Improvement Mathematical Concept Understanding of High School Student Through Problem-Based Learning Model Assisted by Quizizz

Tiara Rossa Nurfadhilah[1], Beni Yusepa Ginanjar Putra[2*)], Siti Maryam Rohimah[3]
[1,2,3]Universitas Pasundan
*) pyusepa.fkip.pmat@unpas.ac.id

Abstract
This study aims to see the improvement of high school students' mathematical concept understanding through the Problem-Based Learning (PBL) model with the help of Quizizz. The method used is quasi-experiment with nonequivalent control group design. The subjects of this study were grade X students in one of the high schools in Bandung Regency consisting of two classes, namely class X-H as the control class and class X-I as the experimental class, each totaling 36 students. The research instrument was a description test of mathematical concept understanding. The results showed that the improvement in the ability to understand the mathematical concepts of students who used the PBL model with the help of Quizizz was higher than students who used the PBL model.
Keywords: Mathematical Concept Understanding, Problem-Based Learning, Quizizz

Introduction

Education is a series of learning that involves providing knowledge, developing skills, understanding values, and forming attitudes in order to develop individual potential, this is in line with the objectives of national education as stated in Law No. 20 of 2003 Article 3 concerning the National Education System, which states that education aims to develop the potential of students to become humans who are faithful, pious, noble, healthy, knowledgeable, capable, creative, and independent. In addition, Bloom emphasizes the importance of balance in the development of cognitive, affective and psychomotor aspects, so that education can produce individuals who are intellectually competent, have character and skills.

Education is one of the most effective methods to improve the quality of human resources, shape the character, ethics and morality of the nation, create unity, harmony, and togetherness among national components and strengthen resistance to foreign influences in Indonesia (Hakim and Darojat, 2023). Broadly speaking, education is the process of providing individuals with information, understanding, skills and expertise to help them improve their abilities and character. According to (Jihan, et al., 2023) said that along with developments in all fields of life, education always undergoes changes, developments, and

improvements. Thus, education is not fixed, but is something that is required to continuously make changes. These changes can occur in various aspects, such as teaching methods, reading materials, media, or learning multimedia, as well as learning materials. Along with the times, technology is also growing rapidly. Technology in education is used as a tool that supports the learning process both as a means of accessing information and as a support in the implementation of learning and assignments (Permana, et al., 2024) Education can be obtained anywhere and through various means, One of them is seen from the form of technological advances that penetrate the field of education, seen from the many digital teaching media that support the learning process both online and offline (Purnasari & Sadewo, 2021). However, education is generally associated with schools through teaching and learning activities known as formal education, because formal education is more systematic and structured (Zuldiansyah & Zuska, 2022).

Educational process in Indonesia involves learning and teaching activities, including the learning of mathematics. Mathematics is one of the subjects taught at all levels of education, from kindergarten to university. A strong understanding of mathematics is one of the main skills that must be mastered during the learning process. Thus, students need to have skills in understanding concepts in everyday life, especially in the context of mathematics learning, and be taught from an early age. For this reason, learning mathematics and the ability to understand mathematical concepts are very important. Therefore, this subject is considered difficult. (Hermawati et al, 2024) said that mathematics learning tends to be categorized as learning that is difficult and related to numbers and formulas which in the teaching process requires methods that can attract students' attention.. The view of mathematics as a dry, abstract, theoretical science, and full of confusing symbols and formulas, which is based on unpleasant experiences when learning mathematics at school, has led to negative perceptions of mathematics among student (Mulyana, et al., 2022).

Importance of understanding mathematical concepts according to Permendikbud Number 58 of 2014 explained that mathematics subjects aim to enable students to: 1) Understand mathematical concepts, 2) Solve problems, 3) Use mathematical reasoning, 4) Communicate problems systematically, and 5) Have attitudes and behaviors that are in accordance with the values in mathematics.

Based on these objectives, it can be seen that understanding mathematical concepts is the cognitive ability of students to understand mathematical material which includes the

ability to convey ideas, process information, and explain in their own words through the learning process to solve problems using rules based on concepts (Rochmah, et al., 2021). The National Council of Teachers of Mathematics (NCTM) in 2000 explained that the ability to understand mathematics is very important in mathematics teaching methods. NCTM also states that students must be able to master and apply procedures, concepts, and processes. Therefore, in order for pupils to successfully study mathematics, they must have a solid grasp of the subject since this is the first step in learning mathematics.. The formation of new knowledge is basically based on understanding, so that with an understanding of a concept, students are expected to be able to solve problems, express ideas, and explain concepts that have been learned both in writing and orally.

Indonesia's low understanding of mathematical concepts is based on the results of the 2022 PISA survey, which showed that it ranked 70th out of 81 countries, although it rose 5 positions from 2018. Indonesia's math score dropped 13 points to 366, far below the OECD average of 472. PISA assesses aspects of concept understanding, problem solving, connection, communication, and representation (Darwani, et al., 2023).

Desmi et al. (2023) in their research results stated that students' understanding of mathematical concepts was still relatively low. Research by Prasetyo, et al., (2023) shows that many students still have difficulty in applying mathematical concepts effectively when facing various problems. The findings of studies conducted by Fathurrahman, et al., (2023) state that the ability to understand the mathematical concepts of high school students on the material of equations and quadratic functions is still low, one of which is caused by student errors in understanding the problem and not mastering the concept well. The results of Nuraini and Afifurrahman (2023) also show a lack of understanding of the concept of students so that they make procedural and conceptual errors.

Low results obtained are caused by various factors, including internal factors that come from the students themselves. Learner factors that cause students to be uninterested in learning mathematics, such as lack of motivation and interest of students. As a result, learners lose interest and motivation to learn until it has an impact on the results, this is suppoerted by (Juaini & Nofisulastri, 2023) said good motivation in learning will show good results as wellIn other cases, learners memorize mathematical concepts and formulas without understanding their meaning, content, and usefulness. This causes, most students can only solve what is given by the educator, even if only the problem resembles, this is supported by Khasanah, et al., (2020) said that when educators give similar problems but

not the same, students still experience confusion and difficulty so that they end up asking the educator repeatedly. External factors are caused by mistakes in choosing strategies that do not encourage active learner involvement during learning. Errors in the choice of methods can reduce students' interest in participating in math lessons. An interesting and effective learning model is needed to improve understanding of mathematical concepts. The Problem-Based Learning (PBL) model is one of the learning approaches that emphasizes student participation in the process of learning, this is supported by (Aulia & Yesi, 2022) said that learning using problem-based learning models can actively involve students in learning and can better understand the learning material because the characteristics of this learning are problem-oriented to students.

PBL is a learning activity that can emphasize active student involvement in exploring ideas and strategies to solve mathematical concept understanding. This is in accordance with what Hidayatni and Wahyuningsih (2024) said that PBL is a form of active learning that involves students as the main subject in the learning process. PBL encourages students to be actively involved in solving real problems that are relevant to their daily lives. PBL provides a more real context and introduces students to various problem-solving strategies, this supported by (Wardani, 2023) said Problem-Based Learning (PBL) has been recognized as an innovative learning model that enables students to develop collaboration and communication skills, critical thinking, communication, and real-world problem solving .In PBL, learners also actively seek solutions, discuss and collaborate with classmates. Students are given various problems that require accuracy, precision, analysis, logic in solving a mathematical problem Khairani and Putra (2020). Thus, the PBL model not only improves academic understanding but also develops important skills such as problem solving, critical thinking, and teamwork, making students the center of learning and making them more active and have a sense of responsibility. In addition, it is an effort to utilize the current technological era in education which provides opportunities for the development of more innovative learning.

The development of technology is characterized by the development of digital information and the use of computer-based or mobile phones. This means that the use of Information and Computer Technology (ICT) cannot be ignored because it is the main focus in various public policies, including in the field of education. This opinion is in line with Firmadani (2020) which states that learning media acts as a link between educators and students in transferring knowledge, so it cannot be separated in the learning process. In

addition to learning models, one way to make learning more engaging and increase student participation is through the Quizizz app. Quizizz allows students to actively participate in challenging interactive quizzes, real-time questions and leaderboards. These features not only make learning more interesting, but also encourage students to be more focused and motivated in following the learning material.

Quizizz is a game-based application that can be used to help learners learn. Kinanti, et al., (2023) say that Quizizz is a web-based learning platform that allows educators to create quizzes, surveys, and games for their learners. The platform is designed to be interactive and fun, with features such as memes, emojis and music to make learning more engaging. The use of Quizizz in math learning has the potential to increase student engagement, deepen their understanding of the material, and motivate them to actively learn, so this can help students in concept understanding.

Based on the problems described regarding the characteristics of the PBL model and Quizizz as well as the results of relevant research and related to existing variables, researchers believe that the use of PBL model and Quizizz will support the development of mathematical concept understanding. Therefore, researchers plan to conduct research with the title "Improvement Mathematical Concept Understanding of High School Student Through Problem-Based Learning Model Assisted by Quizizz".

Method

This research approach is a process that includes collecting and analyzing data to find answers to research questions. In this study using a quantitative approach. Sugiyono (2024) states that quantitative research is based on the philosophy of positivism, this approach is used to research certain populations or samples, with data collection through research instruments and data analysis that is quantitative or statistical. This research uses a quantitative approach because the data collected are numbers and analyzed by statistical methods.

This study aims to observe the cause-and-effect relationship through the participation of two groups, namely the control group and the experimental group. It is not possible for researchers to select students at random for this study, nor is it feasible to control for all significant variables, including learning environments, classroom setup, learning materials, learning time, and other elements that researchers are unable to control. Therefore, in this study the method used is quasi experiment or pseudo experiment with

quantitative approach, data collection through research instruments and quantitative or statistical data analysis (Sugiyono, 2024). This research used a quasi-experiment method with a research design of nonequivalent control group design, this research design does not have a randomly drawn group, so the control class cannot fully control the outside variables that affect the implementation of the experiment (Sugiyono, 2023).

O_1 X O_2

O_3 X O_4

Source: (Sugiyono, 2023)

Description

O_1 : Before the pretest in the experimental class

O_2 : Before the posttest in the control class

O_3 : Before the pretest in the experimental class

O_4 : Before the posttest in the control class

X : Treatment for the experimental class using the PBL model assisted by Quizizz

Subject of this research was one of the X grade high schools in Bandung Regency, as many as two classes, namely class X-H as the control class which obtained the PBL model and class X-I as the experimental class which obtained the PBL model assisted by Quizizz. Determination of control and experimental classes is carried out using Purposive Sampling technique for sample selection, this technique uses certain considerations through careful determination of population characteristics. Data collection was carried out through a description test of the ability to understand mathematical concepts. The data analysis methods used were descriptive statistics, normality test, homogeneity test, and t-test. Data were processed using SPSS 23.0 for Windows.

Results and Discussion

This research was conducted at Bina Muda Cicalengka High School in class X. The data presented are the final test results of the ability to understand mathematical concepts in control class students and experimental classes which are then processed and analyzed with the help of SPSS 23.00 for Windows. Before testing the hypothesis, first descriptive statistical test, normality test, and homogeneity test on the data of each group. The results of the mathematical concept understanding ability test were used as data for testing. The

results of the descriptive statistical test of mathematical concept understanding ability test are presented in Table 1 below.

Table 1. Descriptive Statistics of Students' Mathematical Concept Understanding

Class	Statistics	Statistical Value		
		Pretest	**Posttest**	**N-Gain**
Experiment	Sample	36	36	36
	Minimum	0,00	25,00	0,05
	Maximum	32,14	100,00	1,00
	Mean	15,6747	62,3006	0,5492
	Std. Deviation	8,46399	47,6194	0,22627
	Variance	71,639	354,017	0,051
Control	Sample	36	36	36
	Minimum	0,00	17,86	0,04
	Maximum	39,29	89,29	0,85
	Mean	18,6511	47,6194	0,3619
	Std. Deviation	9,43496	18,27099	0,20760
	Variance	89,018	333,829	0,043

Based on Table 1, it can be seen that the pretest results of students' mathematical concept understanding ability at Bina Muda Cicalengka High School for the experimental class have a minimum value of 0.00, a maximum value of 32.14, an average value of 15.6747, a standard deviation value of 8.46399, and a variance value of 71.639. While in the control class, the minimum value is 0.00, the maximum value is 39.29, the average value is 18.6511, and the variance value is 89.018. Furthermore, for the acquisition of posttest scores of mathematical concept understanding ability in the experimental class has a minimum value of 25.00, a maximum value of 100.00, an average value of 62.3006, a standard deviation value of 47.6194, and a variance value of 354.017. Meanwhile, in the control class, the minimum value was 17.86, the maximum value was 89.29, the mean value was 47.6194, the standard deviation value was 18.27099, and the variance value was 333.829. From the acquisition of these values, it can be seen that there is a better score increase in the posttest results compared to the pretest results.

Then, for the N-Gain value, it can be seen that in the experimental class the minimum value is 0.05, the maximum value is 1.00, the average value is 0.5492, the standard deviation value is 0.22627, and the variance value is 0.051. While in the control class, the minimum value is 0.04, the maximum value is 0.85, the mean value is 0.3619, the standard deviation value is 0.20760, and the variance value is 0.043. It is possible to

draw the conclusion that the experimental class increased more than the control class based on the values acquired in each class in the N-Gain findings.

Furthermore, the normality test was carried out using the Shapiro-Wilk test with the help of SPSS 23.0 software for Windows, the results of the analysis can be seen in Table 2. This normality test aims to ensure that the data used in this study follow a normal distribution, which is an important prerequisite for further statistical analysis. The results of the Shapiro-Wilk test will provide information on whether the normality assumption is met or not. The data presented in Table 2.

Table 2. Normality Test

Variabel	Class	Shapiro-Wilk		
		Statistic	Df	Sig.
Mathematical Concept Understanding	Experiment	0,968	36	0,364
	Control	0,957	36	0,177
N-Gain	Experiment	0,986	36	0,921
	Control	0,963	36	0,271

The results of the normality test calculation are shown in Table 2, where it is evident that each data point in both groups and both variables has a significance value (sig.) larger than 0.05. As a result, it may be said that both groups' data came from a normal distribution. This normality test is important to ensure that the data used meets the assumption of normal distribution, which is a prerequisite for advanced statistical analysis such as the t-test.

Furthermore, the homogeneity test was conducted using the Levene test with the help of SPSS 23.00 software for Windows, and the results are presented in Table 3. This homogeneity test aims to test the similarity of variance between groups, which is also one of the important assumptions in parametric statistical analysis. With the results of the Levene test, we can find out whether the variances of the two groups are the same or not. If the significance value of the Levene test is greater than 0.05, it can be concluded that the variances of the two groups are homogeneous or uniform. The data presented in Table 3.

Table 3. Homogeneity Test

Variable	Levene Statistic	Df1	Df2	Sig.
Mathematical Concept Understanding	0,304	1	70	0,583
N-Gain	0,804	1	70	0,373

Table 3 displays the results of the homogeneity test calculation which shows that the significance value (sig.) for each data in both groups and both variables is more than 0.05. Therefore, the data obtained can be concluded that the variance of the two data is

homogeneous. This shows that the concept understanding and N-Gain of students from the group that obtained the PBL model assisted by Quizizz and the group that obtained the PBL model had a homogeneous variance. Based on the test results above, it shows that each data is normally distributed and homogeneous. Furthermore, hypothesis testing can be carried out using Independent Sample T-Test with the help of SPSS 23.0 for Windows software to see the improvement of students in the ability to understand mathematical concepts. The data test results are shown in Table 4.

Table 4. T-Test N-Gain

		Levene's Test for Equality of Variances
		Sig. (2-tailed)
N-Gain	Equal variances assumed	0,000
	Equal variances not assumed	0,000

Based on Table 4, it can be seen that the two-party significance value (sig.2-tailed) for equal variance assumed is 0.000. Because what is used is a one-sided hypothesis test (one tailed), the two-sided significance value (sig.2-tailed) must be divided by two, being $\frac{0,000}{2} = 0,000$. The significance value is less than the 5% significance level (α=0.05) so that based on the testing criteria, H_a is accepted. This shows that students who get the PBL model assisted by Quizizz experience a higher increase in mathematical concept understanding ability compared to students who only get the PBL model. This shows that the learning method, namely PBL assisted by Quizizz applied in the experimental class is more effective in improving students' understanding and skills compared to the method used in the control class, namely using the PBL model alone. The higher improvement in the experimental class not only reflects a greater increase in the average score, but also shows a significant difference in the distribution of score improvement among students, reflecting the positive effect of the learning intervention provided. Thus, it can be concluded that the use of more innovative and interactive learning methods in the experimental class contributed more to the achievement of student learning outcomes compared to the approach applied in the control class.

Based on the research, there were differences in the ability to understand mathematical concepts between students in the experimental class who used the PBL model with the help of Quizizz and students in the control class who used the PBL model without Quizizz. Students who learn with the PBL model assisted by Quizizz show a higher understanding of mathematical concepts compared to students who use the PBL model. This increase is due to the PBL approach which presents contextual problems,

making students more active and motivated to understand concepts and apply them in real situations. As explained by Wibawa, et al., (2023) suggests that in PBL, the problems given to students are related to real situations or relevant contexts related to real situations or relevant contexts. This helps them understand the application of mathematics in everyday life. This approach allows learners to master the material more quickly and improve their understanding of mathematical concepts. PBL not only helps learners understand math concepts better, but is also designed to get them actively involved in the learning process. In this method, learners work in groups to search and discover concepts through observation, classification, hypothesis generation, explanation, and conclusion. This collaborative process accelerates understanding of the material and improves learners' critical and creative thinking skills. We can see from one or two answers to the posttest results from the experimental class and control class as evidence to compare the differences in the process of answering questions.

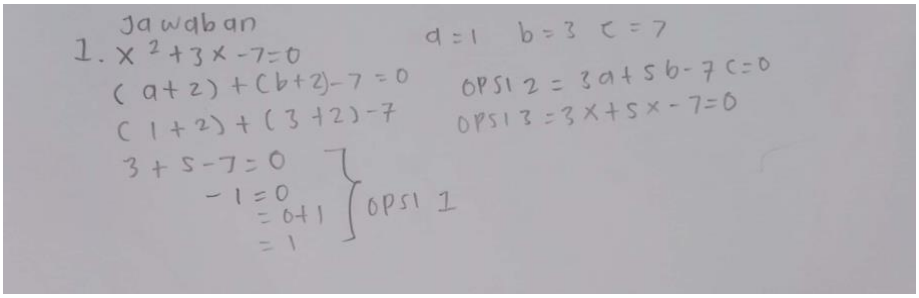

Figure 1. Answer of Control Class Student

In Figure 1, the final test answers for number 1 from students in the control class are shown. From the figure, it can be seen that students in the control class tend to provide answers to questions without going through systematic stages. They did not write the known and asked parts, but immediately gave the final answer. This shows that these learners did not fully understand what was asked in the problem. As a result, they could not answer the question properly and the results obtained were unsatisfactory.

In addition, ignoring simple initial steps such as writing down known and asked information can hinder the development of their analytical skills in deciphering problems. These analytical skills are very important in learning mathematics, as they help learners in understanding and solving problems in a systematic and structured way. Failure to follow these steps can lead to difficulties in understanding more complex concepts in the future. Thus, it is important for learners to master the basic steps in answering problems in order to develop analytical skills and a better understanding of the mathematical concepts taught.

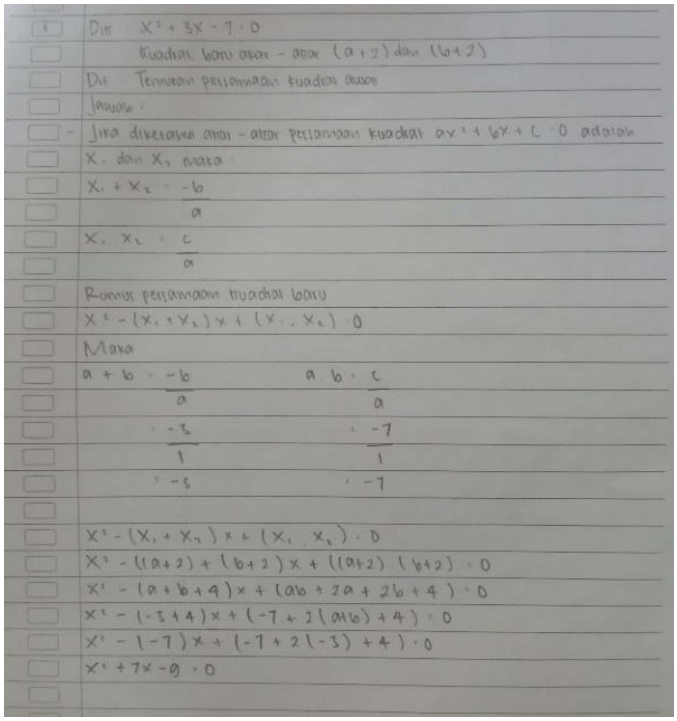

Figure 2. Answer of Experiment Class Student

Next, the answer from one of the experimental class students can work on the problem in a good way, starting with writing what is known in the problem, what is asked in the problem, meaning that the students accept well what is asked or becomes a problem in the problem, and the students already understand how to solve the problem and are able to work on it so that they get good results. This shows that experimental class students follow systematic steps in solving problems. By writing "known", learners ensure that they understand the data and information available in the problem. Meanwhile, writing "asked" helps learners focus on the purpose of problem solving and determine the steps needed to reach the answer. So it can be concluded that the indicator of the ability to understand mathematical concepts, namely restating each concept in question 1 for the experimental class can be said to be achieved, while in the control class it is not achieved.

This is because students in the experimental class who were treated with the Problem-Based Learning (PBL) model assisted by Quizizz showed better mathematical concept understanding abilities compared to the control class which only used the PBL model without the help of Quizizz. In the learning process of the PBL model assisted by Quizizz, the delivery of material becomes more interesting and interactive, thus increasing students' interest in learning.

In addition, in the Quizizz app, learning and questions are presented in the form of a game, which motivates learners to be the first to answer in order to get high scores and be

at the very top of the ranking. This triggers a sense of competition among learners, which in turn encourages them to be more active and engaged in the learning process. Learners in the experimental class were also given Learner Worksheets (LKPD) designed in accordance with the steps of the PBL model. This LKPD helps students follow the problem-solving process systematically, which is the essence of the PBL model. Thus, students are not only motivated by the game in Quizizz but also helped by the structure provided by the LKPD, so that their understanding of mathematical concepts can develop better and deeper. The use of Quizizz as a tool in the PBL model not only makes learning more interesting but also increases the interaction and active participation of learners. This is very different from the control class which only uses the PBL model without interactive support such as Quizizz, which tends to be less effective in motivating students to be actively involved in learning. As a result, the learning results in the experimental class showed a more significant increase in mathematical concept understanding ability compared to the control class.

Learning with the PBL model in the control class showed that students were not very active during the learning process. They tended to only pay attention to the researcher who presented the material, without much interaction or active participation. Only a few learners dared to ask questions, so learning activities tended to be passive. As a result, the learning objectives that were expected to run well and actively were not achieved in the control class. When given exercise questions, only the same learners are brave and able to answer the questions. The same thing happened during the question and answer session, where only the same learners dared to ask. This condition causes learning to be less effective, because not all learners are actively involved in the learning process. As a result, students' abilities cannot be improved optimally, as seen from the analysis of the improvement of students' mathematical concept understanding abilities.

This contradicts the principles of PBL which should actively involve learners in solving the problems given. PBL is designed to encourage active participation, collaboration, and full involvement of learners in the learning process, all of which are essential for improving critical thinking skills and concept understanding. However, in practice in the control class, these principles were not well realized, so the expected learning outcomes were not achieved. Based on the discussion above, it can be concluded that learning using the PBL model assisted by Quizizz is better in improving the ability of

students, one of which is the ability to understand the mathematical concepts of students than learning with the model.

Furthermore, the following are presented other research results that can support. One of them is a study conducted by (Marliana et al., 2023) showing that the PBL learning model has a positive effect on students' mathematical concept understanding ability. The next relevant research, namely research conducted by (Siagian et al., 2021) shows that self-regulated learning, emotional intelligence, self-regulated learning and emotional intelligence have a significant influence on the mathematical understanding of high school students. The results of research by (Sari et al., 2022)show that the use of quizizz in each learning evaluation can improve students' mathematical understanding skills.

Conclusion and Suggestion

Based on data analysis and testing regarding the ability to understand mathematical concepts of students who obtained the PBL model assisted by Quizizz and students who obtained the PBL model, it was concluded that the increase in the ability to understand mathematical concepts of students who obtained the PBL model assisted by Quizizz was higher than students who obtained the PBL model.

References

Aulia, L., & Yesi, B. (2022). PENERAPAN MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH. *Journal Of Elementary School Education (Jouese)*, *2*(1), 105–109. https://doi.org/https://doi.org/10.52657/jouese.v2i1.1628

Darwani, Hafriani, & Angkat Yuni. (2023). Kemampuan Pemahaman Konsep Matematis Siswa Melalui Model Pembelajaran Flipped Classroom di SMP/MTS. *Educator Development Journal*, *1*(1), 51–59. https://doi.org/https://doi.org/10.2022/edj.v1i1.2162

Fathurrahman, M., Ba'diah, A. S., & Husain, A. K. (2023). Identifikasi Kesalahan Siswa Dalam Menyelesaikan Soal Persamaan Kuadrat dan Fungsi Kuadrat. *KAMBIK: Journal of Matematics Education*, *1*(2), 35–42. https://ejournal.um-sorong.ac.id/index.php/jme/article/view/2966

Firmadani, F. (2020). Media Pembelajaran Berbasis Teknologi Sebagai Inovasi Pembelajaran Era Revolusi Industri 4.0. *KoPeN: Konferensi Pendidikan Nasional*, *2*(1), 93–97. https://ejurnal.mercubuana-yogya.ac.id/index.php/Prosiding_KoPeN/article/view/1084

Hakim, A. R., & Darojat, J. (2023). Pendidikan Multikultural dalam Membentuk Karakter dan Identitas Nasional. *Jurnal Ilmiah Profesi Pendidikan*, *8*(3), 1337–1346. https://doi.org/10.29303/jipp.v8i3.1470

Hermawati, A. D., Sholikhah, O. H., & Ratnawati, E. (2024). Pengaruh Penggunaan Metoda Technology Based Learning Dalam Menghadapi Kesulitan Belajar Pada Pembelajaran Matematika Kelas II. *Jurnal Media Akademik (JMA)*, *2*(11).

https://scholar.googleusercontent.com/scholar?q=cache:haN6fJrlQFEJ:scholar.google.com/+pembelajaran+matematika+sering+dianggap+sulit+karena+sifatnya+yang+abstrak,+sehingga+memerlukan+pendekatan+yang+tepat+dalam+pengajarannya+&hl=en&as_sdt=0,5&as_ylo=2020

Hidayatni, N. A., & Wahyuningsih, B. Y. (2024). Penerapan Model Problem Based Learning Sebagai Upaya Dalam Meningkatkan Kemampuan Pemahaman Konsep Matematika Siswa. *Jurnal Teknologi dan Pendidikan Dasar*, *1*(1), 17–22. https://prospek.unram.ac.id/index.php/JTPD/article/view/1056

Jihan, I., Asbari, M., & Nurhafifah, S. (2023). Quo Vadis Pendidikan Indonesia: Kurikulum Berubah, Pendidikan Membaik? *JISMA: Journal of Information Systems and Management*, *02*(05), 17–23. https://doi.org/https://doi.org/10.4444/jisma.v2i5.431

Juaini, M., & Nofisulastri, N. (2023). Penggunaan Model Pembelajaran Student Teams Achievement Division (STAD) untuk Meningkatkan Motivasi dan Prestasi Belajar Matematika Siswa Kelas X. *Panthera : Jurnal Ilmiah Pendidikan Sains dan Terapan*, *3*(1), 13–22. https://doi.org/10.36312/pjipst.v3i1.144

Khairani, V. F., & Putra, B. Y. G. (2020). Peningkatan Kemampuan Berpikir Kritis Matematis Siswa SMA Melalui Model Pembelajaran Matematika Knisley Dengan Metode Brainstorming. *Symmetry | Pasundan Journal of Research in Mathematics Learning and Education*, *5*(1). https://doi.org/https://doi.org/10.23969/symmetry.v5i1.2923

Khasanah, M., Esti Utami, R., & Rasiman, R. (2020). Analisis Kemampuan Pemahaman Konsep Matematis Siswa SMA Berdasarkan Gender. *Imajiner: Jurnal Matematika dan Pendidikan Matematika*, *2*(5), 347–354. https://doi.org/https://doi.org/10.26877/imajiner.v2i5.6517

Kinanti, P., Ramadhani, R. S., Nawaidah, Y. S., Subakdi, S., Satino, S., Hidayatullah, A., & Suprima, S. (2023). Keefektifan Quizizz Dalam Pelaksanaan Proses Pembelajaran Kelas XI Di MAN 1 Kota Bogor. *Innovative: Journal Of Social Science Research*, *3*(6), 4539–4549. https://doi.org/https://doi.org/10.31004/innovative.v3i6.6725

Marliana, P., Sunaryo, Y., & Zamnah, L. N. (2023). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Pemahaman Konsep Matematis Siswa. *J-KIP (Jurnal Keguruan dan Ilmu Pendidikan)*, *4*(1), 183–190.

Mulyana, D., Gunadi, F., & Nurhasanah, S. (2022). Keterampilan Mengajar Guru Matematika Terhadap Aktivitas Belajar Siswa SMA Negeri 1 Losarang Di Masa Pembelajaran Daring. *ProSANDIKA UNIKAL (Prosiding Seminar Nasional Pendidikan Matematika Universitas Pekalongan)*, *3*(1), 309–316.

Nuraini, I., & Afifurrahman, A. (2023). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Matematika Materi Persamaan Kuadrat. *Journal of Math Tadris*, *3*(2), 15–31. https://doi.org/10.55099/jmt.v3i2.89

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. https://doi.org/10.55606/khatulistiwa.v4i1.2702

Prasetyo, A., Fatah, A., & Novaliyosi, N. (2023). Analisis Kesalahan Siswa Kelas XI Dalam Menyelesaikan Soal Pemahaman Konsep Matematis Pada Materi Matriks. *Wilangan: Jurnal Inovasi dan Riset Pendidikan Matematika*, *4*(4), 328–335. https://doi.org/http://dx.doi.org/10.56704/jirpm.v4i4.20820

Purnasari, P. D., & Sadewo, Y. D. (2021). Strategi Pembelajaran Pendidikan Dasar di Perbatasan Pada Era Digital. *Jurnal Basicedu*, *5*(5), 3089–3100.

https://doi.org/10.31004/basicedu.v5i5.1218

Rochmah, N., Pujiono, S., & Wiyono. (2021). Peningkatan Kemampuan Pemahaman Konsep Materi Gaya dan Gerak Menggunakan Model Course Review Horay. *Educatif Journal of Education Research*, *5*(1), 87–99. https://doi.org/10.36654/educatif.v5i1.152

Sari, S. P., Djamilah, S., & Nugroho, A. G. (2022). Penerapan Quizizz Dalam Pembelajaran Matematika Terhadap Pemahaman Matematis Siswa. *Seminar & Conference Proceedings of UMT*, 16–21.

Siagian, R. E. F., Marliani, N., & Lubis, E. M. (2021). Pengaruh Kemandirian Belajar Terhadap Kemampuan Berpikir Kritis Pada Siswa Sekolah Menengah Atas. *Jurnal Educatio FKIP UNMA*, *7*(4), 1798–1805. https://doi.org/10.31949/educatio.v7i4.1597

Sugiyono. (2023). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* (Sutopo (ed.); 2 ed.). ALFABETA.

Sugiyono. (2024). *Metode Penelitian Kuantitatif*.

Wardani, D. A. W. (2023). Problem Based Learning: Membuka Peluang Kolaborasi dan Pengembangan Skill Siswa. *Jurnal Penelitian dan Penjaminan Mutu*, *4*(1).

Wibawa, T. P., Eliyarti, W., & Saputra, J. (2023). Pengaruh Model Problem Based Learning Terhadap Kemampuan Pemahaman Konsep Matematis Berbantuan Geogebra. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*, *8*(1), 109–118. https://doi.org/10.23969/symmetry.v8i1.8851

Zuldiansyah, M. F., & Zuska, F. (2022). Ethnographic Gayo Community Of Tampur Paloh Village In The Lower Tamiang River, Simpang Jernih District, East Aceh Regency, Aceh Province. *Progress In Social Development*, *3*(1), 33–43. https://doi.org/10.30872/psd.v3i1.38