DOI: https://doi.org/10.33487/edumaspul.v9i1

EDUMASPUL
JURNAL PENDIDIKAN

Vol 10 No. 01 (2026) page 234-249

p-ISSN 2548-8201 | e-ISSN 236-0469
https://ummaspul.e-journal.id/maspuljr/

Students' Critical Thinking and Mathematical Problem Solving Skills through *the Problem Based Learning* (PBL) Model and Guided Inquiry at SMA Negeri 5 Lebong

Jeli Dahliah[1], Apriza Fitriani[2], Risnanosanti[3]
[123]Universitas Muhammadiyah Bengkulu
Email: *jelidahliah@gmail.com, aprizafitriani@umb.ac.id, Risnanosanti@umb.ac.id*

Abstract

This study aims to determine whether there are differences and influences on students' critical thinking and mathematical problem-solving abilities through the Problem Based Learning (PBL) and Guided Inquiry models at SMA Negeri 5 Lebong. The population of this study was all grade X students of SMA Negeri 5 Lebong. The sampling technique used cluster random sampling, namely random sampling based on class, so that three sample classes were obtained, each consisting of 33 students, namely class X.1, X.2, and X.5 with a total of 99 students. The type of research used was quasi-experimental. Data collection was carried out using essay tests to measure students' critical thinking and mathematical problem-solving abilities. Data were analyzed using the One Way ANOVA test. The results of the study showed that there were significant differences in students' critical thinking and mathematical problem-solving abilities between classes using the PBL, Guided Inquiry and Conventional Learning models. The Guided Inquiry model was more effective in improving critical thinking abilities and the PBL model showed more effectiveness in improving students' mathematical problem-solving abilities.

Keywords: *Problem Based Learning (PBL), Guided Inquiry, Critical Thinking Skills, Mathematical Problem Solving, Mathematics Learning.*

Abstrak

Penelitian ini bertujuan untuk mengetahui apakah terdapat perbedaan dan pengaruh kemampuan berpikir kritis dan pemecahan masalah matematis siswa melalui model *Problem Based Learning* (PBL) dan Inkuiri Terbimbing di SMA Negeri 5 Lebong. Populasi penelitian ini adalah seluruh siswa kelas X SMA Negeri 5 Lebong. Teknik pengambilan sampel menggunakan *cluster random sampling*, yaitu pengambilan sampel secara acak berdasarkan kelas, sehingga diperoleh tiga kelas sampel, masing-masing berjumlah 33 siswa, yaitu kelas X.1, X.2, dan X.5 dengan total 99 siswa. Jenis penelitian yang digunakan adalah *quasi eksperimen*. Pengumpulan data dilakukan dengan menggunakan test essay untuk mengukur kemampuan berpikir kritis dan kemampuan pemecahan masalah matematis siswa. Data di analisis menggunakan uji *One Way Anova*. Hasil penelitian menunjukan bahwa terdapat perbedaan yang signifikan kemampuan berpikir kritis dan pemecahan masalah matematis siswa antara kelas menggunakan model PBL, Inkuiri Terbimbing dan Pembelajaran Konvensional. Model Inkuiri Terbimbing lebih efektif untuk meningkatkan kemampuan berpikir kritis dan Model PBL Menunjukan lebih efektif dalam meningkatkan kemampuan pemecahan masalah matematis siswa.

Kata Kunci: *Problem Based Learning* (PBL), Inkuiri Terbimbing, Kemampuan berpikir kritis, pemecahan masalah matematis, pembelajaran matematika

Research Background

The development of 21st century skills is a must in the modern educational curriculum. Students must be trained to develop communication, problem-solving, collaboration, digital literacy, critical and creative thinking and life skills. Acquiring these skills students will be ready to face the challenges of the future, succeed in their lives and contribute positively to an ever-evolving society (Yusuf, 2023). 21st century learning emphasizes technology integration, Cretical skills development *Thinking* (critical thinking), *Creativity* (creativity), *Communication* (communication) and *Collaboration* (collaboration) (4C), promoting contextual learning that is problem-oriented.

In an era where information is widely available and change is happening rapidly, education must be able to produce individuals who are not only academically skilled, but also able to adapt, solve problems, and innovate (Ayi et al., 2024). Meanwhile, according to (Reginata & Mukhlis, 2023) 21st century skills include critical thinking, problem-solving, communication, creativity, innovation, and collaboration as essential parts of the learning process.

Critical thinking skills are the process of brain performance that contains ideas or ideas to understand something in order to find a way out of the problem at hand. To achieve goals and objectives (thinking results), the ability to think critically is a very essential support for a job and functions effectively in all other aspects of life. Critical thinking skills as a skill empowered to solve problems (Sudirman et al., 2023). Critical thinking skills enable students to analyze information, provide logical reasons, and make reflective decisions (Ayu et al., 2023). Critical thinking plays an important role in helping students solve various problems, both in academic contexts and in daily life (Fitriyah & Wardani, 2022). However, learning activities that train critical thinking and problem-solving skills are still rarely optimally applied in schools (Kartika & Rakhmawati, 2022). As a result, students tend to only be able to solve problems similar to the examples in class, without understanding the concepts in depth (Habibi et al., 2020).

According to Polya (Rahayu & Afriansyah, 2025) Problem solving can be interpreted as an attempt to find a solution to a difficulty or a way to achieve a goal that cannot be achieved directly, problem solving involves a high level of intellectual activity, where a person tries to find a solution to the problem faced by utilizing the knowledge and experience he has had. Problem-solving skills are also at the core of 21st-century skills. Training this ability means fostering the ability to think analytically, creatively, and systematically in facing various challenges, especially in the curriculum that is currently applied to education in Indonesia, namely the independent curriculum (Yusuf, 2023).

Based on the results of initial observations at SMA Negeri 05 Lebong on mathematics subjects in October 2025 through interviews with mathematics teachers, researchers found identification that most students still have difficulty in understanding mathematical concepts in depth and applying them to solve contextual problems. Students tend to memorize formulas and completion procedures without understanding the meaning behind the concepts learned. This condition has an impact on students' low ability to develop critical thinking skills and mathematical problem solving. This condition has an impact on the low ability to develop critical

thinking skills and mathematical problem solving.

Based on the mathematics learning results in school assessments are still below the Learning Goal Achievement Criteria (KKTP), only 65% of students have achieved the KKTP, while 35% of students have not met the set criteria. This shows that students' critical thinking and mathematical problem-solving skills are still relatively low. Findings are in line with the results of the study (Farcis, 2021) which shows that the critical thinking and mathematical problem-solving skills of high school students are still relatively low because learning tends to be teacher-centered and does not provide opportunities for students to explore problem-solving strategies independently. Therefore, it is necessary to implement a model based on the Pancasila Student Profile that can foster critical thinking, collaboration and creativity skills in the context of meaningful mathematics learning.

Addressing these conditions requires innovative learning models that are student-centered and require active involvement in discovering and building concepts. One of the models that is considered relevant for developing critical thinking and mathematical problem-solving skills is *Problem Based Learning* (PBL). Models *Problem Based Learning* (PBL) It is a learning approach that requires students' active participation in facing real problems so that they can build their own understanding, hone their thinking skills at a higher level, and foster confidence (Nova et al., 2022).

According to (Mallu et al., 2024) Models *Problem Based Learning* (PBL) is a learning approach that directs students to be actively involved in problem solving that requires critical and creative thinking skills. Based on this description, the author is interested in conducting research with the title "Students' critical thinking skills and mathematical problem solving through a learning model *Problem Based Learning* (PBL) and Guided Inquiry at SMA Negeri 5 Lebong."

Research Methodology

This study uses Design *Pretest-Postest Control Group*. In this design, two groups were randomly selected. Then a pretest was given to find out the difference in circumstances between the experimental group and the control group (Soesana et al., 2023) In this study, the three groups were first given a pretest with the same test, then for experiment class 1 they were given special treatment, namely by using a learning model *problem-based learning* and experimental class 2 using the learning model *project based learning,* Then the control class was given treatment using the direct learning model, after the three groups were given treatment, then given the final test (*post-test).*

The research was carried out from January to February 2026 at SMP Negeri 5 Lebong. The population of all class X students at SMA Negeri 05 Lebong is 165 students consisting of 5 classes consisting of X_1, X_2, X_3, X_4, X_5. Of the five classes in the population, three classes were drawn as research samples. So that the class is obtained As an Experiment class with action X_1*Problem Based Learning* (PBL, Class as an experimental class with action as a Control class with Conventional Learning and Class as an experimental class with Guided Inquiry action. The sample consists of three classes: two experimental classes and one control class.X_2 X_5

In this study, data collection was carried out using instruments in the form of

critical thinking ability tests and mathematical problem solving. The method used to analyze the data in this study is variance analysis (ANOVA). Before ANOVA is implemented, the researcher will conduct a prerequisite test, namely a normality test and a homogeneity test, to ensure that the assumptions of the analysis are met.

Results and discussion

A. Problem Based Learning *(PBL)* Learning Model

1. Definition of *Problem Based Learning* (PBL)

Models *Problem Based Learning* (PBL) is a student-centered learning approach by making real problems the starting point of the learning process Huda et al. in (Aguswandi & Herwandi, 2025) . Through stages such as recognizing problems, gathering information, designing solution strategies, and presenting the results, students are encouraged to think critically, collaborate, and be responsible for their own learning process Khofifah et al in (Aguswandi & Herwandi, 2025). In mathematics learning, PBL is considered very appropriate because it trains students to analyze non-routine problems, relate concepts, and formulate logical and systematic solution steps. Thus, the application of this model is believed to significantly improve students' mathematical problem-solving abilities Minarti et al. in (Aguswandi & Herwandi, 2025).

According to Isrok'atun and Amelia (Kotto et al., 2022), problem-based learning (PBL) involves giving students real-world problems, then helping them find solutions through a variety of learning activities and experiences. According to Abidah et al. (Kotto et al., 2022), Students are required to take an active role in their own learning through the PBL paradigm, which encourages thinking, reasoning, communicating, analyzing, and drawing conclusions. Students are encouraged to apply their knowledge by solving real-world problems using scientific methods in problem-based learning (PBL). Students can improve their critical thinking and problem-solving skills through an educational technique known as problem-based learning (PBL).

Students are encouraged to actively participate in their own learning through real-world problem-solving that is directly related to the subject matter in problem-based learning (PBL). Through PBL-based learning activities, students can create a mental model for learning, and form independent learning habits through practice and reflection on the collaborative atmosphere Yew & Goh, 2020 in (Mallu et al., 2024)

Sec. 2. Advantages and Disadvantages of *Problem Based Learning* (PBL)

Regarding the implementation *Problem-Based Learning* (PBL), there are a number of implications, both positive and negative. The benefits and drawbacks of problem-based learning (PBL) will be discussed in the following paragraphs.

a. Advantages of Learning Model *Problem Based Learning* (PBL)(Irwandi, 2020) Outline the benefits of use *Problem Based Learning* (PBL), including:
    a) Problem-solving is arguably one of the most effective approaches to gaining an in-depth understanding of the subject matter being researched.
    b) The problem-solving process can offer students the opportunity to test their talents and give them decisions that can help them acquire new knowledge.

c) Student learning activities can be improved through problem-solving.
d) Through the process of problem-solving, students can more effectively transfer their knowledge to understand real-life circumstances.
e) Students can build on their new knowledge and become more responsible for the learning they do through the problem-solving process.
f) Students can benefit from problem-solving because it fosters critical thinking skills and the capacity to learn new technologies.
g) The problem-solving process gives students the opportunity to apply the knowledge they gain in the classroom to real-world problems.

Even after they complete their formal education, students can still gain an interest in continuous learning through the problem-solving process.

Learn More (Irwandi, 2020) presented several weaknesses in PBL learning, among others.

a) Students who are less interested or do not perceive the problem being researched as challenging will be reluctant to engage in efforts to solve it.
b) The effectiveness of learning strategies through Problem-Based Learning (PBL) requires a considerable investment of time for careful preparation.

Without a comprehensive understanding and earnest effort to address the problems at hand, they will not gain the knowledge they seek.

B. Guided Inquiry Learning Model

1. Definition of Guided Inquiry Learning Model

According to Sabti et al. in (Sinaga et al., 2025) , the guided inquiry model is a learning approach that emphasizes the active involvement of students in the learning process. This model not only helps students understand the material cognitively, but also fosters moral attitudes as well as critical, logical, and analytical thinking skills. Additionally, this approach respects individual differences and encourages students to build knowledge based on their own experiences. Meanwhile, Palajukan et al. (2021) explained that the guided inquiry model is learning in which teachers play a role in providing broad direction and guidance to students. (Sinaga et al., 2025)

The development of the pedagogical paradigm of guided inquiry is closely related to contextual learning. Guided inquiry learning encourages students to use their critical thinking and analytical skills to find solutions to real-world problems by conducting their own experiments and observations (Herung et al., 2025). Found that guided inquiry learning increased student engagement with the material. Teachers take the lead in developing and executing problem-solving strategies. (Iswatun in Jundu et al., 2020)

In classroom environments with diverse student abilities, the guided inquiry learning paradigm can be a useful tool. In the guided inquiry learning paradigm, students lead their

own learning and are able to hone their critical thinking and thinking skills. It can also inspire students to love learning. (Sarumaha & Harefa, 2022)

2. **Disadvantages and Advantages of Guided Inquiry Learning Model**

The disadvantages of guided inquiry learning are: 1) it is very difficult to design learning, 2) in its application requires a long investment (Faelani, 2020). Based on the above shortcomings, it can be concluded that the guided inquiry learning model still largely depends on students' internal abilities such as mathematics, language and independent learning skills. (Pramudya, 2022)

Advantages in the implementation of the guided inquiry learning model according to Wardani & Firdaus, in (Syafila et al., 2024) There are 4 advantages including: providing natural opportunities and encouragement for students to explore, improving students' ability to learn independently, providing opportunities for students to discuss, seek, and find solutions to problems that have been formulated, in the hope of fostering their confidence and active involvement and providing more opportunities to reflect on learning, deepen understanding, as well as develop students' cognitive and psychomotor abilities optimally. (Diana & Anugraheni, 2022)

C. Critical Thinking Skills

1. **Definition of Critical Thinking Skills**

The ability to think critically mathematically, is the ability to think effectively in making, assessing or evaluating, as well as formulating decisions about something in this case related to mathematics (Jumaisyaroh et al., 2020). According to Abdullah (2021), the ability to think mathematical critically is the mental activity of a person (student) which refers to the steps of scientific work starting from understanding and formulating problems, collecting and processing or analyzing information, formulating hypotheses or temporary conjectures, conducting hypothesis testing, drawing conclusions, and evaluating and then deciding something based on the scientific process that has been carried out. (Kisnawati & Darnawati, 2024)

Critical thinking skills are one of the *higher order thinking skills* that are very important in mathematics learning. Critical thinking not only requires students to remember or understand concepts, but also assess, evaluate, and make decisions based on logical reasons and accountable evidence (Jumaisyaroh et al., 2020). According to Abdullah (2021), the ability to think mathematically critical thinking is a mental activity that refers to the scientific process, namely understanding problems, formulating problems, collecting and analyzing information, formulating provisional conjectures (hypotheses), testing hypotheses, drawing conclusions, and evaluating the results of problem solving. Furthermore, according to Wahana et al. (2024), critical thinking in the context of mathematics is the ability of students to use their knowledge and reasoning in evaluating arguments, solving complex problems, and making rational decisions based on available evidence or data. This process includes the ability to identify assumptions, interpret information, and

connect mathematical concepts to real context. According to Ennis (in Fisher, 2020), critical thinking is the ability to think reflexively and rationally to decide what to believe or do. Ennis stated that critical thinking skills can be measured through several indicators that include thinking skills and thinking attitudes.

2. Indicators of Critical Thinking Ability

In the context of mathematics learning, the indicators of critical thinking ability can be described as follows:

1. Provide Elementary *Clarification*
   Students are able to understand problems, identify main questions, and explain the meaning of terms or concepts used in math problems.
2. Building basic skills (*Basic Support*)
   Students can use facts, data, or calculation results to support the arguments and decisions made. At this stage, students begin to learn to give logical reasons for the completion steps taken.
3. Inference
   Students are able to draw conclusions based on relevant evidence and information. In mathematics, this includes the ability to interpret patterns, generalize outcomes, or predict possible answers.
4. Provide Advanced *Clarification*
   Students are able to assess the validity of a mathematical argument, distinguish between valid and invalid assumptions, and explain the reasons for the conclusions drawn rationally.
5. Organizing strategies and tactics
   Students can plan systematic problem-solving steps, choose the right strategy, and assess the effectiveness of the solutions that have been made.

These indicators illustrate that critical thinking in mathematics focuses not only on the final outcome, but also on the thinking process that students use to understand, reason, and evaluate the solutions they find. Thus, mathematical critical thinking skills play an important role in helping students become logical, reflective, and creative problem solvers.

3. Students' Mathematical Solving Abilities

One of the most important aspects of learning math is solving math puzzles. Problem-solving skills should be developed so that students can use them flexibly for a variety of assignments as well as for additional math education. Various efforts have been made to improve learning activities, such as objectives, curriculum, implementation, instruction, assessment, and qualification of teachers, in order to improve mathematical problem-solving skills. All components of education, including teachers, are responsible for this. (Rifa'i et al., 2019)

Students try to find solutions to difficulties, especially when studying math. The use of techniques, protocols, and tactics that can be consistently proven to be accurate is emphasized in problem solving in mathematics education. In mathematics, tasks designed to improve students' mathematical knowledge and skills are referred to as problem-solving.

According to Cai & Leister (Albay, 2019), students can improve their communication, conceptual understanding, and connections in mathematics by solving problems. Students' problem-solving skills are essential for improving cognitive capacity and can inspire them to master math, according to Pehkonen (Siswono, 2019). Furthermore, problem-solving skills also encourage students to solve given math problems using their own ideas and methods (Intaros et al., 2020). This is in accordance with Bayat & Tarmizi (2020), which states that students' cognitive skills can be improved by problem solving. (Rahmmatiya & Miatun, 2020)

The four stages of problem solving as outlined by According to Polya (Riyanto et al., 2024), there are four steps to solving mathematical problems, namely: (1) understanding the problem (*understanding the problem*); (2) Drawing up a plan (*devising a plan*); (3) Implement the plan (*carrying out the plan*); (4) Double-check (*Looking back*).

D. The Essence of Mathematics Learning

In helping the progress of science and technology as well as our daily lives, mathematics is an indispensable and practical auxiliary science. It is important for students to be encouraged to think critically, methodically, objectively, and rationally from an early age, and mathematics is a tool to achieve this. Thus, students should use mathematics as a tool to improve their critical thinking skills and, furthermore, their problem-solving capacity. (Hartati et al., 2024)

Improving students' intellectual abilities or capacity is the main goal of mathematics education (Mariamah, 2020). Students who take the time to study mathematics not only develop their numeracy and critical thinking skills, but also their capacity to apply mathematical ideas in a variety of contexts and disciplines. (Afsari et al., 2021) Based on the above statement, we can conclude that the purpose of learning mathematics is basically not only for students to be able to calculate or use formulas, but also to form a way of thinking and positive attitudes towards mathematics. In general, the objectives of learning mathematics are: 1. Mastering mathematical concepts and principles, 2. Developing numeracy and procedural skills 3. Train logical, critical, systematic, and creative thinking skills, 4. Develop problem-solving skills, 5. Cultivate a positive attitude towards mathematics, and 6. Associate mathematics with daily life and other sciences. The data in this study is data on critical thinking and problem-solving skills obtained from *the pretest* and *posttest results*. The data of *the pretest* results are given before the student receives *treatment using* the Problem Based Learning *(PBL)* learning model and the *postest* Guided Inquiry is given after the student receives treatment using the *Problem Based Learning* learning model (PBL) and Guided Inquiry to find out students' critical thinking and problem-solving skills. The description of the data that has been obtained is as follows:

Normality Test

a. The data from *the pretest* results made students think critically before being treated that the data in all research classes was distributed normally. This is shown by the significance value in each class, both the control class, the class that uses *the Problem Based Learning* (PBL) model, and the Inquiry class, which is

above the set significance level. Significance values greater than 0.05 indicate that the data does not deviate from the normal distribution.

b. The data from *the posttest results of* the students think critically after being treated that the data in all research classes is distributed normally. This can be seen from the significance values in the control class, *the Problem Based Learning* (PBL) class, and the Inquiry class which are above the set significance level. Significance values greater than 0.05 indicate that the data does not deviate from the normal distribution.

c. The data on the results *of the pretest* for mathematical problem solving of students using *the Kolmogorov–Smirnov* test, it is known that the data in the control class, *the Problem Based Learning* (PBL) class, and the Inquiry class have a significance value greater than the set significance level. In accordance with the test criteria, if the significance value is greater than 0.05, the data is declared to be normally distributed.

d. The data from *the posttest* results of mathematical problem solving of *Kolmogorov-Smirnov* test students obtained that the data in the control class, *the Problem Based Learning* (PBL) class, and the Inquiry class had a significance value greater than the specified significance level. Based on the test criteria, if the significance value is greater than 0.05, the data is declared to be normally distributed. Thus, the data on problem-solving ability at the *posttest* stage in all research classes is distributed normally.

D. Homogeneity Test

1. Test the homogeneity of critical thinking ability in the *pretest*, it is known that all class groups show significance values that are above the set test criteria. This can be seen both in tests based on mean, median, median with degree of freedom adjustment, and *trimmed mean*. Thus, the variance of data on students' critical thinking skills at the *pretest stage* between learning groups was declared homogeneous.
2. Test the homogeneity that all class groups have significance values that are above the set test criteria. These results were consistent with tests based on *mean*, median, median with adjustment of degrees of freedom, and *trimmed mean*. Thus, the variance of data on students' critical thinking ability at the *posttest stage* between learning groups was declared homogeneous.

a. The homogeneity test *of variance* of problem-solving ability in the *pretest*, obtained a significance value on the entire basis of the test greater than the set criteria. This shows that the data variance in the three research classes, namely the control class, *the Problem Based Learning* (PBL) class, and the Inquiry class, did not have a significant difference. Thus, it can be concluded that the three classes have *the same or* homogeneous variance.

b. The homogeneity test of *variance* of problem-solving ability in the *posttest*, obtained a significance value on the entire basis of the test greater than the criteria that have been set. This shows that there was no significant difference *in variance* between the study groups. Thus, *the variance of* students' problem-solving ability in the control class, *Problem Based Learning* (PBL) class, and Inquiry class can be declared homogeneous.

E. Hypothesis Test

a. Differences in Students' Mathematical Critical Thinking Skills

1. Difference between PBL Model and Guided Inquiry

   The results of the *Least Significant Difference* (LSD) test showed that the mathematical critical thinking ability of students in classes using *the Problem Based Learning* (PBL) model did not show significant differences when compared to classes using the Guided Inquiry model. The results of this test showed that both learning models provided relatively equal results in improving students' mathematical critical thinking skills.

2. Difference between PBL Model and Guided Inquiry

   The results of *the Least Significant Difference* (LSD) test, the mathematical critical thinking ability of students in classes using the Problem Based Learning (PBL) model showed significant differences compared to classes using conventional learning. These results show that the application of the PBL model provides better results in improving students' mathematical critical thinking skills compared to conventional learning.

3. Difference between Guided and Conventional Inquiry Models

   The results of *the Least Significant Difference* (LSD) test, the mathematical critical thinking ability of students in classes using the Guided Inquiry model showed a significant difference compared to conventional learning. These results show that the application of the Guided Inquiry model provides better results in improving students' mathematical critical thinking skills compared to conventional learning.

b. Differences in Students' Mathematical Problem-Solving Abilities

1. Difference between PBL Model and Guided Inquiry

   The results of *the Least Significant Difference* (LSD) test, students' mathematical problem-solving ability in classes using the Problem Based Learning (PBL) model did not show significant differences when compared to classes using the Guided Inquiry model. These results show that both learning models provide relatively similar results in improving students' mathematical problem-solving skills.

2. Difference between PBL and Conventional Model

   The results of *the Least Significant Difference* (LSD) test, students' mathematical problem-solving ability in classes using the Problem Based Learning (PBL) model, showed significant differences compared to classes using conventional learning. These results show that the application of the PBL model provides better results in improving students' mathematical problem-solving skills compared to conventional learning.

3. Difference between Guided and Conventional Inquiry Models

   The results of *the Least Significant Difference* (LSD) test, students' mathematical problem-solving ability in classes using the Guided Inquiry model showed significant differences compared to classes that used conventional learning. These results show that the application of the Guided Inquiry model provides better results in improving students' mathematical

problem-solving skills compared to conventional learning.

c. The Influence of Learning Models on Mathematical Critical Thinking Skills

The results of the One Way ANOVA test on the mathematical critical thinking ability pretest data, it is known that there is no difference in the average ability of students in each class before being given learning treatment. This shows that students' mathematical critical thinking skills in classes using the Problem Based Learning (PBL), Guided Inquiry, and conventional learning models are at relatively equal initial conditions.

The results of the One Way ANOVA test on the posttest data of mathematical critical thinking skills were obtained that in classes using the Problem Based Learning (PBL) model, there was a significant difference in the average mathematical critical thinking ability of students. Meanwhile, in the Guided Inquiry class and the conventional learning class, no significant average difference was found. These results show that the application of the PBL model has an influence on the improvement of students' mathematical critical thinking skills after learning takes place. In contrast, in the Guided Inquiry class and conventional learning, students' improved mathematical critical thinking skills were less likely to show significant differences.

d. The Influence of Learning Models on Mathematical Solving Skills

The results of the One Way ANOVA test on the pretest data on mathematical problem-solving ability, it is known that there is no difference in the average ability of students starting between classes before being given learning treatment. This shows that the mathematical problem-solving ability of students in each class is in a relatively equal initial condition.

The results of the One Way ANOVA test on posttest data on mathematical problem-solving ability were obtained that there was a difference in the average mathematical problem-solving ability of students between classes after being given learning treatment. These results show that the applied learning model has an influence on students' mathematical problem-solving ability.

e. The Influence of Learning Models on Critical Thinking and Problem Solving Skills Simultaneously

The results of *the Multivariate Analysis of Variance* (MANOVA) test in the *Multivariate Tests* table, obtained significance values on all *multivariate statistics*, namely *Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root*, showed significance values that were smaller than the significance level of 0.05. These results show that there is a significant influence of the learning model on students' critical thinking skills and problem-solving abilities simultaneously. The multivariate statistical values of the Class variables, critical thinking ability and problem-solving ability showed that the differences in learning models applied to each class contributed significantly to the change of the two dependent variables together.

The PBL model emphasizes solving real problems as a trigger for learning, while Guided Inquiry directs students to conduct systematic investigations. This is in line with the theory of constructivism (Puspitasari, 2020) which states that knowledge is built through the active activity of individuals in interacting with the learning environment. Thus, the equality of results of the two

models shows that problem-based and investigation-based active learning are equally effective in developing mathematical critical thinking skills.

The results showed that there was a difference in mathematical critical thinking skills between students who learned using the PBL model and conventional learning, where the PBL model provided better results. According to (Yusuf, 2023), Problem Based Learning is designed to develop high-level thinking skills through authentic investigative and problem-solving activities. In the PBL process, students are trained to identify problems, propose hypotheses, and evaluate the solutions produced. In contrast, conventional learning tends to be teacher-centered so that students receive more information passively. This condition does not support the development of critical thinking skills as explained by (Sudirman, 2023) which affirms that critical thinking develops through active analytical and reflective activities. Therefore, the PBL model has been shown to be more effective in improving students' mathematical critical thinking skills.

The Guided Inquiry model produces better mathematical critical thinking skills compared to conventional learning. According to (Kartika, 2022) Through the theory of discovery learning, learning that involves the process of discovering concepts independently can improve students' understanding and thinking skills. The Guided Inquiry Model provides direction to students to observe, question, collect data, and draw conclusions so that the thinking process takes place actively. In addition, (Habibi, 2020) explains that effective learning occurs through social interaction and appropriate guidance in the zone of proximal development. In guided inquiry, the teacher acts as a facilitator who provides scaffolding so that students are able to develop critical thinking skills optimally.

Mathematical problem-solving skills between PBL models and Guided Inquiry. This shows that both models are equally effective in training students' problem-solving skills. According to (Yusuf, 2023), mathematical problem solving involves four main stages, namely understanding the problem, planning the solution, implementing the plan, and checking again. These stages are reflected in both the PBL syntax and the Guided Inquiry. Both models provide a learning experience that requires students to think systematically and reflectively, so that problem-solving skills develop optimally. The PBL model has better mathematical problem-solving capabilities than conventional learning. According to (Farcis, 2021), PBL helps students develop problem-solving skills through collaborative and investigative activities. Students not only memorize procedures, but understand concepts through real-world problem-solving experiences. Conventional learning that focuses on routine practice provides less opportunities for students to develop problem-solving strategies independently. Therefore, students' problem-solving skills develop more optimally through PBL.

The Guided Inquiry model results in better mathematical problem-solving capabilities compared to conventional learning. According to (Mallu et al., 2024), inquiry learning emphasizes the process of scientific thinking through investigative activities so that students are accustomed to finding solutions independently. The process of exploration and discovery of concepts helps students understand the relationships between mathematical concepts in more depth. This supports the opinion (Nova et al., 2022) that inquiry-based learning models are effective in developing high-level thinking

skills, including problem-solving skills. The learning model has a significant influence on students' mathematical critical thinking skills. According to (Nurkhasanah, et al., 2023), critical thinking skills develop through learning experiences that demand interpretation, analysis, evaluation, and inference. The PBL model and Guided Inquiry provide these activities through discussion, investigation, and learning reflection. These findings also fit in with the theory of social constructivism (Sarumaha & Harefa, 2022) which emphasizes the importance of interaction in building understanding and high-level thinking skills.

The learning model has a significant influence on students' mathematical problem-solving abilities. According to (Pramudya, 2022), problem-solving skills develop through practice dealing with challenging problem situations. The PBL and Guided Inquiry model provide these conditions through investigative activities and contextual problem solving. In addition, (Budiasa & Gading, 2020) states that problem-based learning is effective in improving problem-solving skills because students are trained to connect concepts with real-life situations.

Conclusion

Based on the results of the research and data analysis that has been described, it can be concluded that:

1. There is no difference in students' mathematical critical thinking skills between those taught using the Problem Based Learning (PBL) learning model and the Guided Inquiry model. Both learning models show relatively equal effectiveness in improving students' mathematical critical thinking skills.
2. There is a difference in students' mathematical critical thinking skills between those who are taught using the Problem Based Learning (PBL) learning model and conventional learning. The PBL model provides better results than conventional learning.
3. There is a difference in students' mathematical critical thinking skills between those taught using the Guided Inquiry model and conventional learning. The Guided Inquiry model has been shown to be more effective in improving students' mathematical critical thinking skills compared to conventional learning.
4. There was no difference in students' mathematical problem-solving abilities between those taught using the Problem Based Learning (PBL) learning model and the Guided Inquiry model. Both learning models provide relatively equal results in students' mathematical problem-solving skills.
5. There is a difference in students' mathematical problem-solving abilities between those who are taught using the Problem Based Learning (PBL) learning model and conventional learning. The PBL model shows higher results than conventional learning.
6. There is a difference in students' mathematical problem-solving skills between those taught using the Guided Inquiry model and conventional learning. The Guided Inquiry model provides improved mathematical problem-solving skills that are better than conventional learning.
7. The Problem Based Learning (PBL) and Guided Inquiry learning models significantly affect students' mathematical critical thinking skills. Student-centered learning through problem-solving activities and inquiry processes is able to

encourage students to think analytically, reflectively, and critically.

8. The Problem Based Learning (PBL) and Guided Inquiry learning models significantly affect students' mathematical problem-solving skills. The application of these two learning models is able to improve students' ability to understand problems, plan solution strategies, and evaluate the results of solutions systematically.

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