Thinking.
- Prihatini, E., Lestari, P. & Saputri, S. A. (2018). Meningkatkan Kemampuan Berpikir Kritis Matematis Menggunakan Pendekatan Open Ended. *PRISMA Prosiding Seminar Nasional Matematika* (pp. 58–64). Semarang State University.
- Putri, A., Sumardani, D., Rahayu, W., & Hajizah, M. N. (2020). Kemampuan berpikir kritis matematis menggunakan model generative learning dan connecting, organizing, reflecting, extending (CORE). *Jurnal Program Studi Pendidikan Matematika*, 9(1), 108–117. <https://doi.org/10.24127/ajpm.v9i1.2617>
- Rahardjoni, A. S., Hasanah, I. N., & Nugraheni, M. S. (2020). Developing critical thinking competence in algebraic thinking using augmented reality for junior high school. *PRISMA Prosiding Seminar Nasional Matematika* (pp. 497–503). Semarang State University.
- Ropii, N., Hardyanto, W., & Ellianawati. (2019). Guided inquiry scratch increase students' critical thinking skills in the linier motion concept: can it be?. *Jurnal Penelitian dan Pengembangan Pendidikan Fisika*, 5(1), 63–68. <https://doi.org/10.21009/1.05107>
- Sugiyono. (2016). *Metode penelitian pendidikan pendekatan kualitatif, kuantitatif dan R&D*. Alfabeta.

- Sukmawati, A. (2015). Berpikir aljabar dalam menyelesaikan masalah matematika. *Math Didactic: Jurnal Pendidikan Matematika*, 1(2), 88-93. <https://doi.org/10.33654/math.v1i2.5>
- Syawaludin, A., Gunarhadi, Rintayati, P. & Subiyantoro, S. (2020). Preservice elementary school teachers' need for interactive multimedia based on augmented reality in science learning. *Proceedings of the 3rd International Conference on Learning Innovation and Quality Education (ICLIQE)*, pp. 2352-5398. <https://doi.org/10.2991/assehr.k.200129.111>
- Ulva, P. (2018). Profil kemampuan berpikir kritis matematis siswa smp negeri pada materi sistem persamaan linier dua variabel (SPLDV). *Jurnal Pendidikan Tembusai*, 2(3), 944-952. <https://doi.org/10.31004/jptam.v2i5.73>
- Wahyudi, M., Suwatno & Santoso, B. (2020). Kajian analisis keterampilan berpikir kritis siswa sekolah menengah batas. *Jurnal Pendidikan Manajemen Perkantoran*, 5(1), 67-82. <https://doi.org/10.17509/jpm.v5i1.25853>
- Yulianisa, A. & Sudihartinih, E., (2022). Pengembangan media pembelajaran matematika materi perkalian aljabar berbasis aplikasi scratch. *Jurnal Pendidikan Matematika Universitas Lampung*, 10(2), 142-156. <http://dx.doi.org/10.23960/mtk/v10i2.pp142-156>
- Yulhendri (2022). Peningkatan keterampilan tik guru dan pengayaan bahan ajar memanfaatkan media pembelajaran menggunakan scratch di igtki-pgri cengkareng Jakarta barat. *Jurnal Adibas*, 3(3), 599-606. <https://doi.org/10.31004/abdidas.v3i3.631>

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