**Tsaqila** Jurnal Pendidikan dan Teknologi [TJPT]
Vol 6 Number 1 July 2026, hal: 27- 35
ISSN: 2807-6273

# Integration of Augmented Reality Technology in Problem-Based Learning Models on Students' Critical Thinking Skills

**Eva Julyanti[1], Nurlina Ariani Hrp[2], Laili Habibah Pasaribu[3]**

[123] Pendidikan Matematika, FKIP, Universitas Labuhanbatu

[1]evajulyanti@ulb.ac.id, [2]nurlinaariani@ulb.ac.id, [3]laili.habibah.pasaribu@gmail.com.

***Abstract***

*This study aims to analyze the effect of integrating Augmented Reality (AR) technology into the Problem-Based Learning model on students' critical thinking skills regarding the topic of integers. aThis study employs a quantitative approach using a quasi-experimental method with a non-equivalent control group pretest-posttest design. The study population consisted of all 60 Grade VII students at MTs Amalianur. The research sample comprised Class VII-A (30 students) as the experimental group and Class VII-B (30 students) as the control group. Data collection was carried out through a critical thinking skills test using an essay-based instrument administered during the pretest and posttest stages. Data analysis was conducted using normality tests, homogeneity tests, and hypothesis testing via an independent sample t-test. The research results show that the students' average post-test score increased compared to the pre-test score, rising from 18.23 to 76.42. Meanwhile, for the control class taught using conventional methods, the pretest score was 11.21 and the posttest score was 15.67. Based on the t-test, the hypothesis testing results show t-calculated = 1.588 > t-table = 0.86, with a significance level of 0.000 < 0.05. Thus, Ha is accepted and $H_0$ is rejected. The research results indicate that the integration of Augmented Reality technology into the Problem-Based Learning model has a positive effect on students' critical thinking skills. The use of Augmented Reality technology can serve as an effective learning innovation to support the development of students' critical thinking skills in mathematics learning*

**Keywords: Augmented Reality (AR) Technology, Problem Based Learning Model, Critical Thinking Skills**



## 1. INTRODUCTION

Global developments in the 21st century require individuals to have the ability to access, understand and utilize information intelligently and critically (Cahyono, A. N., Sukestiyarno, Y.L., Kharisudin, I., Zulkardi, Z., Safrdiannur, S., Lavicza, Z., 2025). The era of globalization is characterized by the increasingly open borders between countries, including in the field of education, so that the education system is required to be able to adapt to developments in science and technology (Zhang, C., Wen, M., Tong, K., Chen, Z., Wen, Q., Yang, T., & Liu, Q. Sciences (Switzerland), 2022). In facing these challenges, education needs to develop students' cognitive abilities, such as critical thinking, problem solving, decision making, and the ability to adapt to change (Ratnaningsih, 2017). Education has a strategic role in preparing a generation that is able to face various global problems through mastering 21st century skills (Aripin, 2025). Therefore, the learning process must be able to adapt to developments in the times and the needs of students through effective and relevant learning innovations (Kemendikbudristek, 2022). Efforts to provide quality education are one of the main focuses in developing the national education system (Dwikoranto, Dzulkiflih, Lintangesukmanjaya R. T, D. A. Putra, 2025).

AR technology is experiencing rapid development, with one of its applications in the field of education as an interactive learning tool. This facilitates student interaction and social communication (Gudoniene, D., & Rutkauskiene, 2019). The cause of the rapid development of science and technology is its impact on the national education system. The education implemented is no longer conventionally based, but is also combined with digital technology (Darmawan, T. H., Charlina & Septyanti, 2024). In the ever-growing technological

advancements, conventional learning methods are often considered boring, and the material presented is less easy to understand (Hidayat, M. L., 2015).

The low level of critical thinking skills in students is mostly due to the continued use of conventional learning which is still teacher-centered, with students memorizing more. Based on the results of observations at the high school level, it can be seen that the learning process is generally still dominated by conventional learning such as lectures and question and answer sessions. The implementation of the PBL model is necessary for updating learning media so that it can run more effectively. One promising alternative technology is Augmented Reality (AR), a medium that provides students with a learning experience to interact directly with digital media (Nurmayanti D, Setiadi, D, Lestar, T.A, 2026).

In its application, Augmented Reality (AR) can display information, such as labels or virtual objects, which are only visible through the camera on a cellphone or computer, thus providing a more interactive and enjoyable experience for users (Saefudin, M. S., & Ekasari, 2017). Three main characteristics must be present in a technology for Augmented Reality (AR) to be implemented (Albani, S.D., Rachman, A. & Panindias, 2024). First, the technology must combine the real and virtual worlds, allowing users to see virtual objects in the context of the reality around them. Second, Augmented Reality (AR) technology must provide information interactively and in real-time, allowing users to interact with virtual objects. Finally, Augmented Reality (AR) technology must display virtual objects in three dimensions, allowing users to view objects from multiple perspectives (Mustaqim, 2016).

In Problem Based Learning (PBL) it emphasizes the active involvement of students in solving real-world problems. The stages in the problem-based learning process include: (1) the teacher gives the students problems, (2) the teacher asks the students to discuss in small groups, (3) the teacher asks students to conduct studies related to problems that must be solved independently, (4) then the teacher asks students to return to their original groups to exchange information, learn with peers, and work together to solve problems, (5) the teacher asks students to present the solutions they have found, and (6) the teacher helps students to evaluate all learning activities that have been carried out (Susilo, 2022).

This learning requires critical and analytical thinking as well as collaborative efforts (Hursen, 2021). In this model, students are required to think critically, work together, discuss, and find solutions to the problems given. Mathematical critical thinking is the basis of the thinking process in generating ideas, analyzing arguments, and developing logical thought patterns (Hage, 2020). Critical thinking skills are very important for higher order thinking skills (FitzPatrick, B., & Schulz, 2015). This is because, with critical thinking skills, students can think rationally and apply it to their mathematical abilities (Nasution, N.R.; Wahyudin, W.; and Nurlaelah, 2023). However, in reality, critical thinking skills are still complex to improve, and current students' skills are still low (Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, 2021). Problem solving itself is used as a means of conveying messages, so that students can think logically, critically and creatively (Dwikoranto, Dzulkiflih, Lintangesukmanjaya R. T, D. A. Putra, 2025). The basic ways of doing mathematics are the result of measuring, calculating, comparing, classifying, and deducting, all of which originate from the natural environment in which they developed (D'Ambrosio, 2016). In addition, ideally, mathematics learning allows students to gain learning experiences to be able to construct their own knowledge (Meriza, D., Hiltrimartin, C., & Hartono, 2024).

This study aims to analyze students' critical thinking skills in mathematics using the Problem Based Learning model based on Augmented Reality (AR) media. Through problem solving (PBL) integrated with Augmented Reality (AR) technology, the aim is for students to develop critical thinking skills when understanding integer material. Integers are often challenging for students due to their abstract nature. To improve critical thinking skills, integrating Augmented Reality (AR) technology into Problem-Based Learning (PBL) models is a valuable step in helping students understand integers. Students are faced with a problem in integers. At the same time, AR media is present to help them understand the material through critical thinking. In this learning, students are forced to think critically starting from analyzing problems, testing mathematical hypotheses, to evaluating the final results so that

their mathematical understanding is formed in depth. It is hoped that it can be an effective learning alternative in helping students think critically so that learning objectives can be achieved optimally.

## 2. RESEARCH METHODOLOGY

The research method used was quantitative quasi-experimental with a pretest-posttest non-equivalent control group design. This study considers the class conditions that have been determined by the school. The independent variable used in this study is the Augmented Reality-based Problem-Based Learning model, while students' critical thinking skills are the dependent variable. Two classes were involved in this study, one group as the experimental class, namely students who learned using the Problem Based Learning Model Based on Augmented Reality (AR) Media, and one group as the control class. The research sample consisted of 60 students of Mts Amalianur consisting of 30 students of class VII A in the experimental group and 30 students of class VII B in the control group. Data collection was carried out using a mathematical critical thinking ability test, carried out using a comprehension ability test consisting of 5 questions. The instrument to indicate students' critical thinking skills is used to measure the assessment of students' answers to integer material.

The research procedure began with the implementation of a pretest, both in the experimental class and the control class, which aimed to measure and determine students' initial critical thinking abilities. The experimental class treatment was carried out using the Problem-Based Learning (PBL) model based on Augmented Reality (AR), while the control class used conventional learning. After the entire series of learning was completed, both classes were given a posttest to measure students' critical thinking skills in the material on integers.

The data analysis technique in this study uses normality tests and homogeneity tests to ensure the suitability of the data before hypothesis testing is carried out. Data were analyzed using IBM SPSS 29.0 statistical software. Normality and homogeneity were checked before statistical testing. N-Gain was used to assess the improvement in students' critical thinking skills in mathematics in both classes. Detailed information about SPSS is described in the literature (Afifah, S.; Mudzakir, A.; and Nandiyanto, 2022).

## 3. RESULT

This research was conducted at Mts Amalianur, Labuhanbatu Regency. This study involved grade VII students of Mts Amalianur in the 2024/2025 academic year. The number of students consists of 60 students, consisting of two classes, namely class VII-A with 30 students and class VII-B with 30 students. In the study, the experimental group received instructions through a Problem Based Learning model based on Augmented Reality (AR), while the control group received instructions through a conventional approach. Before providing the material, a pretest is first held to determine the students' initial state in studying mathematics. The pretest questions consisted of 5 whole number questions and the questions were given to the experimental class and control class. To analyze the data, a pre-test and post-test were conducted on the experimental class and the control class. The Pre-Test and Post-Test given to students function to see students' critical thinking skills in solving problems through the Problem Based Learning Model based on Augmented Reality (AR) Media on the topic of Integers for Class VII MTs Amalianur.

Based on the data obtained, the pretest scores of students in the experimental class can be seen in the following table:

**Table 1**
**Results of the Pretest of Students' Critical Thinking Skills**

| Statistik | *Pretest* |
|---|---|
| Average | 18,23 |
| Variance | 33,143 |

| | |
|---|---|
| St. Deviation | 5,721 |
| Maximum | 40 |
| Minimum | 10 |

Based on the pretest data obtained, which consisted of 5 questions to determine students' critical thinking abilities with an initial level of ability before being given teaching treatment, the average pretest score for students was 18.23, data standard deviation 5.721, data variance 33.143, maximum value 40 and minimum value 10.

Based on the description of the pretest data obtained, the following pretest grouping results were obtained:

**Table 2**
**Pretest Grouping**

| No | Intervals | % | Category |
|---|---|---|---|
| 1 | 95,00 – 100,00 | 12.5 | High |
| 2 | 66,00 – 94,00 | 85 | Medium |
| 3 | 27,00 – 65,00 | 2.5 | Low |

Based on Table 2, it was found that 12.5% of the students had the highest scores, 85% had the middle scores, and 2.5% had the lowest scores. The data can also be seen in the bar chart of the pretest grouping results below:

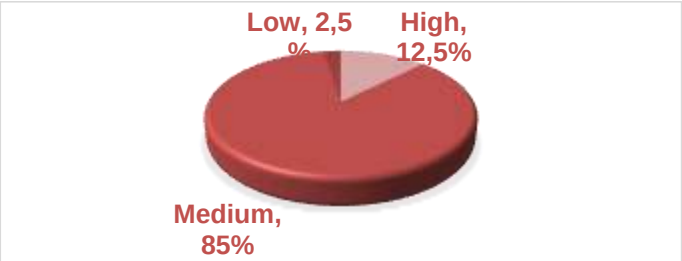


**Figure 1 Pretest Grouping Results**

After administering the pretest, the researcher provided treatment in learning by providing a Problem Based Learning Model Based on Augmented Reality (AR) Media, then a test was given in the form of a Posttest.

Below, the researcher will explain a summary of the posttest scores of students in the experimental class.

**Table 3**
**Students' Critical Thinking Posttest**

| Statistik | *Posttest* |
|---|---|
| Average | 76,42 |
| Variance | 57,127 |
| St. Deviation | 6,501 |
| Maximum | 80 |
| Minimum | 65 |

Posttest data was obtained by giving test questions consisting of 5 descriptive questions to determine students' critical thinking with the final ability level after being taught using the Problem Based Learning model based on Augmented Reality (AR), then the average value of

the student's pretest was 76.42, the data standard deviation was 6.501, the data variance was 57.127, the maximum value was 80 and the minimum value was 65.
Based on the posttest data obtained, the following results were obtained:

**Table 4**
**Critical Thinking Skills Score**

| No | Interval | % | Kategori |
|---|---|---|---|
| 1 | 61,00 - 90,00 | 75 | High |
| 2 | 40,00 – 60,00 | 25 | Medium |
| 3 | 10,00 – 39,00 | 0 | Low |

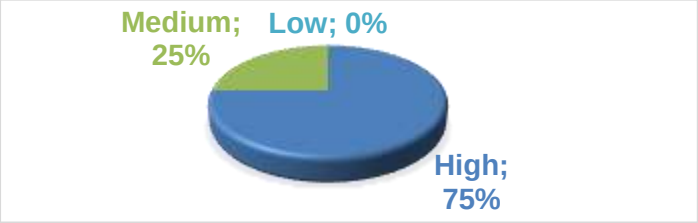


**Figure 2 Pie Chart of Critical Thinking Ability Score Intervals**

Based on the data above, it can be concluded that the majority of students' critical thinking abilities are included in the high category, namely 75%, while a small proportion of students, namely 25%, are included in the medium category and 0% are included in the low category.

Meanwhile, the control learning obtained the following results of the Pretest and Posttest grouping data:

**Table 5**
**Pretest and Posttest Results for the Control Class**

| Statistik | *Pretest* | Posttest |
|---|---|---|
| Average | 11,21 | 15,67 |
| Variance | 23,25 | 31,32 |
| St. Deviation | 3,214 | 5,057 |
| Maximum | 20 | 40 |
| Minimum | 8 | 20 |

Based on the pretest and posttest data for the control class, the average pretest score was 11.21, the data standard deviation was 3.214, the data variance was 23.25, the maximum score was 20 and the minimum score was 8. And the posttest average value is 15.67, the data standard deviation is 5.057, the data variance is 31.32, the maximum value is 40 and the minimum value is 20.

Based on the description of the Pretest and Posttest data obtained, the following grouping results were obtained:

**Table 6**
**Results of Pretest and Posttest of Critical Thinking Skills**

| No | Categories | Frequency | |
|---|---|---|---|
| | | Prettest | Posttest |
| 1 | High | 14 % | 65% |
| 2 | Medium | 83% | 35% |
| 3 | Low | 3% | 0% |

| | | |
|---|---|---|
| Amount | 100% | 100% |

**Table 7 N-Gain Results**

| N-Gain Class | Score | | | |
|---|---|---|---|---|
| | **Minimum** | **Maximum** | **Average** | **Stand. Dev** |
| Experiment | 91 | 48 | 68.30 | 11.089 |
| Control | 78 | 27 | 52.39 | 13.850 |

Gain test score for the control class was 52, the minimum score in the control class was 27 and the maximum score was 78.

**Table 8**
**Results of N-Gain Normality Test**

| Class | Sig | Sig level | Interpretation |
|---|---|---|---|
| Experiment | 0.414 | 0.05 | Normal |
| Kontrol | 0.393 | 0.05 | Normal |

Based on the N-Gain normality test data for the experimental class, the significance value was 0.414 > 0.05, so it can be said that H0 is accepted and the data is normally distributed. In the control class, the significance value obtained was 0.393 > 0.05 so it can be said that H0 is accepted and the data is normally distributed. It can be seen that the Problem Based Learning model based on Augmented Reality (AR) media is very effective for application in mathematics learning.

**Table 9**
**N-Gain Homogeneity Test Results**

| Sig | Sig Level | Information |
|---|---|---|
| 0.056 | 0.05 | Ha Accepted |

The data analysis obtained shows that the sample is in a normal and homogeneous condition, so the data analysis calculation can be continued. For hypothesis testing with a Sig. value < level. Significance (α = 0.05) then H0 is rejected and Ha is accepted. The regression coefficient is significant Sig < 0.05 or t count > t table. Based on the analysis with the t test, the results of the hypothesis testing are t count =1.588 > t table = 0.86 with a significance of 0.000 < 0.05 so that Ha is accepted and Ho is rejected.

The results of the data analysis show an increase in the critical thinking skills of students in the experimental class after the implementation of the Problem-Based Learning learning model assisted by Augmented Reality technology. This research is in line with Nurmayanti D, et al., (2026) who stated that the problem based learning model assisted by augmented reality has a significant effect on the critical reasoning abilities of class XI students of SMAN 1 Labuapi, which is indicated by a significance value of 0.000 < 0.05 and a corrected average value of the experimental class (76.218) which is higher than the control class (51.282). So it can be concluded that there is an influence of the Problem Based Learning model based on Augmented Reality (AR) media on students' Critical Thinking skills in understanding mathematics problems on the Integer material in class VII MTs Amalianur.

## 4. DISCUSSION

At the beginning of learning, some students still have difficulty understanding the concept of integer operations, especially in the operations of addition, subtraction, multiplication and division of negative numbers Students are also still less active in asking and answering teacher questions. After implementing the Augmented Reality (AR) Problem-Based Learning model, students have become accustomed to solving problems through group discussions, thereby developing their critical thinking skills. The test questions given consisted of 5

descriptive questions, to determine students' critical thinking skills with the final ability level after being taught using the Problem Based Learning model, the average student pretest score was 18.23 and the student posttest score was 76.42. Meanwhile, the control class which was taught using conventional methods obtained a pretest score of 11.21 and a posttest score of 15.67.

Based on the application of the Augmented Reality (AR) Problem Based Learning Model on integer material, the results showed that students' critical thinking skills had increased. The learning process is carried out by providing real problems related to integer operations so that it can make students more active in discussing, asking questions, and finding solutions to the problems given. This can be seen from the results of the normal distribution and homogeneity tests, and the results obtained with a calculated t value > t table, namely 1.588 > 0.86, so Ha is accepted and H0 is rejected. In other words, there is an influence of the Augmented Reality (AR) Based Problem Based Learning Model on students' critical thinking skills on integer material.

Significant improvements in critical thinking skills were seen. This learning provided students with a solid understanding of how to optimize their ability to identify problems, analyze information, draw conclusions, and evaluate the results of the PBL model supported by Augmented Reality (AR). Learning model based on augmented reality (AR) media in learning strengthens students' critical reasoning abilities. Research on the integration of different pedagogical approaches, such as project-based learning and problem-based learning, may offer better opportunities for students to engage in exploratory activities that encourage deeper and more meaningful development of their statistical thinking skills (Hasim, S.M.; Rosli, R.; and Halim, 2024). This study also provides ideas in mathematics teaching and learning, as reported elsewhere. These students' thinking processes have a significant impact on the development of students' critical thinking skills (Susilo, 2022). Based on these results, it can be concluded that the application of the Problem Based Learning Model Based on Augmented Reality (AR) Media on integer material is effective in critical thinking skills in solving problems.

## 5. CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that the application of the Problem-Based Learning (PBL) model assisted by Augmented Reality (AR) media is significantly more effective in improving students' critical thinking skills compared to conventional learning models, which is indicated by a significance value of 0.000 <0.05. With the t test, the results of the hypothesis testing were obtained, namely t_count = 1.588> t_table = 0.86 with a significance of 0.000 <0.05 so that Ha is accepted and Ho is rejected.

Based on the research results, it can be concluded that the integration of Augmented Reality technology in the Problem Based Learning model has a positive influence on students' critical mathematical thinking skills on integer material. The application of problem-based learning combined with Augmented Reality technology is able to create a more interactive, contextual, and interesting learning process, thus encouraging students to be more active in discussing, analyzing problems, and finding solutions independently. The results of the study showed an increase in students' critical thinking skills after participating in learning using the integration of Augmented Reality technology in the Problem Based Learning model. In addition, the use of Augmented Reality technology helps students visualize abstract mathematical concepts, thereby facilitating the process of understanding learning materials. The integration of technology in learning also supports the creation of 21st-century learning that emphasizes the development of critical thinking skills, problem solving, collaboration, and the use of digital technology in the learning process. Therefore, the integration of Augmented Reality technology in the Problem Based Learning model can be used as an alternative effective learning innovation to improve students' critical mathematical thinking skills. This research is expected to be a reference for educators in developing innovative technology-based learning that is in accordance with developments in the field of Educational Technology. In addition, further research is recommended to develop the use of Augmented Reality in other

mathematical materials by involving a wider number of samples in order to obtain more comprehensive research results.

## REFERENCES

Afifah, S.; Mudzakir, A.; and Nandiyanto, A. B. D. (2022). How To Calculate Paired Sample T-Test Using SPSS Software: From Step-By-Step Processing For Users To The Practical Examples In The Analysis Of The Effect Of Application Antifire Bamboo Teaching Materials On Student Learning Outcomes. *Indonesian Journal of Teaching in Science*, *2*(1), 81–92.

Albani, S.D., Rachman, A. & Panindias, A. N. (2024). Instagram filter with AR technology as an innovation for introducing fauna to Generation Z in Indonesia. *Jurnal Inovasi Teknologi Pendidikan*, *11*(1), 24–34. https://doi.org/https://doi.org/10.21831/jitp.v11i1.57755

Aripin, et al. (2025). The Role of Problem-Based Learning in Developing Science Literacy and 21st-Century Skills in High School Students: A Meta-Analysis. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *15*(1), 269–284. https://doi.org/http://dx.doi.org/10.30998/formatif.v15i1.27799

Cahyono, A. N., Sukestiyarno, Y.L., Kharisudin, I., Zulkardi, Z., Safrdiannur, S., Lavicza, Z., & M. (2025). Learning mathematical literacy across islands in an archipelagic country through crosscultural STEM trails. *Mathematics Education Journal*, *19*(4), 673–692. https://doi.org/https://doi.org/10.22342/mej.v19i4.pp673-692

D'Ambrosio, U. (2016). *An overview of the history of ethnomathematics*. 5–10. https://doi.org/https://doi.org/10.1007/978-3-319-30120-4_2

Darmawan, T. H., Charlina & Septyanti, E. (2024). Development of student worksheet based AR video and QR-timertest on biographical text materials Class X Senior High School 1 Pelalawan. *Jurnal Inovasi Teknologi Pendidikan*, *11*(3), 310–320. https://doi.org/https://doi.org/10.21831/jitp.v11i3.67633

Dwikoranto, Dzulkiflih, Lintangesukmanjaya R. T, D. A. Putra, B. L. N. (2025). Problem-Based Learning Assisted By Cre-Asi (Creative Assessment With Solving Instrument) To Improve Students' Creative Thinking Skills. *Jurnal Pendidikan IPA Indonesia. UNNES Semarang*, *14*(3), 480–495.

FitzPatrick, B., & Schulz, H. (2015). Do curriculum outcomes and assessment activities in science encourage higher order thinking? *Canadian Journal of Science, Mathematics and Technology Education*, *15*(2), 136–154. https://doi.org/https://doi.org/10.1080/14926156.2015.1014074

Gudoniene, D., & Rutkauskiene, D. (2019). Virtual and augmented reality in education. *Baltic Journal Of Modern Computing*, *7*(2), 293–300. https://doi.org/https://doi.org/10.22364/bjmc.2019.7.2.07

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

Hasim, S.M.; Rosli, R.; and Halim, L. (2024). A systematic review on teaching strategies for fostering students' statistical thinking. *International Journal of Learning, Teaching and Educational Research*, *23*(1), 136–158.

Hidayat, M. L., & S. (2015). Implementasi metode mind mapping dan metode resitasi dalam pelajaran IPS materi persebaran flora dan fauna di Indonesia Kelas VII SMP IP Assalamah Ungaran Kabupaten Semarang. *Edu Geography*, *3*(8), 19–26.

Hursen, C. (2021). The Effect of Problem-Based Learning Method Supported by Web 2.0 Tools on Academic Achievement and Critical Thinking Skills in Teacher Education. *Technology, Knowledge and Learning*, *26*(3), 515–533.

Kemendikbudristek. (2022). *Early Childhood, Primary, and Secondary Education Learning and Assessment Guide*.

Meriza, D., Hiltrimartin, C., & Hartono, Y. (2024). Development of problem based differentiated learning comparison materials in junior high school. *Jurnal Pendidikan Matematika*, *18*(3), 447–468. https://doi.org/https://doi.org/10.22342/jpm.v18i3.pp447-468

Mustaqim, I. (2016). Pemanfaatan augmented reality sebagai media pembelajaran. *JPTK: Jurnal Penidikan Teknologi Dan Kejuruan*, *13*(2), 174–183. https://doi.org/https://doi.org/10.23887/jptkundiksha.v13i2.8525

Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, A. (2021). Difficulties in implementing 21st century skills competence in vocational education learning. *International Journal of Evaluation and Research in Education*, *10*(4), 1229–1236.

Nasution, N.R.; Wahyudin, W.; and Nurlaelah, E. (2023). Problem BasedLearning in mathematical critical thinking ability : A survey on senior high school. *J. Eng. Sci. Technol*, *19*(2), 9–16.

Nurmayanti D, Setiadi, D, Lestar, T.A, J. (2026). The Influence of the Problem Based Learning Model Assisted by Augmented Reality on the Critical Reasoning Ability of Class XI Students at SMAN 1 Labuapi *Journal of Classroom Action Research*, *8*(1), 59–67.

https://doi.org/https://doi.org/10.29303/jcar.v8i1.14002

Ratnaningsih, N. (2017). The analysis of mathematical creative thinking skills and self-efficacy of high students built through implementation of. *Jurnal Pendidikan Matematika Indonesia*, *2*(2), 42–45.

Saefudin, M. S., & Ekasari, M. H. (2017). Aplikasi pembelajaran fauna endemik indonesia menggunakan augmented reality berbasis Android. *SIMETRIS: Jurnal Teknik Industri, Mesin, Elektro Dan Ilmu Komputer*, *8*(1), 27–34. https://doi.org/https://doi.org/10.24176/simet.v8i1.816

Susilo, B. E. (2022). Students' mathematical critical thinking ability in problem-based learning viewed based on learning style. *Jurnal Elemen*, *8*(1), 187–200. https://doi.org/https:/doi.org/10.29408/jel.v8i1.4536

Zhang, C., Wen, M., Tong, K., Chen, Z., Wen, Q., Yang, T., & Liu, Q. Sciences (Switzerland), 12 (17). (2022). Institutional adoption and implementation of blended learning in the era of intelligent education. *Applied Sciences (Switzerland)*, *12*(17).