The Effect of Problem-Based Learning Assisted by the Quizizz Educational Game on Students' Mathematical Conceptual Understanding

Putri Maisyarah Ammy[1*], Alya Rahma Sitorus[2], Irvan[3]
[1,2,3]Universitas Muhammadiyah Sumatera Utara
[1,2,3] Jl. Kapten Muchtar Basri, Glugur Darat II, Medan, Indonesia
Correspondence Email: putrimaisyarah@umsu.ac.id

Abstract:
Students' mathematical conceptual understanding still needs to be improved through learning that encourages active involvement and meaningful problem solving. This study aims to analyze the effect of implementing the Problem-Based Learning (PBL) model, assisted by Quizizz, on students' mathematical conceptual understanding. The research method employed was quantitative, utilizing a one-group pretest posttest design. The research sample consisted of 20 eighth-grade students of Insan Cita Islamic Junior High School, Medan. Data were collected through descriptive pretest and posttest tests that measured mathematical conceptual understanding, then analyzed using paired sample t-test and Cohen's d effect size. The results of the study indicate a significant improvement in students' understanding of mathematical concepts through an increase in pretest to posttest scores. These findings indicate that the implementation of the PBL model assisted by Quizizz is effective in improving mathematical conceptual understanding through students' active involvement in problem solving and learning reflection, and provide implications that the integration of problem-based learning with interactive digital media can be a strategic alternative in improving the quality of mathematics learning.

Abstrak:
Kemampuan pemahaman konsep matematika peserta didik masih perlu ditingkatkan melalui pembelajaran yang mendorong keterlibatan aktif dan pemecahan masalah secara bermakna. Penelitian ini bertujuan untuk menganalisis pengaruh penerapan model Problem Based Learning (PBL) berbantuan Quizizz terhadap kemampuan pemahaman konsep matematika peserta didik. Metode penelitian yang digunakan adalah kuantitatif dengan desain one group pretest posttest. Sampel penelitian terdiri atas 20 peserta didik kelas VIII MTs Insan Cita, Medan. Data dikumpulkan melalui tes pretest dan posttest berbentuk uraian yang mengukur kemampuan pemahaman konsep matematika, kemudian dianalisis menggunakan paired sample t-test dan *Cohen's d effect size*. Hasil penelitian menunjukkan adanya peningkatan yang signifikan pada pemahaman konsep matematika siswa, yang ditunjukkan oleh kenaikan skor dari pretest ke posttest. Temuan ini menunjukkan bahwa penerapan model PBL berbantuan Quizizz efektif dalam meningkatkan pemahaman konsep matematika melalui keterlibatan aktif peserta didik dalam pemecahan masalah dan refleksi belajar, serta memberikan implikasi bahwa integrasi pembelajaran berbasis

Putri Maisyarah Ammy[1], Alya Rahma Sitorus[2], Irvan[3]*

masalah dengan media digital interaktif dapat menjadi alternatif strategis dalam meningkatkan kualitas pembelajaran matematika.

INTRODUCTION

Conceptual understanding of mathematics is one of the essential competencies that students must possess to meet the challenges of the 21st century (Cajandig & Ledesma, 2025). Conceptual understanding extends beyond the ability to memorize formulas; it also involves the ability to connect, explain, and appropriately apply concepts across various real-world contexts (OECD, 2019). The low level of mathematical conceptual understanding in Indonesia can be observed through the results of the Programme for International Student Assessment (PISA), which indicate that many students across various countries, including Indonesia, continue to experience difficulties in applying mathematical concepts to real-world situations. This reflects a limited depth of conceptual mastery. This persistent gap indicates that Indonesian students' ability to understand mathematical concepts is still relatively low (Kaluge, 2025). These national level findings suggest that difficulties in conceptual understanding are not merely global statistics, but are also likely reflected in classroom-level learning practices in schools.

These national issues are reflected in the context of learning in schools. Based on the results of an interview with one of the mathematics teachers at MTs Insan Cita, located at Jl. Al-Falah No. 6, Glugur Darat II, information was obtained that mathematics learning is still dominated by conventional lecture methods and practice problems. This method is effective in conveying the material, but it does not provide enough space for students to build a deep understanding of concepts and develop critical thinking skills in solving non-routine problems.

Teachers also revealed that when students are faced with more difficult problems or those based on case studies, many students feel confused and tend

to give up before trying to understand and find a solution. This difficulty becomes even more apparent when students are faced with contextual problems that require not only the application of formulas but also a systematic understanding of concepts and problem solving strategies. This is in line with the opinion of Hayati and Jannah (2024), which states that learning mathematics requires a strong understanding of concepts because of the abstract nature of mathematics and its relationship to everyday life.

This condition shows that learning, which is still centered on the teacher, causes the active involvement of students to be less than optimal, so that high-level thinking processes such as reflection and self-correction have not developed optimally (Rahman & Nasryah, 2020). Therefore, learning innovations are needed that can encourage students to actively participate in the learning process and build meaningful conceptual understanding. Teachers have a strategic role in organizing and creating a learning environment that encourages student activity and engagement (Ramadhani & Azis, 2020).

One relevant alternative learning innovation is the implementation of Problem Based Learning (PBL). PBL provides students with the opportunity to actively build conceptual understanding through contextual problem-solving (Khadijah, Nurhadi, Wijaya, Baiturrahman, Azahra, & Hambali, 2025). This model emphasizes learning by doing, encouraging students to think critically, independently, and responsibly in finding solutions to given problems (Fariz & Mamesah, 2025). Previous research shows that the application of PBL is able to improve students' conceptual understanding compared to conventional learning (Kurniawan, Dwikoranto, & Marsini, 2023).

However, the implementation of PBL that is not supported by interesting learning media has the potential to cause boredom in students. Siregar, Siagian, and Prayuda (2023) stated that if the PBL model is applied monotonously, students' enthusiasm for solving problems will decrease. On the other hand, technological developments provide opportunities for teachers to create more interactive and engaging learning experiences (Zebua, 2023). The use of technology in learning can also optimize the use of digital devices owned by students, such as smartphones, to make them more educationally valuable (Permana, Hazizah, & Herlambang, 2024).

One interactive, game-based learning medium that can be used is Quizizz. Quizizz is characterized by game elements, immediate feedback, and quiz-based evaluation that is easily accessible to students. According to Salsabila, Habiba, and Amanah (2020), Quizizz is an educational application

Putri Maisyarah Ammy[1]*, Alya Rahma Sitorus[2], Irvan[3]

that creates a fun learning evaluation environment. Furthermore, using Quizizz has been proven effective in improving students' understanding of mathematical concepts (Prasetyo, Sumarno, & Khasanah, 2024) and can divert smartphone use in a more positive direction in learning.

The integration of PBL with Quizizz is considered relevant because each has complementary strengths. The PBL structure encourages students to analyze problems, develop strategies, and reflect on solutions, while Quizizz provides immediate feedback that helps students self-correct any conceptual errors. Thus, the combination of PBL and Quizizz not only increases student engagement but also specifically addresses weaknesses identified in teacher interviews, namely, students' low critical thinking and reflection skills.

Several recent studies have examined the implementation of Problem-Based Learning (PBL) integrated with Quizizz or similar interactive digital media in mathematics and related learning outcomes. For example, Rahayu, Zuhri, Ariyanto, and Wibawa (2025) investigated the effect of a PBL model assisted by Quizizz on mathematics achievement and found that the combination significantly improved students' performance compared to conventional methods. Another study by Pramasanti and Kundera (2025) reported that integrating PBL with Quizizz and instructional videos enhanced student learning outcomes in mathematics classrooms, with marked improvements from pre-cycle to post-cycle scores. Nurjannah, Arfah, and Wahyudi (2024) also documented that PBL assisted by the Quizizz application effectively improved thematic learning outcomes, highlighting the potential of this integration to increase engagement and achievement. These findings demonstrate that Quizizz can support PBL implementation by providing interactive, game-based feedback that enhances motivation and cognitive engagement.

Although the integration of Problem-Based Learning (PBL) and Quizizz has been shown to improve learning outcomes and student engagement, previous research has focused on general academic achievement. Studies specifically examining mathematical conceptual understanding, particularly in the context of Islamic Junior High Schools (MTs), are still limited. Furthermore, the relationship between PBL and Quizizz is generally viewed as a combination of methods and media, and has not been studied as an integrated learning framework that supports student reflection and self correction.

Based on this gap, this study aims to analyze the effect of the implementation of the Problem-Based Learning model assisted by Quizizz on

students' mathematical concept comprehension ability at MTs Insan Cita. This study is expected to provide theoretical contributions in the development of problem-solving-based mathematics learning integrated with technology, as well as practical contributions for teachers in improving the quality of mathematics learning.

METHODS

This study uses a type of quantitative research with a quasi-experimental method. This method is also an experimental research that is carried out on only one group, namely the experimental group, without a comparison group or control group. The research design that will be used is a one-group pretest-posttest design. This design is measured by conducting a pretest before being given treatment and a posttest that is carried out after being given a learning treatment. The population in this study is all grade VIII students, as many as 60 people, and the sample is only 20 students at MTs Insan Cita. The instrument used in this study consisted of essay-type pretest and posttest questions designed to measure students' mathematical conceptual understanding after the implementation of Problem-Based Learning assisted by the Quizizz game-based application. The conceptual understanding ability was measured using four indicators, namely: (1) the ability to restate mathematical concepts, (2) the ability to classify objects according to the properties of the concept, (3) the ability to apply concepts in solving contextual problems, and (4) the ability to represent concepts in various mathematical forms (Sukaesih, Indiati, & Purwosetiyono, 2020; Wicaksono & Artha, 2022).

To ensure the quality of the instrument, content validity was established through expert judgment involving mathematics education lecturers, while construct validity was examined based on the alignment between the indicators and the theoretical framework of conceptual understanding. Furthermore, the reliability of the instrument was tested using Cronbach's Alpha, which showed that the instrument met the criteria for reliable measurement. Data analysis techniques included the normality test, homogeneity test, Wilcoxon Rank Test to examine the research hypothesis, and Effect Size (Cohen's d) to determine the magnitude of the effect of the application of Problem Based Learning assisted by Quizizz on students' mathematical conceptual understanding.

Putri Maisyarah Ammy[1*], Alya Rahma Sitorus[2], Irvan[3]

RESULTS AND DISCUSSION

Variable data was obtained through tests carried out before (pretest) and after (posttest) the implementation of problem-based learning assisted by Quizizz educational games.

1. Trends of Research Variables

The following are the results of the pretest and posttest obtained regarding the influence of Quizizz educational game-based PBL on students' ability to understand mathematical concepts, which shows that most students have not met the expected requirements before the implementation of Quizizz educational game-based PBL, and there has been an increase after the implementation of game-based PBL Quizizz education, which is from 57,15 to 87,45, using IBM SPSS 29 Software.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Sum	Red	Std. Deviation	Variance
Pretest	20	40	66	1143	57,15	6,846	46,871
Posttest	20	78	95	1749	87,45	4,211	17,734

2. Data Prerequisite Testing

The following are the results of the normality test using IBM SPSS 29 Software.

Table 2. Normality Test Results

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0,124	20	0,200*	0,932	20	0,172
Posttest	0,152	20	0,200*	0,970	20	0,759

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on the table of normality test results, it is known that the significance value (Sig.) in the pre-test data is 0,172 and in the post-test data is 0,759. Both values are greater than 0.05, which means that the pre-test and post-test data are normally distributed. Thus, it can be concluded that the assumption of normality is fulfilled, so that the data is feasible to be analyzed using parametric statistical tests.

3. Hypothesis Testing

a. Paired-Samples T Test

Paired t-test (Paired-samples T-test) is one of the hypothesis testing methods where the data used is not free (in pairs). Decision-making in paired t-tests is based on significance values (Asymp. Sig. 2-tailed). If the Sig. Value is ≤ 0,05, then there is a significant difference between the two conditions tested, while if the Sig. Value is > 0,05, then there is no significant difference. The following are the results of the normality test using IBM SPSS 29 Software.

Table 3. Test Results of Pretest and *Posttest Score Differences*

					95% Confidence Interval of the Difference				
Paired Samples Test									
Paired Differences									
		Red	**Std. Deviation**	**Std. Error Mean**	**Lower**	**Upper**	**t**	**df**	**Sig. (2-tailed)**
Pair 1	Pretest-Posttest	-30,30	5,89	1,32	-33,05	-27,54	-23,02	19	,000

Based on the test results, the average pre-test score was 57,15 with a standard deviation of 6,846, while the average post-test score increased to 87,45 with a standard deviation of 4.211. The significance value (Asymp. Sig.) is obtained < 0,000, which means it is smaller than 0.05.

Thus, it can be concluded that there is a significant difference between pretest and posttest scores. This means that the PBL model based on the Quizizz educational game has a positive influence on improving students' ability to understand mathematical concepts. This increase in grades shows that the learning approach used is effective in helping students understand the material better.

b. Size effect (Cohen's)

After hypothesis testing, Cohen's D calculation was carried out to determine the effect size of the PBL applicator based on the Quizizz educational game.

$$SD_{pooled} = \sqrt{\frac{6,846^2 + 4,211^2}{2}} = \sqrt{\frac{46,868 + 17,732}{2}} = \sqrt{32,3} = 5,683$$

Putri Maisyarah Ammy[1]*, Alya Rahma Sitorus[2], Irvan[3]

$$d = \frac{87{,}45 - 57{,}15}{5{,}683} = \frac{30{,}3}{5{,}683} = 5{,}33$$

The result d = 5,33 showed a very large effect of the treatment (quizizz-based PBL) on the improvement of students' ability to understand mathematical concepts.

The improvement in students' mathematical conceptual understanding through the implementation of Problem-Based Learning (PBL) supported by Quizizz in this study aligns with constructivist theory, which emphasizes that knowledge is actively constructed through learners' engagement in problem-solving and reflection on learning experiences. Within this framework, PBL serves as a medium for constructing concepts through contextual problems, while Quizizz facilitates the internalization of concepts by providing immediate feedback (Fauziah, Alfazli, Aisyah, Yusmita, & Marwa, 2025). These findings further support the perspective that instructional approaches emphasizing active cognitive engagement among learners are more effective than traditional transmission-based methods.

Empirical evidence from this study aligns with previous findings reported by Fariha and Andrijati (2024), indicating that the use of Problem-Based Learning supported by Quizizz contributes to the enhancement of students' thinking processes, particularly in analytical and reflective dimensions. However, while earlier research primarily emphasized the development of critical thinking skills, the present study reveals that the integration of PBL and Quizizz also exerts a direct influence on students' mathematical conceptual understanding, including their ability to connect, interpret, and apply concepts appropriately. This result aligns with the findings of (Boye & Agyei, 2024), who demonstrated that the implementation of Problem-Based Learning fosters higher levels of cognitive engagement and strengthens students' conceptual understanding through collaborative problem solving processes.

The findings of this study further reinforce the results reported by Panggabean and Sinambela (2023), who found that the integration of Problem-Based Learning supported by Quizizz enhances students' mathematical problem solving abilities. The relationship between problem solving skills and conceptual understanding is particularly significant, as students who are able to solve problems meaningfully tend to demonstrate a deeper grasp of underlying concepts. This study emphasizes that problem solving activities

within the PBL framework function not merely as procedural exercises but as a central mechanism for developing conceptual understanding. This perspective is consistent with the findings of Fakhruddin, Nurjanah, and Martadiputra (2025), who highlighted that the integration of PBL with educational technology strengthens both mathematical conceptual understanding and higher-order thinking skills.

Furthermore, the role of Quizizz as an interactive learning medium in this study aligns with the findings of Lestari, Widyaningrum, and Susanti (2024), which indicate that Quizizz can enhance students' motivation and engagement in learning. However, the present study offers a more specific contribution by demonstrating that the immediate feedback provided through Quizizz not only increases motivation but also supports students' self-correction of conceptual errors, thereby reinforcing reflective learning processes that are central to the PBL approach. Similar conclusions were drawn by Khoiruddin and Rahmawati (2025) who reported that Quizizz facilitates conceptual reinforcement through formative feedback and interactive gamification in mathematics learning.

Moreover, the findings of this study complement those of Ulya and Dewi (2025); Zuriantia (2025), who emphasized the effectiveness of integrating PBL and Quizizz in enhancing the quality of mathematics instruction. Unlike prior studies that primarily focused on learning outcomes or numeracy literacy, this research contributes by highlighting the specific effectiveness of combining PBL and Quizizz in strengthening students' conceptual understanding. Thus, this study not only corroborates previous research but also extends the empirical evidence regarding the role of technology-integrated problem-based learning in fostering deeper conceptual comprehension.

CONCLUSION

Students' mathematical conceptual understanding has been shown to improve through the implementation of the Problem Based Learning model, supported by the educational game Quizizz. This learning model encourages students to actively engage in problem solving, reflection, and self-correction, making learning more meaningful and fostering deeper conceptual understanding. The integration of Problem-Based Learning and Quizizz also creates a more interactive learning environment, addressing students' low mathematical conceptual understanding, previously influenced by conventional learning methods. Based on the findings of this study,

Putri Maisyarah Ammy[1], Alya Rahma Sitorus[2], Irvan[3]*

mathematics teachers are advised to utilize the Problem Based Learning model, supported by Quizizz, as an alternative learning method to improve students' conceptual understanding. However, this study was limited to one school and one learning material, so the results cannot be broadly generalized. Therefore, further research is recommended to involve more diverse subjects, different materials, and to examine other mathematical abilities to obtain a more comprehensive picture of the effectiveness of integrating PBL and Quizizz in mathematics learning.

ACKNOWLEDGMENT

DECLARATIONS

Author Contribution	:	PMA: Conceptualization, Investigation, Editing, Writing–Original Draft, Methodology, and Visualization.
		ARS: Methodology, Formal analysis, Data Curation, Writing–Review & Editing.
		I: Investigation, Data analysis support, and Project Administration.
Funding Statement	:	This research was not funded.
Conflict of Interest	:	The authors declare no conflict of interest.
Additional Information	:	Additional information is available for this paper.

REFERENCES

Boye, E. S., & Agyei, D. D. (2024). Understanding problem-based learning and its application in learning mathematics concepts among pre-service teachers. *European Journal of Mathematics and Science Education*, *5*(1), 51–65. https://doi.org/10.12973/ejmse.5.1.51.

Cajandig, A. J. S., & Ledesma, Z. C. (2025). The synergy between 21st century

skills and mathematical proficiency. *International Journal of Research and Innovation in Social Science (IJRISS)*, *9*(04), 1470–1475. https://doi.org/10.47772/IJRISS.2025.90400108.

Fakhruddin, Y. H., Nurjanah, & Martadiputra, B. A. P. (2025). The impact of problem-based learning on mathematics education: a systematic literature review. *EDUTEC: Journal of Education and Technology*, *8*(2), 310–324. https://doi.org/10.29062/edu.v8i3.1112.

Fariha, N. I., & Andrijati, N. (2024). The problem-based learning model assisted by quizizz papermode improves critical thinking ability in mathematics learning. *Journal Od Education Research and Evaluation*, *8*(3), 499–507. https://doi.org/10.23887/jere.v8i3.77204.

Fariz, M., & Mamesah, I. (2025). Analisis filsafat pendidikan john dewey melalui konsep learning by doing dalam pendidikan modern dhorva. *Indonesian Journal of Multidisciplinary Studies*, *1*(1), 1–20.

Fauziah, Alfazli, M. A., Aisyah, S., Yusmita, & Marwa, M. (2025). Pemanfaatan quizizz dan problem based learning untuk meningkatkan hasil dan motivasi belajar. *Prosiding Seminar Nasional Magister Pedagogi Innovation and Sustainability in Pedagogical Research and Education (SEMNAS INSPIRE) 2025*, 113–119.

Hayati, M., & Jannah, M. (2024). Pentingnya kemampuan literasi matematika dalam pembelajaran matematika. *Griya Journal of Mathematics Education and Application*, *4*(1), 40–54.

Kaluge, A. H. (2025). Pemanfaatan AI untuk meningkatkan pemahaman konsep matematika di era digital. *Mathematical Proceedings of The Widya Mandira Catholic University*, *2*(1), 191–205.

Khadijah, I., Nurhadi, M. W. J., Wijaya, A., Baiturrahman, R., Azahra, K. Z. F., & Hambali, M. S. (2025). Pengaruh problem based learning terhadap kemampuan memecahkan masalah peserta didik. *Jurnal Pendidikan Indonesia*, *5*(4). https://doi.org/10.59818/jpi.v5i4.1837.

Khoiruddin, M. A., & Rahmawati, E. (2025). Effectiveness of quizizz in enhancing cognitive competence in mathematics at islamic elementary schools. *Noumerico: Journal of Technology in Mathematics Education*, *3*(2), 73–82. https://doi.org/10.33367/jtme.v3i2.7454.

Kurniawan, B., Dwikoranto, & Marsini. (2023). Implementasi problem based learning untuk meningkatkan pemahaman konsep siswa: studi pustaka.

Putri Maisyarah Ammy[1]*, Alya Rahma Sitorus[2], Irvan[3]

Practice of the Science of Teaching Journal: Jurnal Praktisi Pendidikan, 2(1), 27–36. https://doi.org/10.58362/hafecspost.v2i1.28.

Lestari, D., Widyaningrum, I., & Susanti, N. (2024). The effectiveness of problem based learning model and quizizz application in improving learning outcomes and motivation. *Numerical: Jurnal Matematika dan Pendidikan Matematika*, 8(1), 260–268. https://doi.org/10.25217/numerical.v8i1.4824.

Lisma Zuriantia, P. L. N. b. (2025). Inovasi pembelajaran matematika: implementasi pbl dan quizizz untuk hasil belajar lebih baik. *Jurnal Edukasi Matematika dan Sains*, 14(2), 193–198. https://doi.org/10.59672/emasains.v14i2.4790.

Nurjannah, Arfah, M., & Wahyudi, A. A. (2024). Penggunaan media quizizz berbasis problem based learning (pbl) untuk meningkatkan hasil belajar ppkn pada siswa kelas III SDN pao-pao. *Didaktif*, 10(4), 332–342. https://doi.org/10.36989/didaktik.v10i04.5425.

OECD. (2019). *PISA 2018 results (Volume I): what students know and can do*. Paris: OECD Publishing. https://doi.org/10.1787/5f07c754-en.

Panggabean, C. P., & Sinambela, P. N. J. M. (2023). Penerapan model pembelajaran problem based learning dengan berbantuan media quizizz untuk meningkatkan kemampuan pemecahan masalah matematika siswa SMP swasta r.a kartini tebing tinggi. *Journal on Education*, 05(04), 13899–13906.

Permana, B. S., Hazizah, L. A., & Herlambang, Y. T. (2024). Teknologi pendidikan : efektivitas penggunaan media pembelajaran berbasis teknologi di era digitalisasi. *Khatulistiwa: Jurnal Pendidikan Dan Sosial Humaniora*, 4(1), 19–28.

Pramasanti, D. K., & Kundera, I. N. (2025). Penerapan model problem based learning (PBL) berbantuan video pembelajaran dan quizizz untuk meningkatkan hasil belajar siswa. *Jurnal Ilmu Multidisiplin*, 5(1), 75–89. https://doi.org/10.37329/metta.v5i1.3527.

Prasetyo, S., Sumarno, & Khasanah, S. K. (2024). Kognitif menggunakan media quizizz untuk meningkatkan minat belajar siswa. *Jurnal Riset HOTS Pendidikan Matematika*, 4(1), 377–383.

Rahayu, M. D., Zuhri, M. S., Ariyanto, L., & Wibawa, A. (2025). Model pembelajaran problem based learning berbantuan quizizz dalam meningkatkan hasil belajar matematika. *Proximal: Jurnal Penelitian*

Matematika dan Pendidikan Matematika, *8*(1), 1–10.

Rahman, A. A., & Nasryah, C. E. (2020). Efektivitas model pembelajaran missouri mathematics project untuk meningkatkan hasil belajar siswa SMA. *Mosharafa: Jurnal Pendidikan Matematika*, *9*(2), 335–346. https://doi.org/10.31980/mosharafa.v9i2.650.

Ramadhani, K., & Azis, Z. (2020). Efektivitas model pembelajaran tipe team assisted individualization (TAI) terhadap hasil belajar matematika pada siswa SMK PAB 2 helvetia medan t. p. 2019/2020. *Journal Mathematics Education Sigma [JMES]*, *1*(1), 34–40. https://doi.org/10.30596/jmes.v1i1.4025.

Salsabila, U. H., Habiba, I. S., & Amanah, I. L. (2020). Pemanfaatan aplikasi quizizz sebagai media pembelajaran ditengah pandemi pada Siswa SMA. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, *4*(2), 163–172. https://doi.org/10.22437/jiituj.v4i2.11605.

Siregar, J. A., Siagian, A. E. S., & Prayuda, M. S. (2023). Pengaruh penggunaan model pembelajaran problem based learning (PBL) terhadap minat belajar siswa pada mata pelajaran ipa materi ekosistem di SD kartika 1 medan. *Jurnal Pendidikan: Media, Strategi, dan Metode*, 145–150. https://doi.org/10.0905.vol1iss3no10pp145.

Sukaesih, E. S., Indiati, I., & Purwosetiyono, F. D. (2020). Kemampuan pemahaman konsep matematis siswa dalam memecahkan masalah kontekstual ditinjau dari komunikasi matematis siswa. *Imajiner: Jurnal Matematika dan Pendidikan Matematika*, *2*(4), 310–320. https://doi.org/10.26877/imajiner.v2i4.5882.

Ulya, M., & Dewi, R. F. K. (2025). Pengaruh model problem based learning berbantu quizizz dalam peningkatan literasi numerasi siswa sekolah dasar. *Jurnal Riset Pendidikan Dasar*, *8*(1), 127–137.

Wicaksono, B., & Artha, L. F. (2022). Analisis kemampuan pemahaman konsep matematika siswa dalam pembelajaran online. *LAPLACE*, *5*(1), 61–74. https://doi.org/10.31537/laplace.v5i1.928.

Zebua, F. R. S. (2023). Analisis tantangan dan peluang guru di era digital. *Jurnal Informatika dan Teknologi Pendidikan*, *3*(1), 21–28. https://doi.org/10.25008/jitp.v3i1.55.