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Discovery Learning and Problem-Based Learning (PBL) Models for Learning Motivation and Critical Thinking Skills of Grade VII Students at SMPN 8 Lebong

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Abstract: *This study aimed to examine the differences in the effects of Discovery Learning, Problem Based Learning (PBL), and conventional learning models on students' learning motivation and critical thinking skills in seventh-grade mathematics classes at SMP Negeri 8 Lebong. This study employed a quantitative approach using a quasi-experimental method with a Pretest-Posttest Control Group Design. The population consisted of all seventh-grade students of SMP Negeri 8 Lebong in the 2025/2026 academic year, totaling 153 students. The sample comprised 95 students selected through cluster random sampling, consisting of an experimental class taught using the Discovery Learning model, an experimental class taught using the Problem Based Learning model, and a control class taught using conventional learning. Data were collected through a learning motivation questionnaire and a critical thinking skills test and were analyzed using One-Way ANOVA. The results revealed significant differences in students' learning motivation and critical thinking skills among those taught using Discovery Learning, Problem Based Learning, and conventional learning models. Both Discovery Learning and Problem Based Learning were found to be more effective than conventional learning in improving students' learning motivation and critical thinking skills. Therefore, these learning models can serve as effective alternatives for enhancing the quality of mathematics instruction at the junior high school level.*

Keywords: *Discovery Learning; Problem Based Learning; learning motivation; critical thinking skills; mathematics learning.*

Introduction

The rapid development of the twenty-first century has pushed governments worldwide to strengthen the quality of human resources, with critical thinking recognized as one of the most essential competencies to be cultivated (Junaedi et al., 2021). Ennis (1991) argued that critical thinking is not merely about deciding what to believe or do, but also involves creative tasks such as formulating hypotheses. Building on this, Alvira (2022) explained that critical thinking connects active reasoning steps and various skills to construct concepts, conduct analysis, apply ideas, explore alternatives, and monitor problems through personal experience or direct observation. These perspectives place critical thinking at the core of twenty-first-century educational goals, particularly within disciplines that demand logical and analytical reasoning, such as mathematics.

Critical thinking is widely regarded as an indispensable skill that students must acquire in order to solve problems effectively. Dewi (2025) emphasized that children need to learn how to think critically because doing so equips them with the capacity to resolve problems independently. Similarly, Fitriyah et al. (2021) noted that critical thinking skills allow students to become accustomed to evaluating information and making sound decisions, which in turn helps them navigate everyday challenges. Embedding this skill within school curricula is therefore expected to make students more flexible, adaptive, and creative when facing increasingly complex problems, including those involving mathematical reasoning.

Alongside critical thinking, learning motivation constitutes another internal factor that plays a decisive role in determining students' success during the learning process. Motivated students tend to participate more actively and strive harder to achieve optimal learning outcomes. Uno (2021) described learning motivation as the driving force that keeps students engaged, provides them with direction, and sustains their learning activities over time. In line with this view, the OECD (2021) reported that low learning motivation is directly associated with reduced student participation and poorer learning outcomes, particularly in subjects that require higher-order thinking skills such as mathematics.

Within this context, the role of teachers becomes central to optimizing mathematics instruction. Teachers and students must work collaboratively to develop logical reasoning and problem-solving mindsets, which can only be achieved through carefully designed learning models and methods. As a discipline used in daily life, mathematics supports the attainment of national education goals and contributes to shaping a generation that is productive, creative, and innovative. Consequently, mathematics instruction should extend beyond the mere transfer of knowledge; it must also foster critical mathematical thinking as a foundation for addressing real-life challenges.

Despite this ideal, classroom conditions often fall short of expectations. Preliminary observations and information gathered from seventh-grade teachers at SMPN 8 Lebong indicate that teaching and learning activities remain largely teacher-centered, dominated by lectures and routine practice tasks. As a result, students rarely have the opportunity to actively explore ideas or solve problems that require independent reasoning. This condition is reflected in students' passive classroom behavior; minimal questioning, limited participation in discussions, and a tendency to wait for teachers or peers to provide answers, all of which restrict the development of their critical thinking abilities, especially when dealing with analytical or context-based problems such as linear equations in one variable.

This gap between the intended learning outcomes and actual classroom practice is further substantiated by international assessment data. The 2018 Programme for International Student Assessment (PISA) recorded Indonesian students' average mathematics score at 366, considerably lower than the OECD average of 472, placing Indonesia at the 70th position out of 81 participating countries. This finding suggests that Indonesian students generally lack well-developed higher-order thinking skills, including critical thinking in mathematics. Locally, this pattern is mirrored in the results of the 2024–2025 mid-semester and end-semester mathematics examinations at SMPN 8 Lebong, where the average scores of 153 seventh-grade students across five classes remained below the minimum learning achievement criterion (KKTP) of 70.00.

While prior studies have explored various instructional approaches to enhance motivation and critical thinking, research specifically examining the comparative and combined effectiveness of Discovery Learning and Problem-Based Learning (PBL) on both learning motivation and critical thinking—particularly within the context of linear equations in one variable at the junior secondary level—remains limited. Nurrohmi (2017) found that Discovery Learning improves critical thinking through activities such as pattern recognition, trial and error, generalization, and hypothesis verification (Firdayati, 2020), while Husniah (2024) noted that the problem-statement stage encourages students to formulate problems independently and propose alternative solutions. Meanwhile, Siahaan et al. (2025) described PBL as a model that immerses students in ambiguous, real-world problems without a single correct answer, compelling them to determine what they need to learn to resolve the issue. This is further supported by Asri et al. (2024) and Asmara et al. (2024), who found that PBL fosters active participation throughout the learning process, and by Sutanto et al. (2018), who highlighted those problem orientation, investigation, and solution-presentation stages of PBL that specifically cultivate students' analytical and creative thinking. Despite this evidence, both models have not been optimally implemented at SMPN 8 Lebong, leaving a gap between their documented potential and their actual application in the local classroom context.

Building on this identified gap, the present study aims to examine the differences in learning motivation and critical thinking ability among students taught using Discovery Learning, Problem-Based Learning, and conventional instruction, and to determine which model proves more effective in enhancing both outcomes among seventh-grade students at SMPN 8 Lebong. This study is expected to contribute theoretically by enriching the body of knowledge on innovative learning models for teaching linear equations in one variable, and practically by offering mathematics teachers empirical guidance for selecting instructional strategies that foster both motivation and higher-order thinking skills, thereby helping to narrow the academic achievement gap evident in current classroom outcomes.

Method

This study employed a quantitative approach using a quasi-experimental method with a pretest–posttest design involving three groups: two experimental classes and one control class. Experimental Class 1 was taught using the Discovery Learning model, Experimental Class 2 was taught using the Problem-Based Learning (PBL) model, and the control class received conventional instruction, following the design adapted from Isnawan et al. (2020). The study was conducted at SMPN 8 Lebong from April to May 2026. The population comprised 153 seventh-grade students across five classes (VII.A–VII.E) in the 2025–2026 academic year.

Using cluster random sampling, three classes were randomly selected from the population, yielding a total sample of 95 students: Class VII.A (32 students) as Experimental Class 1 receiving Discovery Learning, Class VII.D (32 students) as Experimental Class 2 receiving PBL, and Class VII.E (31 students) as the control class receiving conventional instruction. Random selection was carried out through a lottery procedure to eliminate subjective bias in assigning classes and to ensure that every class had an equal chance of being selected. Prior consultation with the mathematics teachers confirmed the absence of "high-achieving" tracked classes at the seventh-grade level, meaning students across all classes began with a similarly distributed range of abilities. This baseline comparability supports the validity of subsequent between-group comparisons and indicates that the selected sample adequately represents the broader population of seventh-grade students.

Two types of instruments were used to collect data. Learning motivation was measured using a 20-item closed questionnaire adapted from Suhirman (2018), rated on a four-point Likert scale (1 = strongly disagree to 4 = strongly agree) and covering six indicators, including the desire for success, learning drive, future aspirations, appreciation of the learning process, engaging learning activities, and a supportive learning environment. Critical thinking ability was measured using an essay-based test consisting of five items constructed according to a test blueprint aligned with Ennis's (2011) five critical thinking indicators—elementary clarification, basic support, inference, advanced clarification, and strategies and tactics—scored on a 0–4 rubric reflecting the completeness and logical coherence of student responses. Both instruments were administered as pretest and posttest to all three classes, following a three-stage procedure: (1) a preparation stage involving the development of lesson plans, research instruments, and expert validation, along with coordination with the classroom teacher; (2) an implementation stage in which all classes completed identical pretests before receiving their respective treatments, followed by identical posttests; and (3) a final stage involving data compilation and analysis. Data were analyzed using one-way ANOVA in SPSS version 26, preceded by normality (One-Sample Kolmogorov–Smirnov) and homogeneity (Levene's) tests at a 5% significance level, with the Least Significant Difference (LSD) post hoc test applied to identify which group means differed significantly when the ANOVA results were significant.

Results and Discussion

Results

1. Learning Motivation

a) Learning Motivation before Treatment

Prior to treatment, a learning motivation questionnaire was administered to all three groups; the Discovery Learning (DL) class, the Problem-Based Learning (PBL) class, and the conventional (control) class, to obtain baseline data on students' motivation to learn.

Table 1. Distribution of Students' Learning Motivation Questionnaire Results Before Treatment

Class	N	Mean	Std. Deviation	Std. Error	95% CI Lower	95% CI Upper	Min	Max
DL	32	51.97	4.261	.753	50.43	53.51	42	62
PBL	32	52.13	4.682	.828	50.44	53.81	41	63
Control	31	51.65	4.409	.792	50.03	53.26	40	60
Total	95	51.92	4.411	.453	51.02	52.81	40	63

Before treatment, a learning motivation questionnaire was administered to all three groups—the Discovery Learning (DL) class, the Problem-Based

Learning (PBL) class, and the conventional (control) class—to establish a baseline measure of students' motivation to learn. As shown in Table 1, the DL class (n = 32) recorded a mean motivation score of 51.97 (SD = 4.261, SE = 0.753, 95% CI = 50.43–53.51, range = 42–62), the PBL class (n = 32) recorded the highest baseline mean, 52.13 (SD = 4.682, SE = 0.828, 95% CI = 50.44–53.81, range = 41–63), and the control class (n = 31) recorded a mean of 51.65 (SD = 4.409, SE = 0.792, 95% CI = 50.03–53.26, range = 40–60). Although PBL was numerically highest, the differences among the three groups were small enough to fall within overlapping confidence intervals, indicating no meaningful pre-existing advantage. The overall mean across all 95 students was 51.92 (SD = 4.411, SE = 0.453, 95% CI = 51.02–52.81, range = 40–63), confirming that the three groups began from a statistically comparable level of learning motivation—an important precondition that strengthens the validity of later comparisons, since any differences observed after treatment can be attributed with greater confidence to the instructional model applied rather than to pre-existing disparities among the groups.

Table 2. Normality Test of the Learning Motivation Questionnaire Before Treatment (One-Sample Kolmogorov-Smirnov Test)

Class	N	Mean	Std. Deviation	Absolute	Positive	Negative	K-S Z	Asymp. Sig. (2-tailed)
DL	32	51.97	4.261	.098	.098	-.087	.555	.918
PBL	32	52.13	4.682	.155	.145	-.155	.877	.425
Control	31	51.65	4.409	.129	.113	-.129	.717	.683

A One-Sample Kolmogorov-Smirnov test was conducted to examine whether the pretest learning motivation data for the DL, PBL, and control classes were normally distributed, using a significance threshold of 0.05 as the decision criterion. As shown in Table 2, the DL class produced a Kolmogorov-Smirnov Z value of 0.555 with an Asymp. Sig. (2-tailed) of 0.918, the PBL class produced a Z value of 0.877 with a significance of 0.425, and the control class produced a Z value of 0.717 with a significance of 0.683. Since all three significance values (0.918, 0.425, and 0.683) exceeded the 0.05 threshold, the null hypothesis of normality was retained for each group, confirming that the pretest motivation data for the DL, PBL, and control classes were normally distributed. This result satisfies the normality assumption required for subsequent parametric analyses, including the homogeneity of variance test and the one-way ANOVA used to compare group means.

Table 3. Homogeneity of Variance Test of the Learning Motivation Questionnaire Before Treatment

Variable	Levene Statistic	df1	df2	Sig.
Motivation (Based on Mean)	.011	2	92	.989

A Levene's test of homogeneity of variance was conducted to determine whether the pretest learning motivation data across the DL, PBL, and control classes exhibited equal variances, a prerequisite assumption for conducting a valid one-way ANOVA. As shown in Table 3, the test yielded a Levene Statistic of 0.011 with degrees of freedom df1 = 2 and df2 = 92, producing a significance value of 0.989. Since this value far exceeds the 0.05 threshold, the null hypothesis of equal variances was retained, indicating that the variance in learning motivation scores was statistically homogeneous across the three groups prior to treatment. This result confirms that the assumption of variance homogeneity was satisfied, allowing the subsequent one-way ANOVA to proceed without violating its underlying statistical requirements.

Table 4. One-Way ANOVA of Students' Learning Motivation Before Treatment

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.761	2	1.880	.095	.910
Within Groups	1825.566	92	19.843		
Total	1829.326	94			

A one-way ANOVA was conducted to determine whether a statistically significant difference existed in learning motivation among the DL, PBL, and control classes prior to treatment, following confirmation that the data met the assumptions of normality and homogeneity of variance. As shown in Table 4, the between-groups sum of squares was 3.761 with 2 degrees of freedom, yielding a mean square of 1.880, compared to a within-groups sum of squares of 1825.566 across 92 degrees of freedom, producing a mean square of 19.843 and a total sum of squares of 1829.326 across 94 degrees of freedom. This produced an F value of 0.095 with a significance value of 0.910, which is well above the 0.05 threshold, leading to the retention of the null hypothesis of no difference among group means. This result indicates that there was no statistically significant difference in learning motivation among the DL, PBL, and control classes before treatment was administered, confirming that the three groups were statistically equivalent at baseline and providing a sound foundation for attributing any subsequent differences in motivation to the instructional treatments themselves rather than to pre-existing group disparities.

b) Learning Motivation before Treatment

Table 5. Distribution of Students' Learning Motivation Questionnaire Results After Treatment

Class	N	Mean	Std. Deviation	Std. Error	95% CI Lower	95% CI Upper	Min	Max
DL	32	58.97	3.605	.637	57.67	60.27	51	66
PBL	32	60.56	3.292	.582	59.38	61.75	52	66
Control	31	52.29	3.761	.676	50.91	53.67	44	61
Total	95	57.33	5.022	.515	56.30	58.35	44	66

Following treatment, learning motivation increased across all three groups, though to markedly different degrees. As shown in Table 5, the DL class (n = 32) recorded a posttest mean of 58.97 (SD = 3.605, SE = 0.637, 95% CI = 57.67–60.27, range = 51–66), rising from 51.97 at pretest and indicating that Discovery Learning enhanced students' interest in learning. The PBL class (n = 32) showed the largest increase, from 52.13 to 60.56 (SD = 3.292, SE = 0.582, 95% CI = 59.38–61.75, range = 52–66), the highest posttest mean among the three groups. In contrast, the control class (n = 31) showed only a marginal increase, from 51.65 to 52.29 (SD = 3.761, SE = 0.676, 95% CI = 50.91–53.67, range = 44–61), suggesting that conventional instruction was comparatively ineffective in enhancing learning motivation. Overall, the mean motivation score across all 95 students rose to 57.33 (SD = 5.022, SE = 0.515, 95% CI = 56.30–58.35, range = 44–66), with the clear separation between the experimental and control classes reinforcing the pattern that both Discovery Learning and Problem-Based Learning produced substantially greater motivational gains than conventional instruction.

Table 6. Normality Test of the Learning Motivation Questionnaire After Treatment

Class	N	Mean	Std. Deviation	Absolute	Positive	Negative	K-S Z	Asymp. Sig. (2-tailed)
DL	32	58.9688	3.60541	.113	.075	-.113	.638	.810
PBL	32	60.5625	3.29161	.106	.063	-.106	.602	.862
Control	31	52.2903	3.76115	.144	.144	-.110	.800	.544

A One-Sample Kolmogorov-Smirnov test was conducted to examine whether the posttest learning motivation data for the DL, PBL, and control classes were normally distributed, following the same 0.05 significance threshold used in the pretest analysis. As shown in Table 6, the DL class recorded a mean posttest score of 58.9688 (SD = 3.60541) with a Kolmogorov-Smirnov Z value of 0.638 and an Asymp. Sig. (2-tailed) of 0.810, the PBL class recorded a mean of 60.5625 (SD = 3.29161) with a Z value of 0.602 and a significance of 0.862, and the control class recorded a mean of 52.2903 (SD = 3.76115) with a Z value of 0.800 and a significance of 0.544. Since all three significance values (0.810, 0.862, and 0.544) exceeded the 0.05 threshold, the null hypothesis of normality was retained for each group, confirming that the posttest motivation data for the DL, PBL, and control classes were normally distributed. This result satisfies the normality assumption required for the subsequent homogeneity of variance test and one-way ANOVA used to compare posttest group means.

Table 7. Homogeneity of Variance Test of the Learning Motivation Questionnaire After Treatment

Variable	Levene Statistic	df1	df2	Sig.
Motivation (Based on Mean)	.030	2	92	.970

A Levene's test of homogeneity of variance was conducted to determine whether the posttest learning motivation data across the DL, PBL, and control classes exhibited equal variances, a prerequisite assumption for conducting a valid one-way ANOVA on the posttest scores. As shown in Table 7, the test yielded a Levene Statistic of 0.030 with degrees of freedom df1 = 2 and df2 = 92, producing a significance value of 0.970. Since this value far exceeds the 0.05 threshold, the null hypothesis of equal variances was retained, indicating that the variance in learning motivation scores remained statistically homogeneous across the three groups after treatment. This result confirms that the assumption of variance homogeneity was satisfied for the posttest data, allowing the subsequent one-way ANOVA to proceed without violating its underlying statistical requirements.

Table 8. One-Way ANOVA of Students' Learning Motivation After Treatment

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1207.653	2	603.827	47.757	.000
Within Groups	1163.231	92	12.644		
Total	2370.884	94			

A one-way ANOVA was conducted to determine whether a statistically significant difference existed in learning motivation among the DL, PBL, and control classes after treatment, following confirmation that the posttest data met the assumptions of normality and homogeneity of variance. As shown in Table 8, the between-groups sum of squares was 1207.653 with 2 degrees of freedom, yielding a mean square of 603.827, compared to a within-groups sum of squares of 1163.231 across 92 degrees of freedom, producing a mean square of 12.644 and a total sum of squares of 2370.884 across 94 degrees of freedom. This produced an F value of 47.757 with a significance value of 0.000, which is well below the 0.05 threshold, leading to the rejection of the null hypothesis of no difference among group means. This result indicates a highly significant difference in learning motivation among the DL, PBL, and control classes after treatment was administered, providing strong statistical evidence that the instructional models applied had a differential effect on students' motivation and warranting further post hoc analysis to identify precisely which group comparisons drove this overall difference.

Table 9. LSD Post Hoc Comparison of Students' Learning Motivation After Treatment

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% CI Lower	95% CI Upper
DL	PBL	-1.594	.889	.076	-3.36	.17
DL	Control	6.678*	.896	.000	4.90	8.46
PBL	DL	1.594	.889	.076	-.17	3.36
PBL	Control	8.272*	.896	.000	6.49	10.05
Control	DL	-6.678*	.896	.000	-8.46	-4.90
Control	PBL	-8.272*	.896	.000	-10.05	-6.49

** The mean difference is significant at the 0.05 level.*

Given the significant overall ANOVA result, a Least Significant Difference (LSD) post hoc test was conducted to identify precisely which pairs of groups differed significantly in learning motivation after treatment. As shown in Table 9, the comparison between the DL and PBL classes produced a mean difference of -1.594 (SE = 0.889, Sig. = 0.076, 95% CI = -3.36 to 0.17), which did not reach statistical significance, indicating that the two experimental models did not differ meaningfully in their effect on motivation. In contrast, the comparison between the DL and control classes produced a mean difference of 6.678 (SE = 0.896, Sig. = 0.000, 95% CI = 4.90–8.46), and the comparison between the PBL and control classes produced an even larger mean difference of 8.272 (SE = 0.896, Sig. = 0.000, 95% CI = 6.49–10.05), both marked as significant at the 0.05 level and both well below the significance threshold. Taken together, these results indicate that both Discovery Learning and Problem-Based Learning produced significantly higher learning motivation than conventional instruction, while performing statistically comparably to one another. This pattern suggests that Discovery Learning and Problem-Based Learning were similarly effective in enhancing students' motivation to learn, although PBL produced the largest overall mean gain, rising from 52.13 at pretest to 60.56 at posttest, making it the model with the strongest observed motivational impact among the three approaches.

2. Critical Thinking Ability

a) Critical Thinking Ability before Treatment

Table 10. Distribution of Students' Critical Thinking Pretest Results

Class	N	Mean	Std. Deviation	Std. Error	95% CI Lower	95% CI Upper	Min	Max
DL	32	2.5313	2.03175	.35917	1.7987	3.2638	.00	6.00
PBL	32	3.0968	2.34314	.42084	2.2373	3.9562	.00	8.00
Control	31	2.8125	2.24955	.39767	2.0015	3.6235	.00	9.00
Total	95	2.8135	2.19910	.22562	2.3625	3.2585	.00	9.00

Prior to treatment, a critical thinking test was administered to all three groups to establish a baseline measure of students' critical thinking ability. As shown in Table 10, the DL class (n = 32) recorded a pretest mean of 2.53 (SD = 2.03175, SE = 0.35917, 95% CI = 1.80–3.26, range = 0.00–6.00), the PBL class (n = 32) recorded the highest pretest mean, 3.10 (SD = 2.34314, SE = 0.42084, 95% CI = 2.24–3.96, range = 0.00–8.00), and the control class (n = 31) recorded a mean of 2.81 (SD = 2.24955, SE = 0.39767, 95% CI = 2.00–3.62, range = 0.00–9.00). The relatively small differences among the three means, together with their overlapping confidence intervals, indicate that students' initial critical thinking abilities were comparable across groups. Overall, the mean pretest score across all 95 students was 2.81 (SD = 2.19910, SE = 0.22562, 95% CI = 2.36–3.26, range = 0.00–9.00), confirming that the three groups began the study with a statistically similar, and generally low, level of critical thinking ability.

Table 11. Normality Test of Students' Critical Thinking Pretest Results

Class	N	Mean	Std. Deviation	Absolute	Positive	Negative	K-S Z	Asymp. Sig. (2-tailed)
DL	32	2.53	2.032	.181	.181	-.140	1.022	.247
PBL	32	3.10	2.343	.169	.169	-.166	.943	.336
Control	31	2.81	2.250	.204	.204	-.166	1.151	.141

A One-Sample Kolmogorov-Smirnov test was conducted to examine whether the pretest critical thinking data for the DL, PBL, and control classes were normally distributed, using the same 0.05 significance threshold applied in the motivation analyses. As shown in Table 11, the DL class recorded a mean pretest score of 2.53 (SD = 2.032) with a Kolmogorov-Smirnov Z value of 1.022 and an Asymp. Sig. (2-tailed) of 0.247, the PBL class recorded a mean of 3.10 (SD = 2.343) with a Z value of 0.943 and a significance of 0.336, and the control class recorded a mean of 2.81 (SD = 2.250) with a Z value of 1.151 and a significance of 0.141. Since all three significance values (0.247, 0.336, and 0.141) exceeded the 0.05 threshold, the null hypothesis of normality was retained for each group, confirming that the pretest critical thinking data for the DL, PBL, and control classes were normally distributed. This result satisfies the normality assumption required for the subsequent homogeneity of variance test and one-way ANOVA used to compare pretest critical thinking scores across groups.

Table 12. Homogeneity of Variance Test of Students' Critical Thinking Pretest Results

Variable	Levene Statistic	df1	df2	Sig.
Critical Thinking	.596	2	92	.553

A Levene's test of homogeneity of variance was conducted to determine whether the pretest critical thinking data across the DL, PBL, and control classes exhibited equal variances, a prerequisite assumption for conducting a valid one-way ANOVA on the pretest scores. As shown in Table 12, the test yielded a Levene Statistic of 0.596 with degrees of freedom df1 = 2 and df2 = 92, producing a significance value of 0.553. Since this value exceeds the 0.05 threshold, the null hypothesis of equal variances was retained, indicating that the variance in critical thinking scores was statistically homogeneous across the three groups prior to treatment. This result confirms that the assumption of variance homogeneity was satisfied for the pretest critical thinking data, allowing the subsequent one-way ANOVA to proceed without violating its underlying statistical requirements.

Table 13. One-Way ANOVA of Students' Critical Thinking Pretest Results

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.036	2	2.518	.515	.599
Within Groups	449.553	92	4.886		
Total	454.589	94			

A one-way ANOVA was conducted to determine whether a statistically significant difference existed in critical thinking ability among the DL, PBL, and control classes prior to treatment, following confirmation that the pretest data met the assumptions of normality and homogeneity of variance. As shown in Table 13, the between-groups sum of squares was 5.036 with 2 degrees of freedom, yielding a mean square of 2.518, compared to a within-groups sum of squares of 449.553 across 92 degrees of freedom, producing a mean square of 4.886 and a total sum of squares of 454.589 across 94 degrees of freedom. This produced an F value of 0.515 with a significance value of 0.599, which is well above the 0.05 threshold, leading to the retention of the null hypothesis of no difference among group means. This result indicates that there was no statistically significant difference in critical thinking ability among the DL, PBL, and control classes before treatment was administered, confirming that the three groups began with statistically equivalent critical thinking abilities and providing a sound foundation for attributing any subsequent differences to the instructional treatments themselves rather than to pre-existing group disparities.

b) Critical Thinking Ability After Treatment

Table 14. Distribution of Students' Critical Thinking Posttest Results

Class	N	Mean	Std. Deviation	Std. Error	95% CI Lower	95% CI Upper	Min	Max
DL	32	12.59	2.613	.462	11.65	13.54	7	18
PBL	32	13.16	2.864	.506	12.12	14.19	8	19
Control	31	4.22	2.305	.414	3.38	5.70	0	9
Total	95	10.00	4.830	.496	9.07	11.04	0	19

The DL class posttest mean rose from 2.53 to 12.59, demonstrating a marked improvement in critical thinking skills. The PBL class showed the largest gain, from 3.10 to 13.16, the highest posttest mean among the three groups, suggesting PBL was the most effective model for developing critical thinking. The control class improved only slightly, from 2.81 to 4.22, indicating that conventional instruction had limited impact on students' critical thinking development.

Table 15. Normality Test of Students' Critical Thinking Posttest Results

Class	N	Mean	Std. Deviation	Absolute	Positive	Negative	K-S Z	Asymp. Sig. (2-tailed)
DL	32	12.59	2.613	.129	.126	-.129	.729	.662
PBL	32	13.16	2.864	.147	.118	-.147	.832	.493
Control	31	4.22	2.305	.171	.113	-.171	.950	.327

A One-Sample Kolmogorov-Smirnov test was conducted to examine whether the posttest critical thinking data for the DL, PBL, and control classes were normally distributed, using the same 0.05 significance threshold applied throughout the analysis. As shown in Table 15, the DL class recorded a mean posttest score of 12.59 (SD = 2.613) with a Kolmogorov-

Smirnov Z value of 0.729 and an Asymp. Sig. (2-tailed) of 0.662, the PBL class recorded a mean of 13.16 (SD = 2.864) with a Z value of 0.832 and a significance of 0.493, and the control class recorded a mean of 4.22 (SD = 2.305) with a Z value of 0.950 and a significance of 0.327. Since all three significance values (0.662, 0.493, and 0.327) exceeded the 0.05 threshold, the null hypothesis of normality was retained for each group, confirming that the posttest critical thinking data for the DL, PBL, and control classes were normally distributed. This result satisfies the normality assumption required for the subsequent homogeneity of variance test and one-way ANOVA used to compare posttest critical thinking scores across groups.

Table 16. Homogeneity of Variance Test of Students' Critical Thinking Posttest Results

Variable	Levene Statistic	df1	df2	Sig.
Critical Thinking	.752	2	92	.474

A Levene's test of homogeneity of variance was conducted to determine whether the posttest critical thinking data across the DL, PBL, and control classes exhibited equal variances, a prerequisite assumption for conducting a valid one-way ANOVA on the posttest scores. As shown in Table 16, the test yielded a Levene Statistic of 0.752 with degrees of freedom df1 = 2 and df2 = 92, producing a significance value of 0.474. Since this value exceeds the 0.05 threshold, the null hypothesis of equal variances was retained, indicating that the variance in critical thinking scores remained statistically homogeneous across the three groups after treatment. This result confirms that the assumption of variance homogeneity was satisfied for the posttest critical thinking data, allowing the subsequent one-way ANOVA to proceed without violating its underlying statistical requirements.

Table 17. One-Way ANOVA of Students' Critical Thinking Posttest Results

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1567.380	2	783.690	115.293	.000
Within Groups	625.357	92	6.797		
Total	2192.737	94			

A one-way ANOVA was conducted to determine whether a statistically significant difference existed in critical thinking ability among the DL, PBL, and control classes after treatment, following confirmation that the posttest data met the assumptions of normality and homogeneity of variance. As shown in Table 17, the between-groups sum of squares was 1567.380 with 2 degrees of freedom, yielding a mean square of 783.690, compared to a within-groups sum of squares of 625.357 across 92 degrees of freedom, producing a mean square of 6.797 and a total sum of squares of 2192.737 across 94 degrees of freedom. This produced an F value of 115.293 with a significance value of 0.000, which is well below the 0.05 threshold, leading to the rejection of the null hypothesis of no difference among group means. This result reveals a highly significant difference in critical thinking ability among the DL, PBL, and control classes after treatment was administered, indicating substantial differences in critical thinking performance following the instructional interventions and providing strong statistical grounds for conducting further post hoc analysis to determine precisely which group comparisons accounted for this overall difference.

Table 18. LSD Post Hoc Comparison of Students' Critical Thinking Ability After Treatment

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% CI Lower	95% CI Upper
DL	PBL	-.563	.652	.390	-1.86	.73
DL	Control	8.368*	.657	.000	7.06	9.67
PBL	DL	.563	.652	.390	-.73	1.86
PBL	Control	8.930*	.657	.000	7.63	10.24
Control	DL	-8.368*	.657	.000	-9.67	-7.06
Control	PBL	-8.930*	.657	.000	-10.24	-7.63

** The mean difference is significant at the 0.05 level.*

Given the significant overall ANOVA result, a Least Significant Difference (LSD) post hoc test was conducted to identify precisely which pairs of groups differed significantly in critical thinking ability after treatment. As shown in Table 18, the comparison between the DL and PBL classes produced a mean difference of -0.563 (SE = 0.652, Sig. = 0.390, 95% CI = -1.86 to 0.73), which did not reach statistical significance, indicating that the two experimental models did not differ meaningfully in their effect on critical thinking. In contrast, the comparison between the DL and control classes produced a mean difference of 8.368 (SE = 0.657, Sig. = 0.000, 95% CI = 7.06–9.67), and the comparison between the PBL and control classes produced an even larger mean difference of 8.930 (SE = 0.657, Sig. = 0.000, 95% CI = 7.63–10.24), both marked as significant at the 0.05 level and both well below the significance threshold. Taken together, these results indicate that both Discovery Learning and Problem-Based Learning were significantly more effective than conventional instruction in improving students' critical thinking ability, while performing statistically comparably to one another. This pattern suggests that although the two experimental models produced similarly strong effects, PBL yielded the highest mean gain overall, rising from 3.10 at pretest to 13.16 at posttest, making it the model with the strongest observed impact on students' critical thinking ability among the three approaches.

Discussion

1. Learning Motivation

Before treatment, learning motivation among the Discovery Learning (DL), Problem-Based Learning (PBL), and control classes did not differ significantly, as confirmed by the ANOVA result (Sig. = 0.910 > 0.05). This baseline equivalence is important because it indicates that any differences observed after treatment can reasonably be attributed to the instructional model applied rather than pre-existing disparities among groups. After treatment, mean motivation scores rose to 60.56 in the PBL class, 58.97 in the DL class, and only 52.29 in the control class, with the ANOVA result (Sig. = 0.000 < 0.05) confirming a significant difference among groups. The LSD post hoc test further showed that both experimental classes differed significantly from the control class, while the difference between DL and PBL was not significant.

The stronger motivational gains in the PBL class can be explained by the nature of the model itself: students were confronted with problems they needed to discuss, investigate, and resolve, which required them to stay engaged and actively invested in reaching a solution. This finding is consistent with Zahara et al. (2025), who reported that PBL effectively enhances learning motivation through meaningful and contextual problem-solving activities, and with the meta-analytic findings of Wijnia et al. (2024), who found that PBL positively influences motivation by increasing students' engagement and sense of responsibility for their own learning. Similarly, in the DL class, students were not given information directly but had to construct it themselves through observation, data collection, processing, and conclusion-drawing—an active involvement that heightened their interest and attention, consistent with Bruner's constructivist view that knowledge becomes more meaningful when discovered by the learner. This is corroborated by Fiska et al. (2025), who found that Discovery Learning increases motivation by providing students with more active and valuable learning experiences.

By contrast, the control class remained teacher-centered, with instruction dominated by lecturing, board examples, and independently completed exercises, leaving little room for exploration or peer interaction—conditions that made learning comparatively monotonous. This pattern aligns with Santrock (2018), who argued that motivation develops when students are given opportunities for active involvement, autonomy, and a sense of meaning in their learning, whereas teacher-dominated instruction fosters passive reception and lowers cognitive and emotional engagement. Supporting evidence comes from Endang et al. (2022), who found markedly higher motivation among students taught with student-centered rather than teacher-centered approaches, and from Safitri et al. (2020), who reported that active learning methods generate greater motivation than passive ones. Taken together, these findings suggest that while both DL and PBL are effective in enhancing motivation, PBL produced the strongest overall effect, followed by DL, and then conventional instruction.

2. Critical Thinking Ability

Prior to treatment, students' critical thinking ability was statistically equivalent across the three classes, as shown by the ANOVA result (Sig. = 0.599 > 0.05). After treatment, however, the ANOVA result (Sig. = 0.000 < 0.05) revealed a substantial change, with the PBL class achieving the highest posttest mean (13.16), followed by the DL class (12.59), and the control class trailing far behind (4.22). The LSD post hoc test confirmed that both experimental classes significantly outperformed the control class, with PBL showing a slightly stronger effect than DL.

In the PBL class, students were required to gather relevant information, identify key facts, and determine evidence to support proposed solutions, while the problem-solving process itself demanded that they design solution steps, select appropriate strategies, evaluate alternatives, and reach a final decision—all of which directly exercise higher-order thinking. This is consistent with Yuliati (2018), who found that PBL strengthens critical thinking through problem observation, information gathering, weighing of solutions, and evidence-based decision-making, and with Kurniawan et al. (2022), who concluded that PBL consistently improves critical thinking because students must apply higher-order thinking skills while investigating and refining problems. In the DL class, the data-processing and verification stages required students to analyze information, connect facts, and draw evidence-based conclusions, directly training their capacity for logical inference, while the generalization stage required them to re-explain their findings and link them to the concepts studied, reinforcing deeper explanatory ability. This finding is supported by Fitriani et al. (2021), who found that Discovery Learning positively affects critical thinking by encouraging students to generate their own ideas, analyze information, and draw conclusions from what they have learned.

In the control class, where the teacher retained full control over the learning process, students spent more time attending to explanations than exploring, constructing, or discovering their own problem-solving approaches, limiting opportunities to develop critical thinking. This is in line with Nuryanti et al. (2018), who found that teacher-centered instruction discourages critical thinking because students merely receive information, and with Handayani and Hidayat (2021), who found that such instruction leads students to memorize ideas without genuinely understanding how they interconnect, ultimately weakening critical thinking ability. Overall, these findings indicate that PBL had the greatest impact on students' critical thinking ability, followed by Discovery Learning, and then conventional instruction.

3. Implementation of Discovery Learning, Problem-Based Learning, and Conventional Instruction

Each class was taught using its designated model (Discovery Learning, Problem-Based Learning, or conventional instruction) with identical content and instructional time to ensure a fair basis for comparison. In the Discovery Learning class, the stages of stimulation, problem identification, data collection, data processing, verification, and generalization were implemented sequentially. Students responded enthusiastically to the stimulus provided by the teacher, actively raised questions, divided tasks during data collection, and engaged in reasoned discussion during the processing and verification stages, with most groups able to present and defend their findings, although some still required teacher guidance to arrive at accurate conclusions.

In the Problem-Based Learning class, students progressed through problem identification, preparation for learning, guided individual and group investigation, development and presentation of results, and evaluation of the problem-solving process. From the outset, students showed strong interest when confronted with real-life problems, engaging actively in group discussion, proposing ideas, analyzing causes, comparing alternative solutions, and defending their positions with logical reasoning; during the presentation and evaluation phase, they were able to structure and communicate their findings while responding to other groups' work. These observations suggest that the PBL model provided the richest opportunities for students to exercise complex thinking, consistent with the quantitative finding that motivation and critical thinking gains were highest in this class.

In the conventional class, instruction followed the stages of introduction, material delivery, question-and-answer, assigned practice, and closing, with the teacher dominating classroom talk and most students passively listening, taking notes, and completing individual exercises based on modeled examples. Few students asked questions, and when confronted with tasks requiring deeper analysis or reasoning, many struggled to formulate justifications or draw independent conclusions. This pattern reflects a learning environment where student engagement remained limited, offering a plausible explanation for the comparatively modest gains in both motivation and critical thinking observed in this group relative to the two experimental classes.

Conclusion

Based on the research findings and discussion regarding the effect of the Discovery Learning and Problem-Based Learning models on the learning motivation and critical thinking ability of seventh-grade students at SMP Negeri 8 Lebong, three conclusions can be drawn. First, a significant difference was found in students' learning motivation across the Discovery Learning, Problem-Based Learning, and conventional classes, with students taught using either Discovery Learning or Problem-Based Learning showing markedly higher motivation than those taught conventionally. Second, a significant difference was likewise found in students' critical thinking ability across the three groups. Third, the Problem-Based Learning model proved more effective than both Discovery Learning and conventional instruction in enhancing learning motivation and critical thinking ability among seventh-grade students on the topic of linear equations in one variable.

These findings imply that the Problem-Based Learning model fosters a more active, student-centered learning process. By solving problems collaboratively, students become more confident in voicing their opinions, working with peers, and actively seeking information to reach solutions. Beginning instruction with a real-world problem also makes students more interested in participating and more motivated to pursue a solution, while the teacher's role shifts to that of a facilitator who guides students through the learning activity, making the classroom more active, engaging, and less monotonous. Beyond motivation, Problem-Based

Learning trains students to analyze problems, search for relevant information, evaluate alternative solutions, and draw conclusions from discussion, gradually building their capacity to think logically, systematically, and critically when facing a problem. Problem-Based Learning can therefore serve as a viable instructional alternative for teachers seeking to enhance both learning motivation and critical thinking ability, particularly in mathematics instruction on linear equations in one variable.

Based on the conclusions above, several recommendations are proposed. Students are strongly encouraged to actively participate in discussions, voice their opinions, and engage in problem-solving during Problem-Based Learning activities on linear equations in one variable, so that their learning motivation and critical thinking ability continue to develop. Teachers are advised to adopt the Problem-Based Learning model, given its proven effectiveness in raising both learning motivation and critical thinking ability on this topic, while school institutions are encouraged to fully support its implementation by providing adequate learning facilities and strengthening teachers' competence in delivering student-centered instruction. Finally, future researchers are recommended to extend this study to other topics, such as systems of linear equations in one variable, and to use a larger sample size to produce more comprehensive and in-depth findings.

References

Alvira, D. L. (2022). Pengembangan Perangkat Pembelajaran Berbasis Pendekatan Contextual Teaching and Learning untuk Meningkatkan Kemampuan Berpikir Kritis Matematis dan Resiliensi Siswa SMP Gajah Mada Medan [Tesis]. Program Studi Pendidikan Matematika.

Asmara, A., Ramadianti, W., & Jumri, R. (2024). Improving Students' Mathematical Skills Through Problem-Based Learning: a Literature Review Perspective. International Journal of Teaching and Learning (INJOTEL), 2(11), 3193–3207.

Asri, I. H., Jampel, I. N., Putu Arnyana, I. B., Suastra, I. W., & Nitiasih, P. K. (2024). Profile of Problem Based Learning (PBL) Model in Improving Students' Problem Solving and Critical Thinking Ability. KnE Social Sciences, 2024, 769–778. https://doi.org/10.18502/kss.v9i2.14898

Dewi, M. R., Kurniawati, S., & Nofriansyah. (2025). Peningkatan Kemampuan Berpikir Kritis Siswa Melalui Model Pembelajaran Problem Based Learning. Research and Development Journal Of Education, 11(2), 1019–1031. https://doi.org/10.30998/rdje.v11i2.23934

Ennis, R. (1991). Critical Thinking: A Streamlined Conception. Teaching Philosophy, 14, 1.

Ennis, R. (2011). Critical Thinking: Reflection and Perspective Part II. Inquiry: Critical Thinking Across the Disciplines, 26(2), 5–19.

Firdayati. (2020). Peningkatan Motivasi Belajar Siswa Melalui Discovery Learning Dengan Geogebra Pada Materi Transformasi. Aksioma, 9(3), 833–841. https://doi.org/10.24127/ajpm.v9i3.2899

Fiska, D. T. A., Andriani, D., Adrias, & Suciana, F. (2025). Penerapan Model Discovery Learning untuk Meningkatkan Motivasi dan Hasil Belajar Siswa Kelas 4 di Sekolah Dasar. Morfologi: Jurnal Ilmu Pendidikan, Bahasa, Sastra dan Budaya, 3(2), 266–275.

Fitriani, F., Asy'ari, M., & Zubaidah, S. (2021). Pengaruh Model Discovery Learning terhadap Kemampuan Berpikir Kritis Siswa. Jurnal Pendidikan Sains Indonesia, 9(1), 1–12.

Fitriyah, I. J., Affriyenni, Y., & Hamimi, E. (2021). Efektifitas Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Kemampuan Berpikir Kritis Mahasiswa. Biormatika: Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan, 7(2), 122–129. https://doi.org/10.35569/biormatika.v7i2.1017

Handayani, R., & Hidayat, T. (2021). Pengaruh Pembelajaran Berpusat pada Guru terhadap Kemampuan Berpikir Kritis Siswa. Jurnal Pendidikan Indonesia, 10(3), 423–432.

Husniah, Sulaeman, Y., & Nugraha, R. A. (2024). Penggunaan Metode Discovery Learning Untuk Meningkatkan Hasil Belajar Siswa Pada Mata Pelajaran IPA Dalam Materi Perubahan Wujud Benda Kelas 3 SDN Koranji 2 Pulosari Pandeglang Banten. Serumpun Mendidik: Jurnal Pendidikan Dan Penelitian, 01(2), 115–119.

Junaedi, Y., Wahyudin, & Juandi, D. (2021). Mathematical creative thinking ability of junior high school students' on polyhedron. Journal of Physics: Conference Series, 1806(1). https://doi.org/10.1088/1742-6596/1806/1/012069

Kurniawan, A., Suryadi, D., & Darhim. (2022). The Effectiveness of Problem-Based Learning in Improving Critical Thinking Skills: A Meta-Analysis Study. Jurnal Pendidikan IPA Indonesia, 11(3), 421–432.

Nurrohmi, Y., Utaya, S., & Utomo, D. H. (2017). Pengaruh Model Pembelajaran Discovery Learning Terhadap Kemampuan. 1985, 1308–1314.

Nuryanti, L., Zubaidah, S., & Diantoro, M. (2018). Analisis Kemampuan Berpikir Kritis Siswa SMP. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 3(2), 155–158.

Safitri, U. N., Khoiri, N., & Hariz, A. R. (2020). Komparasi Motivasi Belajar Siswa Materi Perubahan Lingkungan dan Daur Ulang Limbah Melalui Metode Everyone Is Teacher Here dan Guided Note Taking. Bioeduca: Journal of Biology Education, 2(1), 9–15.

Santrock, J. W. (2018). Educational Psychology (6th ed.). McGraw-Hill Education.

Siahaan, B. M. G., Tamba, E. M., Simbolon, M. E., Enjelika, T. N., & Simangunsong, I. (2025). The Impact of the Problem-Based Learning Model with an Open-Ended Approach on the Creative Thinking Skills of 10th Grade Students in Quadratic Function Education. AR RUMMAN - Journal of Education and Learning Evaluation, 2(1), 3047–1141.

Suhirman, Z. (2018). Pengaruh Model Pembelajaran IPA Berbasis Masalah (Problem Based Learning) Terhadap Kemampuan Berpikir Kritis Dan Motivasi Belajar Kelas 5 MIN 2 Lombok Tengah NTB. 34th European Photovoltaic Solar Energy Conference and Exhibition.

Sutanto, W., Marjono, & Ramli, M. (2018). Penggunaan Problem Based Learning untuk Meningkatkan Kemampuan Berpikir Kreatif dalam Pembelajaran Biologi Peserta Didik Kelas VII F di Salah Satu SMP Negeri di Surakarta. Bioedukasi, 11, 61–65.

Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M. J. P., & Loyens, S. M. M. (2024). The Effects of Problem-Based, Project-Based, and Case-Based Learning on Students' Motivation: A Meta-Analysis. Educational Psychology Review, 36(1), 29.

Yuliati, Y. (2018). Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. Jurnal Cakrawala Pendas, 4(2), 61–69.

Zahara, R., Rozzaqyah, F., & Qonita, F. (2025). Meningkatkan Motivasi Belajar Siswa Melalui Layanan Bimbingan Klasikal dengan Pendekatan Problem Based Learning di SMP Negeri 57 Palembang. Guidance: Jurnal Bimbingan dan Konseling, 22(2), 421–428.