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The Effect of Implementing PBL, DL And DI on Critical Thinking Ability Mathematics Reviewed from Motivation to Learn

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A B S T R A C T

This study aims to improve students' mathematical critical thinking skills by enhancing their intrinsic motivation to learn. It compares the effects of three instructional models PBL (Problem Based Learning), DL (Discovery Learning), and Direct Instruction (DI) on students' mathematical critical thinking across four levels of intrinsic motivation: high, medium, low, and overall. The research employed a quasi-experimental design with a non-equivalent control group. The sample consisted of 75 seventh-grade students: 25 students each from classes VII A and VII B as experimental groups using PBL and DL models, and 25 students from class VII C as the control group using DI. Data were analyzed using two-way ANOVA. Results indicate that PBL significantly outperforms DL in improving students' mathematical critical thinking skills. In turn, DL shows a more pronounced effect compared to DI. Intrinsic motivation plays a crucial role: students with high and medium levels of motivation benefit the most, while those with low motivation show weaker outcomes. A significant interaction effect was found between the type of instructional model and the level of intrinsic motivation, suggesting that the choice of instructional model should consider students' motivational profiles. These findings imply that instructional strategies tailored to students' motivation levels can significantly enhance mathematical critical thinking abilities.

1. Introduction

With the aim of providing students with a meaningful learning experience, modern classrooms require both students and teachers to take an active role in their own education. The value of education depends on students' critical thinking skills, which include problem-solving, discovery learning, the ability to process both informational and direct instruction, and general critical thinking (Ministry of Education and Culture, 2018).

A critical thinker must be able to do the following: (1) analyze claims, arguments, or evidence; (2) draw conclusions using indicative and deductive reasoning; (3) evaluate or assess; (4) make decisions or solve issues. According to Zakiah and Lestari (2019). At its foundation, critical thinking must adhere to the criteria laid out by Santi et al. (2018), which include being clear, accurate, precise, relevant, thorough, logical, significant, and fair. Focus, Reason, Situation, Inference, Clarity, and Overview (FRISCO) is the fundamental component that a critical thinker needs to solve problems (Azizah et al., 2021). These definitions highlight the complexity of critical thinking, especially in mathematics education, where students must integrate logic, analysis, and reflection in solving real-world problems.

Teachers have the primary responsibility of making their pupils understand that the mathematical ideas they are teaching them are applicable to real-world problems by stressing the interconnected nature of mathematical concepts. Students can have a better grasp of mathematical concepts by first engaging in inductive reasoning at the outset of their math education, and then building on that foundation with deductive reasoning (Umbara, 2017). However, implementing these reasoning strategies requires appropriate instructional models. Approaches like Problem-Based Learning, Discovery Learning, and Direct Instruction are designed to foster students' active engagement, reasoning ability, and critical thinking skills. Yet, the effectiveness of these instructional models may vary depending on students' motivation to learn, which is a crucial but often overlooked factor.

The purpose of PBL is to help students acquire both general concepts and specific scientific procedures by having them apply this knowledge to the solution of a predetermined problem (Sianturi et al., 2018). Consequently, it is anticipated that students would grasp the idea of problems pertaining to the core of the problem, and they will acquire knowledge and practice in problem-solving through the use of scientific procedures, while also developing their critical thinking abilities. There are a number of ways in which PBL influences both educators and their pupils. One effective method of education is PBL (Ayunda, 2023).

The Ministry of National Education states that the PBL model encourages students to become autonomous learners who are able to take charge of their own education by developing their own set of learning strategies, being proficient in applying these strategies, and being intrinsically motivated to finish what they start. According to this view, the fundamental goal of problem-based learning is to investigate creative potential. Also, according to the 2013 Mathematics Curriculum for Junior High Schools/Islamic Junior High Schools, which is a book of teacher training materials, there are five steps to problem-based learning: introducing the problem, organizing students, conducting investigations (both individually and in groups), developing and presenting the results of the work, and finally, analyzing and evaluating the process (Maryati, 2018).

A method of teaching known as the "Discovery Learning Model" places an emphasis on student agency in building new information and expanding upon prior understanding. Because of this, students are able to take part in class discussions more actively, and they recall more of what they learn (Marisya & Sukma, 2020).

Another way to look at discovery learning is as a method of instruction that encourages students to think critically by posing questions, gathering information, and drawing their own conclusions based on real-world examples and experiences (Khasinah, 2021).

In light of the foregoing, it is reasonable to say that students engage in discovery learning when they are not given complete course materials but instead are encouraged to seek out underlying ideas on their own. Finding something meaningful in learning is the goal of discovery learning, which is a paradigm for learning according to (Suhito & Nuha, 2018). This model consists of five steps or syntax: stimulation, issue description, data collection, processing, and verification.

A systematic model is the direct teaching model. As per Garrdison and Vaughan, direct instruction offers a framework for discipline and has the potential to facilitate meaningful and methodical learning through experience. (Sidik NH & Winata, 2016). In line with this, Burden and Byrd stated that direct instruction is a learning approach in which teachers provide lessons in simple, sequential arrangements and steps. Direct Instruction is effective in any learning because it is based on the principles of behavioral learning, such as getting students' attention, reinforcing correct responses, providing feedback and corrective feedback to students, and practicing the knowledge gained correctly (Zahriani, 2014).

The five main steps of the direct instruction model of learning are outlined by Shoimin. There are five steps to presenting the model's syntax: 1) orientation/delivering objectives; 2) presentation/demonstration; 3) guided practice; 4) stage of checking understanding and offering feedback; and 5) independent practice. Following the orientation phase, also known as the delivery of learning objectives, is the first stage in the direct instruction learning model. The following step is to provide the necessary information by means of presentations, demonstrations, and guided practice. As a final step, which includes assessing students' knowledge, giving them comments, and giving them opportunities to work independently (Pritandhari, 2017)

First, a strong desire to learn; second, an interest in and focus on the work at hand; third, a willingness to put in the necessary effort to complete assignments; and fourth, a resilience to setbacks. 5) A strong aspiration to achieve success is also present. Creating an engaging learning environment is key to helping students overcome their low critical thinking skills (Ismet, 2022). Students' levels of motivation dictate how much agency they have, how much they put into their work, and how long they stick with a task until they've mastered it (Hidayati et al., 2022). So, with the right amount of inspiration, kids will be eager to find solutions to challenges, and they will be much more so if they feel supported as they take the initiative.

A written scale assessment on tests or questions answered in a questionnaire is one method of measuring motivation. The general level of interest in learning can be gauged by looking at a number of factors. The following are examples of motivational indicators from a user guide for the motivated techniques for learning questionnaire: First, the value component, which includes things like intrinsic and extrinsic motivation, as well as task value; second, the expectation component, which includes things like belief in one's own ability to learn and control over one's own beliefs about learning; and third, the affective component, which includes things like test anxiety (Pintrich et al., 2015).

"Implementation of the Problem Based Learning Model on the Critical Thinking Ability of Class VIII Students in Mathematical Studies Reviewed from Initial Abilities" was the title of the study's findings (Mulyawati et al., 2024). Overall and by beginning ability category (low, medium, high), this study intends to investigate how well junior high school students do in mathematical critical thinking.

Furthermore, this research aims to compare and contrast two successful educational approaches: problem-based learning and conventional learning. Based on initial ability, the experimental group that used the problem-based learning model outperformed the control group that used ordinary learning when it came to mathematical critical thinking. This suggests that there is a significant difference in the two groups' abilities.

The experimental group, which utilised a problem-based learning model, outperformed the control group, which utilised a regular learning model, even when beginning from a high level of ability. This finding suggests a statistically significant difference in the development of mathematical critical thinking abilities between the two groups. Therefore, the research conducted by (Mulyawati et al., 2024) offers an update to the researcher's previous work, specifically looking at the motivational aspects of learning using three learning models (PBL, DL, and DI) to develop mathematical critical thinking abilities.

For pupils to have a solid grasp of mathematical topics, it is necessary to cultivate their critical thinking abilities as well as their math learning skills. Despite the significance of the ability, not all pupils possess it to an optimal level. Less emphasis is placed on students developing their critical thinking abilities throughout the learning process. Class instruction focuses on memorization rather than understanding and applying what students learn. This leaves students with a theoretical understanding of the material but little practical intelligence; therefore, it is imperative that they learn to think critically so that they can comprehend and apply what they learn in the real world.

Preliminary observations conducted at Darul Arifin Islamic Boarding School in Jambi revealed challenges in students' mathematical learning. Many students showed low motivation, struggled to understand mathematical concepts, and lacked confidence in solving problems independently. Teachers reported that students had difficulty applying mathematical reasoning and required continuous guidance. These findings suggest that students' low mathematical critical thinking skills may be linked to their varying levels of intrinsic motivation. This situation underlines the need for instructional models that not only foster critical thinking but also align with students' motivational profiles.

While previous studies have examined the effectiveness of PBL, DL, and DI in promoting critical thinking or learning outcomes individually, few have systematically compared these three models in relation to students' intrinsic motivation levels. Most existing research overlooks how different instructional strategies interact with varying degrees of motivation in shaping students' mathematical critical thinking abilities. Consequently, this study addresses this gap by investigating how PBL, DL, and DI affect students' critical thinking across four motivational strata low, medium, high, and overall using a quasi-experimental design. This comparative approach provides new insights into optimizing instructional practices based on student motivation.

2. Methodology

Standard research procedures were followed in this study, applying a clear quasi-experimental design with non-equivalent control groups. The research pathway is visually summarized below figure 1:

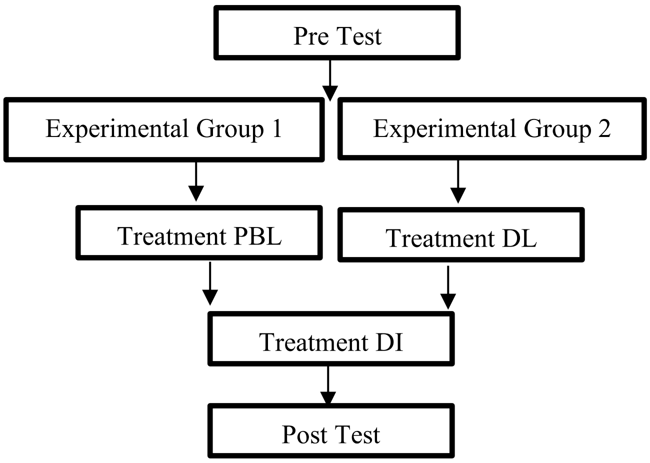

Figure 1. Research Flowchart of the Study

A non-identical control group was utilised in this study before and after the exam as part of the quasi-experimental design. According to Creswell J., quoted by Sugiyono (2019), researchers using a quasi-experimental approach refrain from randomly grouping individuals. Instead, intact classes are used and assigned to treatments. The sample was divided into three seventh-grade classes: VII-A, VII-B, and VII-C. Two classes (VII-A and VII-B) were designated as the experimental groups and received treatments using Problem-Based Learning and Discovery Learning, respectively. The third class (VII-C) served as the control group and was taught using the Direct Instruction model.

There are three categories of variables used in this research: independent, dependent, and moderate. Here we shall break down the three variables. Here, the chosen learning model serves as the independent variable. Using problem-based and discovery learning as pedagogical frameworks, the experimental class receives lesson materials. In addition, the direct instruction learning paradigm is used to provide instructional materials to a control class. In this case, the dependent variable is the capacity of seventh graders to think critically about mathematics and their motivation to study, as measured by pre- and post-tests. Students' access to course materials, the distribution of class time and homework responsibilities, and the quality of instruction all serve as control variables here.

The population consisted of 75 seventh-grade students from Darul Arifin Islamic Boarding School in Jambi. The classes included 25 students each from VII-A, VII-B, and VII-C. A saturated sampling technique was used, meaning all available population members were included in the sample. While the sample was not randomly selected, purposive sampling was applied to ensure that each group received an appropriate and balanced instructional intervention. Consequently, the researcher took into account the sample's determination in this study.

Research instruments are measuring tools that are used to gather data (Sugiyono, 2019). The design and construction of instruments used for data collecting should be such that they generate empirical data. Assessments of students' mathematical reasoning skills, surveys of their intrinsic drive to learn, and documentation of their experiences with PBL, DL, and DI lessons served as the tools for this research. Using markers of students' critical mathematical thinking ability, written examinations consisting of descriptive or essay questions were administered. Research subjects were provided with questionnaires or surveys as instruments of the study. This research made use of a learning motivation survey.

Processing data into fresh information is what data analysis techniques are all about. In order to solve problems, particularly in the field of research, this technique is essential for ensuring that the collected data is easily understandable. Methods for analyzing the study's data include a two-way analysis of variance (ANOVA), a dependent t-test, and tests for normality and homogeneity.

3. Result and Discussion

Students from seventh grade classes A, B, and C at MTS Pondok Pesantren Darul Arifin Jambi participated in this study. The focus was to evaluate how different learning models influenced students' mathematical critical thinking abilities and their motivation to learn. Prior to implementing the instructional models, a pretest was administered to assess students' baseline abilities. After the intervention, a posttest was conducted for both experimental and control groups to evaluate improvement in critical thinking.

The normality of the pretest data was assessed using SPSS. The normality test employed the Monte Carlo method, where a significance value (p-value) of ≥ 0.05 indicates that the null hypothesis (H_0), i.e., the data is normally distributed, is accepted. As shown in Table 1, the p-values for classes VII A, B, and C were 0.080, 0.193, and 0.092 respectively—each exceeding 0.05. Therefore, it can be concluded that the pretest scores are normally distributed across all three classes below tabel 1:

Table 1. Results of the Pretest Data Normality Test

No.	Variable	Sig.	Notes
1	Pretest Eksperimen 1	0,080	Normal
2	Prestest Eksperimen 2	0,193	Normal
3	Protest Kontrol	0,092	Normal

Following the normality test, a homogeneity test was conducted to determine whether the variances among the groups were equal. According to the decision rule, if the significance value is ≥ 0.05, H_0 (equal variance) is accepted. As illustrated in Table 2, the results support the assumption of homogeneity of variance for the pretest scores.

Table 2. Results of the Pretest Data Homogeneity Test

Method Used	Variable	df1	df2	Sig.	Interpretation
Based on Mean	0.228	2	72	0.797	Homogeneous ($p > 0.05$)
Based on Median	0.167	2	72	0.847	Homogeneous ($p > 0.05$)
Median with Adjusted df	0.167	2	71.975	0.847	Homogeneous ($p > 0.05$)
Based on Trimmed Mean	0.223	2	72	0.800	Homogeneous ($p > 0.05$)

According to the criteria for reaching a choice, H_0it is accepted if the significance value is at least 0.05 and rejected if it is less than 0.05. If the supplied data is accurate, then either the pretest value data has a homogenous variance or the number of homogeneity test results is more than or equal to 0.05, and we can accept H_0it.

Pupils' mathematical critical thinking abilities were measured in a posttest that was administered to pupils in grades VII (A, B, and C). The data regarding the students' test scores can be seen in the table below:

The following step is to use SPSS to check if the data is normal. Then, we'll compare the results with a 95% confidence level to the hypothesis: In order to conclude that the data follows a normal distribution, the significance value must be ≥ 0.05. Class VIIA, B, and C pupils' normalcy test results from the preparatory exam. In addition, the table below shows the results of the posttest data normality test as illustrated:

Table 3. Results of the Posttest Data Normality Test

No.	Variable	Sig.	Interpretation
1	Kelas Eksperimen 1	0,161	Normal
2	Kelas Eksperimen 2	0,190	Normal
3	Kelas Kontrol	0,155	Normal

If the significance value is greater than or equal to 0.05, then H_0it is approved, and if the significance value is less than 0.05, then H_0it is rejected, according to the decision-making criteria. It can be concluded that H_0it is accepted or that the posttest value data for experimental class 1, experiment 2, and control are normally distributed based on the normality test results for experimental class 1 PBL learning model, experimental class 2 DL learning model, and control class DI learning model, which are all at ≥ 0.05, according to the data above. In addition, the table below shows the results of the homogeneity test:

Table 4. Results of the Posttest Data Normality Test

Method Used	Variable	df1	df2	Sig.	Interpretation
Based on Mean	0.825	2	72	0.443	Homogeneous ($p > 0.05$)
Based on Median	0.467	2	72	0.629	Homogeneous ($p > 0.05$)
Median with Adjusted df	0.467	2	71.975	0.629	Homogeneous ($p > 0.05$)
Based on Trimmed Mean	0.798	2	72	0.454	Homogeneous ($p > 0.05$)

According to the criteria for reaching a choice, H_0 it is accepted if the significance value is at least 0.05 and rejected if it is less than 0.05. The quantities of results from the homogeneity tests are clearly greater than or equal to 0.05, according to the supplied data. This means that the post-test value data for experimental class 1, experimental class 2, and control have a similar or homogeneous variance, or that the null hypothesis (H_0it) is accepted.

The dependent t-test is not administered until the data from the pretest and posttest have been homogeneously and normally tested. To determine the dissimilarity between two paired samples, or in this instance, pre- and post-test scores, the dependent t-test is employed. Since the PBL class achieved a value of T_hitung= -34.118 and a value of T_tabel= 2.063, we can conclude from the dependent t-test analysis that H_1 is correct and reject H_0. The values do not belong to the range of T_tabel-2.063 to 2.063. This data points to a discrepancy between the average pre- and post-test scores on the PBL course.

The DL class also has a T_hitung= -31,885 and a T_tabel= 2,063, according to the dependent t-test data analysis. We can reject H_0 and accept H_1 because these figures are outside of the range of T_tabel-2,063 to 2,063. Based on these results, it appears that the DL class improved significantly between the first and second assessments. After that, the dependent t-test data analysis calculations revealed that the DI class's T_hitung= -23,307 and T_tabel= 2,063. Since these numbers are outside the range of T_tabel-2,063 to 2,063, we can reject H_0it and accept H_1. In the DI class, the average scores on the pretest and posttest were different, according to these results.

The testing of the hypothesis follows the fulfillment of the necessary conditions. In order to find the average of the several research groups, this hypothesis test employs a two-way ANOVA test. With the help of SPSS, we run a two-way ANOVA (univariate analysis of variance test) and additional tests to see whether our hypotheses hold water. This test has a 95% confidence level with the hypothesis: Assuming the significance value is ≥ 0.05, the data can be considered valid. The following table displays the results of the two-way ANOVA hypothesis test.

Table 5. Hypothesis Test Results Use Two Way ANOVA

Source of Variation	df	F-value	p-value	Interpretation
Learning Model	2	5.996	0.004	Significant effect
Learning Motivation	2	16.637	< 0.001	Highly significant effect
Interaction (Model × Motivation)	3	3.414	0.022	Significant interaction effect

Note:
The learning model and motivation together explain 46.8% of the variance in critical thinking ability ($R^2 = 0.468$, Adjusted $R^2 = 0.413$).

The table above shows that the learning model's significance value is 0.004 (<0.05), thereby rejecting H_0 and accepting H_1. Thus, it is reasonable to assume that the learning paradigm affects pupils' capacity for mathematical critical thinking. Next, looking at the data in the table, we can see that the learning model's significance value is 0.001 (<0.05), which means that H_0 is rejected and H_1 is approved. It follows that students' intrinsic willingness to learn has an effect on their capacity for mathematical critical thinking. The table above shows that the learning model's significance value is 0.022, which is > 0.05. Therefore, H_0 is rejected and H_1 is approved. It follows that the mathematical critical thinking abilities of students are affected by the interplay between the PBL, DL, and DI learning models.

This study investigated the effects of three learning models Problem-Based Learning, Discovery Learning, and Direct Instruction on students' mathematical critical thinking skills, considering variations in learning motivation (low, moderate, and high). While each model demonstrated a positive impact to varying degrees, key differences emerged depending on students' motivational profiles.

The results from the ANOVA test indicate a significant interaction between the learning models and students' motivation levels (p = 0.022), confirming that the effectiveness of a given instructional approach depends partly on the motivational background of the learners. This interaction underscores the importance of personalized pedagogical strategies in the classroom, which sought to gauge students' intrinsic motivation to master mathematical concepts. The table below display the findings of the student learning motivation survey:

Table 6. Student Learning Motivation Questionnaire Data

Motivation Study	Learning model PBL F	PBL %	DL F	DL %	DI F	DI %
Tall	7	28%	4	16%	1	4%
Currently	14	56%	17	68%	12	48%
Low	4	16%	4	16%	12	48%
Amount	25	100%	25	100%	25	100%

Step one in problem-based learning is getting students familiar with the problem at hand. Step two is getting them organized. Step three is directing their individual and group investigations. Step four is creating and presenting the outcomes of their work. Step five is analyzing and evaluating how well they solved the problem.

Following the delivery of model-based PBL implementation instruction, students are given a pre- and post-test to gauge the level of development in their critical thinking skills in mathematics. The improvement in students' critical thinking skills was most pronounced in the PBL group (VII A), especially among students with low learning motivation. This suggests that the collaborative structure of PBL is particularly effective in engaging less motivated students, who benefit from peer support and teacher facilitation. In contrast, students in the DL group (VII B) also showed improvements, but these were more significant among those with moderate to high motivation, likely due to the model’s demand for self-directed inquiry. The DI group (VII C) showed the least improvement, especially for students with low motivation, indicating that teacher-centered instruction may not be sufficient to stimulate higher-order thinking in all learners.

Martani et al. (2021) found that the PBL approach provides an option to the conventional way of teaching in the classroom. Not only does this model provide students with more opportunities to investigate and understand concepts, but it also encourages them to take an active role in their own learning, which in turn encourages them to articulate their thoughts through reasoning and language. The experimental class I (VII A) pupils' motivation was positively affected by the results of adopting PBL learning. This characteristic is shared by students with low learning motivation (number 4), moderate learning motivation (number 14), and high learning motivation (number 7).

There are six steps to Discovery Learning: initial system stimulation, problem identification, data gathering, processing, result verification, and conclusion drawing. Sunarto and Amalia (2022) state that Discovery Learning is an educational paradigm that promotes student agency, critical thinking, active participation in class discussions and activities, independent research and resource utilisation, and creative problem-solving with teachers playing the role of facilitators rather than lecturers. The Discovery Learning model is one way to educate students to actively seek out, analyse, and debate educational subjects, which is in line with Suwiti's beliefs (Suwiti, 2022).

To evaluate the effectiveness of the intervention, students were retested on their critical mathematical thinking skills following the use of the Discovery Learning approach. The Discovery Learning model had a positive effect on students’ critical thinking skills, especially for those with moderate to high learning motivation. These students engaged actively in investigating mathematical problems and comparing relevant data. However, students with low motivation struggled to fully engage with the self-directed nature of DL. This suggests that while DL supports critical inquiry, it is more effective when learners already possess intrinsic motivation and curiosity to explore content independently.

According to a recent study (Laeni, Zulkarnaen, & Efwinda, 2022), the Discovery Learning model improved students' critical thinking skills. Therefore, educators who want to help their students develop these abilities can work with this model. The results of DL learning's implementation have a favourable effect on the motivation of students in experimental class II (VII B). Four students have a strong desire to learn, seventeen have a moderate drive, and four have a low drive. This is true for all three groups.

There are five steps to implementing Direct Instruction in the classroom: establishing goals, delivering the information, practicing with a teacher or peer, assessing for comprehension, and finally, working independently. The direct instruction learning model's stages are structured according to the first stage, which is the orienting phase or communicating learning goals. Following this comes the part where the subject is provided through presentations, demonstrations, and guided practice. The last step is to give students opportunities to practice what they've learned on their own and to review what they've learned. Because in the direct instruction learning approach, instructors provide students with course materials as they pay close attention to each step of the process. Aini et al. (2024) defines direct instruction learning as a teaching method in which students acquire new information and abilities through teacher-led demonstrations and explanations supplemented by student practice and feedback. A wide variety of instructional strategies, including but not limited to lectures, demonstrations, Q&A sessions, and more, can be employed in the context of direction instruction (Sekar, 2020).

After implementing the Direct Instruction methodology, students' critical mathematical thinking skills were tested again using a posttest to gauge the level of change. In the Direct Instruction group, students demonstrated limited improvement in critical thinking skills. While most students listened attentively during the teacher-led presentations, few engaged in active questioning or deeper exploration of the material. This was especially evident among students with low motivation, who remained passive throughout the lessons. Although DI helped maintain classroom order and delivered content clearly, it lacked the interactive and problem-solving elements needed to develop higher-order thinking, especially for disengaged learners.

Statistical analysis using two-way ANOVA revealed a significant interaction between the learning models (PBL, DL, and DI) and students' levels of learning motivation ($p = 0.022$). This finding indicates that the effectiveness of each instructional model varies depending on the students' motivational backgrounds. Notably, PBL yielded the highest gains for students with low motivation, while DL worked better for those with moderate to high motivation. DI showed limited effectiveness across all motivation levels, particularly for low-motivation learners. These results emphasize the importance of aligning teaching models with students' motivational profiles to maximize learning outcomes.

The interaction of PBL, DL, and DI with high, medium, and low mathematics learning motivation impacts students' critical mathematical thinking skills, as shown by data analysis with hypothesis testing. Students acquire hands-on experience with several learning paradigms, such as DL and PBL, through research. The students are involved in their own education, which is seen in their high levels of engagement and enthusiasm for learning. This is due to the fact that students are motivated to think critically as a result of the curriculum's emphasis on problem-solving methodologies and real-world problem-solving experience.

Using the PBL and DL models, students in Class VII A and B at MTS Darul Arifin Jambi improved their critical thinking skills and increased their motivation to learn. The reason problem based learning is more effective than discovery learning is that it places an emphasis on group debate and engagement as a means to solve problems. In addition, the discovery learning paradigm encourages students to take an active part in solving challenges through investigations.

In addition, according to Maslahah et al. (2021), students can be more actively involved in the learning process with the PBL model, which involves posing questions based on real-world problems, and Discovery Learning, on the other hand, encourages students to actively seek out and discover new information by drawing on all of their prior knowledge and skills.

Furthermore, regarding student learning motivation with PBL, DL and DI learning models, it shows that student learning motivation to follow learning varies because each student has different characteristics, so students are happy with the learning model they like. Student learning motivation is a condition that exists in an individual where there is a drive to do something to achieve a goal. Therefore, to achieve a goal, one needs a drive that can induce specific behaviours. The reasons behind someone's behaviours and behaviours strongly influence their ability to achieve their goals.

According to Hamzah B. Uno (Rahman, 2021), there are two types of motivation for learning: intrinsic and extrinsic. Students' intrinsic and extrinsic motivation to learn are affected by the implementation of PBL, DL, and DI learning in this context. This is because students are expected to actively participate in learning through the creation of problems through student worksheets.
The results of the interaction test showed that the mathematical critical thinking abilities of students were affected by a combination of learning motivation and the PBL, DL, and DI learning models. This suggests that students' mathematical critical thinking skills are impacted by a combination of the PBL, DL, and DI learning models with different levels of learning motivation.

4. Conclusion

Improving students' critical thinking skills in mathematics through the use of the PBL paradigm had a favourable impact on experimental class I (VII A) students across all levels of learning motivation—high, medium, and low. Similarly, students in experimental class II (VII B) showed enhanced motivation and mathematical critical thinking skills following the implementation of the DL model. The DI model used in the control class (VII C) had some positive effects, particularly on students with moderate motivation, although gains in critical thinking were limited. An analysis of variance (ANOVA) confirmed a significant interaction between the three learning models (PBL, DL, and DI) and students' levels of learning motivation, indicating that the effectiveness of a teaching approach is influenced by students' intrinsic or extrinsic drive to learn.

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