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The Influence of Students' Perceptions of Learning Models and Self-Efficacy on Critical Thinking Skills in Science

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Abstract

Twenty-first-century educational demands emphasize the importance of critical thinking skills. Deficiencies in students' scientific critical thinking, often stemming from traditional teaching methods and poor self-belief, demand the adoption of progressive educational frameworks like Problem-Based Learning. This research was designed to investigate three key relationships among public middle school students in South Tangerang City: (1) the combined influence of model perception and self-efficacy on science based critical thinking, (2) the individual impact of model perception, and (3) the individual impact of self-efficacy. Using a survey design, the study sampled a population of 874 students across Public Junior High School 11 and Public Junior High School 7. The finding indicated that: (1) the combined effect of both variables was statistically significant (Sig. = 0.000 < 0.05; F = 32.686), accounting 42.9% of the variability in critical thinking scores, with other variables explaining the remaining 57.1%; (2) a significant effect on science critical thinking capacities was exerted by perceptions of learning models (Sig. = 0.000 < 0.05; t = 5.843); and (3) self-efficacy also had a significant effect on science critical thinking skills (Sig. = 0.000 < 0.05; t = 5.783). Therefore, perceptions of learning models and self-efficacy are important factors in improving students' science critical thinking skills.

Keywords: perception, learning model, self-efficacy, science critical thinking skills, survey

1. Introduction

The rapid advancement of science and technology in the twenty-first century has created a demand for educational transformation that extends beyond concept acquisition and emphasizes the development of competencies required in the twenty-first century, commonly referred to as the 4C skills, including critical thinking, creativity, collaboration, and communication (Ministry of Education and Culture Regulation No. 19 of 2025, 2025). According to (Arsanti et al., 2021), these competencies may be enhanced through the implementation of various learning models applied both within and beyond classroom settings. Within science education, critical thinking skills play a crucial role because they are associated with students' capacity to interpret information, assess arguments, and make decisions using logical reasoning supported by valid evidence (Dilonia et al., 2025). Consequently, science learning should be structured using innovative, contextual, and student-centered pedagogy to efficiently cultivate advanced critical thinking skills.

Science learning fundamentally emphasizes not only the acquisition of factual knowledge but also scientific processes such as observing, formulating problems, proposing hypotheses, conducting experiments, analyzing data, and drawing conclusions (A. J. Putri et al., 2023). These processes are closely associated with critical thinking because the curriculum obliges students to scrutinize the correctness of information and construct rational arguments. Siregar and Rambe (2024) explained that critical thinking skills allow students not only to receive information passively but also to examine, compare, evaluate, and synthesize knowledge obtained from different sources when addressing scientific problems. Nevertheless, findings from the 2022 Programme for International Student Assessment (PISA) showed that Indonesian students' achievement in literacy, numeracy, and scientific literacy was still below the average level reported by the OECD, indicating that higher-order thinking skills among Indonesian students remain relatively low (OECD, 2023).

The weak performance of students regarding critical thinking competencies is dictated by learning practices that remain focused on memorization and basic understanding. Hasiana and Pitasari (2025) stated that learning assessments in schools still predominantly measure knowledge acquisition, providing limited opportunities for students to practice analyzing, evaluating, and creating new solutions. Dilonia et al. (2025) similarly stated that the relatively low level of critical thinking skills in science learning may also be associated with the limited variety of instructional strategies implemented by teachers. Findings reported by Anjani et al. (2025) showed that classroom learning continues to rely predominantly on lecture-based approaches, where teachers function as the main source of information and students generally assume passive roles during the learning process. Comparable situations were also observed at Public Junior High School 11 and Public Junior High School 7 in South Tangerang City through classroom observations and interviews. The findings indicated that students frequently memorize formulas without gaining a comprehensive understanding of the underlying concepts, participate less actively in questioning activities, and have not yet sufficiently developed the ability to engage in scientific argumentation discussions.

Another compounding factor is the weak level of students' scientific critical thinking capacities, which affects to poor learning outcomes, as reflected by an average score of 65.83, which remains below the minimum mastery criterion. Mareti et al. (2021) stated that science critical thinking skills significantly influence students' academic achievement. One factor presumed to affect this condition is students' perceptions of the learning model implemented by teachers. Problem-Based Learning (PBL) is regarded as an appropriate instructional approach because it uses contextual issues as the foundation of the learning process, allowing students to develop critical thinking skills through activities such as identifying problems, collecting information, conducting investigations, and formulating conclusions based on available evidence (Fajarwati, 2020). Handayani and Anam (2024) further emphasized that

PBL habituates students to solving real-life problems, enabling them to construct knowledge while simultaneously developing thinking skills.

Numerous studies have demonstrated the positive impact of PBL on science critical thinking skills. Putri et al. (2025) reported that PBL significantly improves both learning outcomes and critical thinking skills by providing students with opportunities to explore solutions and collaborate in groups. Rizkiwati et al. (2024) found that reflective pedagogy-based PBL positively affects the improvement of science critical thinking skills, while Lee (2025) demonstrated that students who learned through PBL exhibited greater improvements in critical thinking and problem-solving skills than those taught through lecture-based methods. Furthermore, Masrinah et al. (2019) and Lu et al. (2025) explained that PBL fosters curiosity, independent thinking, and collaboration in solving real-world problems. Repanovici & Koukourakis (2020) even asserted that PBL can enhance students' self-efficacy, positive attitudes toward learning, and knowledge retention.

Besides students' perceptions of learning models, self-efficacy represents an important internal factor that contributes to cultivating scientific critical thinking skills. Bandura, as cited in (Geovani and Waluya (2025) defined self-efficacy as the degree of confidence individuals possess in structuring and executing the operations vital to reaching defined targets. Stronger self-efficacy within the domain of science education frequently translates into increased student confidence, particularly when it comes to sharing ideas, analyzing core problems, and independently driving problem-solving processes. Ipa and Nggaba (2025) argued that fostering scientific critical thinking cannot be done in isolation; it must be coupled with boosting students' self-belief to cultivate the resilience and independence needed to navigate complex tasks. Research conducted by Nugraheni and Pramugita (2025) further proved that students' self-belief strongly dictates how effectively they apply critical thinking within science classrooms.

Existing studies have predominantly examined self efficacy or instructional models independently. Few studies have simultaneously investigated students' perceptions of learning models and self efficacy as predictors of science critical thinking, particularly in Indonesian lower secondary education.

Despite the considerable number of studies that have explored the degree of confidence individuals possess in structuring and executing the operations vital to reaching defined targets, investigations examining the combined effect of these two variables from students' perspectives in junior high school science education are still relatively limited, especially in public school settings in South Tangerang City.

Although prior studies have established links between self efficacy, learning perceptions, and critical thinking, much of this research has focused on university level students or non-science domains such as language learning. Studies examining the joint contribution of learning model perception and self efficacy on critical thinking among junior high school students in science education, particularly within the Indonesia public context, remain limited. Moreover, few studies have examined whether these two variables contribute independently or share overlapping explanatory power. This study addresses this gap by examining both variables simultaneously among junior high school science students, revealing that despite their individually substantial associations with critical thinking (58.48% and 60.41%, respectively), their combined contribution (42.9%) is lower than a simple additive model would predict, suggesting a shared underlying mechanism rather than two independent pathways of influence.

Driven by these considerations, this study sets out to address the identified literature gap by investigating how learners' views on educational frameworks and their own self-efficacy shape critical thinking skills within science education. By establishing these connections, we anticipate that the findings will offer useful data to help teachers design classroom activities that successfully nurture the core analytical mindsets needed in today's world.

2. Methods

The collection and evaluation of empirical data were conducted using a correlational survey design situated within a quantitative research scope in combination with multiple linear regression analysis. A quantitative method was chosen because it allows relationships among variables to be measured objectively through statistical analysis of numerical data. In addition, to evaluate the target population's scientific critical thinking skills, self-efficacy, and perceptions of instructional models, a survey approach was executed for data collection purposes.

The research population was drawn from Public Junior High School 7 and Public Junior High School 11 in South Tangerang City, comprising 462 and 412 students respectively, encompassing 874 students in total. The sample size was determined using Slovin's formula, $n = N/(1+Ne^2)$, with a 10% margin of error, since the exact population parameters (variance) were unknown and Skovin's formula is commonly applied in survey based educational research under these conditions (Slovin, 1960, as cited in Arman et al. (2024). Applying this formula, $n = 874/(1+874x0.1^2) \approx 89.73$, rounded to 90 respondents. This sample was distributed proportionally between the two schools based on their respective population sizes $(462/874) \times 90 \approx 48$ students from Public Junior High School 7, and $(412/874) \times 90 \approx 42$ students from Public Junior High School 11. This formula continues to be used in recent studies involving junior high school populations in Indonesia (Khoirunisa et al., 2025). The sample was selected through proportional stratified random sampling to ensure that the sampling process was conducted proportionally and representatively according to the number of population members within each subgroup. According to Mbuik (2019), proportional stratified random sampling is a sampling technique in which respondents are randomly selected from an accessible population that is heterogeneous and proportionally stratified.

Three research instruments were employed in this study. First, students' science critical thinking skills were assessed through an essay-based test developed according to Facione's critical thinking dimensions, which include interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2015, as cited in Anggraini and Trimulyono (2025). Second, students' perceptions of learning models were measured using a questionnaire consisting of four indicators adapted: instructional clarity, student engagement, relevance of learning materials, and ease of understanding. These indicators were adapted from recent studies on students' perceptions of teaching and instructional quality (Chen, 2023; Lewohl, 2023; Ahmadi and Saleh, 2026). Third, self-efficacy was measured using a questionnaire developed according to Bandura's dimensions of self-efficacy, including level, generality, and strength (Bandura, as cited in Nurbaiti and Putri, 2024).

Before the data collection process was conducted, all research instruments were subjected to validity and reliability testing procedures. The validity of the instruments was determined through expert judgment and empirical evaluation, whereas reliability was measured using the Cronbach's Alpha coefficient. The findings demonstrated that all instruments satisfied the required standards for validity and reliability and were therefore confirming its absolute eligibility and appropriateness for application in the current research.

To evaluate the research data, the Statistical Package for the Social Sciences (SPSS) version 26 was leveraged. The chosen statistical roadmap involved descriptive statistical analysis, prerequisite testing including normality, linearity, and heteroscedasticity tests, followed by multiple linear regression analysis to examine the impact of self-efficacy and instructional model perceptions regarding students' scientific critical thinking skills.

Methodologically, a quantitative framework was adopted, merging a correlational survey path with multiple linear regression modeling. This objective framework was deemed appropriate since calculating numerical datasets allows for an unbiased verification of how the research variables interact. Sugiyono, as cited in Abdullah et al. (2021) explained that grounded in positivist philosophy, a quantitative approach aims to examine specific groups or representative cohorts by utilizing randomized sampling methodologies, the use of research instruments for data collection, and quantitative or statistical analyses for testing previously formulated hypotheses.

Sembiring et al. (2023) stated that the survey method is a procedure used to gather information from respondents through questionnaires, interviews, or observations in order to obtain an overall description of a particular phenomenon. This approach was selected due to its efficiency, enabling the collection of data from an expansive participant pool despite a constrained timeframe and provides a broader understanding of the variables under investigation (Aldi et al., 2025). To determine how much each independent variable influences the dependent variable, we implemented multiple linear regression testing. This particular technique fit the research objective perfectly, which centered on evaluating statistically significant and quantifiable interactions between the variables.

3. Result and Discussion

3.1 The Influence of Students' Perceptions of Learning Models and Self-Efficacy on Science Critical Thinking Skills

Descriptive statistics of students' science critical thinking skills were obtained from a post-learning essay test administered to 90 respondents. The results indicated a mean score of 71.41, a standard deviation of 15.251, a median of 71.00, and a mode of 60. The maximum and minimum scores were 105 and 35, respectively. The instrument comprised 12 essay questions, each with a maximum score of 10 points.

Table 1.
Distribution of Science Critical Thinking Skills Data

Statistics		
Science Critical Thinking Skills		
N	Valid	90
	Missing	0
Mean		71.41
Median		71.00
Mode		60
Std. Deviation		15.251
Minimum		35
Maximum		105

Individually, students’ perceptions of the learning model were associated with critical thinking skills at 58.48%, while self-efficacy showed a slightly stronger individual association at 60.41%. When examined together, however, the two variables jointly explained only 42.9% of the variance in critical thinking skills. This pattern suggests that perceptions of the learning model and self-efficacy are not fully independent predictors, rather, they likely share overlapping variance, meaning part of what perception captures is also captured by self-efficacy, and vice versa. Practically, this indicates that students who perceive the learning model positively also tend to report higher self-efficacy, and much of their combined influence on critical thinking operates through this shared psychological pathway rather than through two fully separate mechanisms.

This overlap is consistent with Bandura's Social Cognitive Theory, which posits that self-efficacy is not fixed trait but is dynamically shaped by the learning environment through mastery experiences, vicarious learning, and verbal persuasion. A learning model that students perceive as engaging, structured, and supportive (as in Problem Based Learning, where students face authentic problem requiring evidence-based reasoning) is likely to simultaneously build both a favorable perception of the model and students' confidence in their own reasoning ability, since successfully working through a well designed problem based task is itself a mastery experience that reinforces self efficacy. This explains why perception and self efficacy move together rather than independently.

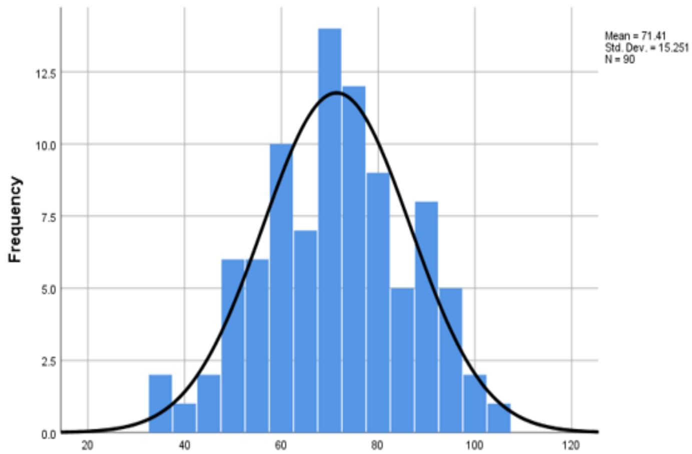
From a constructivist perspective, critical thinking is not transmitted directly but constructed through active engagement with problems, and student perception of the learning environment reflect how much epistemic agency they feel they have within that process. When students perceive the model as one that invites them to construct and test their own reasoning (rather than passively receive information), this perception itself becomes a proximal condition for critical thinking to develop, because constructivist environments require students to externalize, defend, and revise their reasoning, the same processes captured in Facione's Critical Thinking Framework (interpretation, analysis, evaluation, inference, explanation, and self-regulation).

The relatively moderate combined contribution of 42.9% also indicates that a majority of the variance in critical thinking skills is explained by factors outside these two variables. This is consistent with Faciones's framework, which frames critical thinking as multidimensional disposition shaped not only by learner beliefs but also by prior content knowledge, question complexity, task familiarity, and metacognitive habits developed over time, factors not captured by perception or self efficacy measures alone. Problem Based Learning Theory further suggests that the quality and structure of the problem itself (its authenticity, ambiguity, and cognitive demand) plays an independent role in eliciting critical thinking, meaning the instructional design, not just student perception of it, is likely a substantial unmeasured contributor in this study.

Taken together, these findings suggest that fostering critical thinking is unlikely to be achieved by targeting perception or self efficacy in isolation. Instead, learning environments should be designed to build self efficacy directly through structured mastery experiences (per bandura), while ensuring the instructional model itself provides sufficiently authentic and cognitively demanding problems (per Problem Based Learning Theory) to engage the full range of critical thinking sub skills identified by Facione.

Based on the descriptive analysis findings, scientific critical thinking skills observed across state junior high schools in the city of South Tangerang were classified as being at a moderate level. This finding is reflected in the mean score of 71.41, representing 59.50% of the maximum attainable score. For a clearer presentation of the data distribution, the results are displayed in the following histogram.

Figure 1
Histogram of Distribusi Frekuensi Science Critical Thinking Skills



The science critical thinking scores achieved by state junior high school students in South Tangerang City, as presented in the preceding histogram and frequency polygon show a normal distribution pattern. Detailed information regarding the achievement level of each science critical thinking indicator is provided in the following table.

Table 2.
Distribution of Scores by Indicator of Science Critical Thinking Skills

No	Science Critical Thinking Skill Indicator	Mean Score (%)	Category
1	Interpretation	59.72	Moderate
2	Analysis	58.94	Moderate
3	Evaluation	58.83	Moderate
4	Inference	60.94	Moderate
5	Eksplanation	59.39	Moderate
6	Self Regulation	59.22	Moderate
Total	Items 1-12	59.51	Moderate

3.2 The Influence of Perceptions of Learning Models on Science Critical Thinking Skills.

Descriptive statistics for students' perceptions of learning models were obtained from a questionnaire administered to 90 respondents. The findings revealed a mean score of 108.69, a standard deviation of 23.537, a median of 106.50, and a mode of 105. The maximum and minimum scores were 154 and 50, respectively. The instrument comprised 37 statement items, where an individual item could yield an upper limit of 5 points.

Table 3.
Distribution of Students' Perceptions of Learning Models

Statistics		
Science Critical Thinking Skills		
N	Valid	90
	Missing	0
Mean		108.69
Median		106.50
Mode		105
Std. Deviation		23.537
Minimum		50
Maximum		154

The descriptive analysis indicates that students' perceptions of learning models in public junior high schools in South Tangerang City fall within the moderate category. This finding is reflected in the mean score of 108.69, equivalent to 58.75% of the maximum attainable score. The complete descriptive statistics are presented in the appendix. To facilitate a clearer understanding of the data distribution, the results are displayed in the histogram below.

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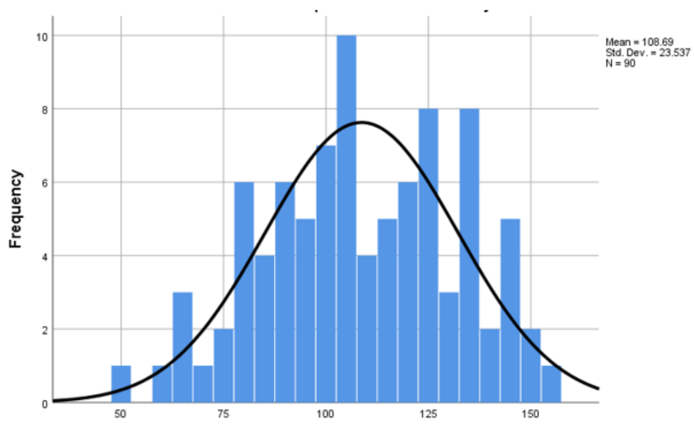
Figure 2

Histogram of the Frequency Distribution of Students' Perceptions of Learning Models



As indicated by the frequency polygon and histogram provided above, South Tangerang City public junior high school students' assessment of instructional models demonstrates a standard bell-shaped normality path. Further information regarding the level of achievement for each perception indicator is presented in the following table.

Table 4.

Distribution of Mean Scores by Indicator of Students' Perceptions of Learning Models

No	Indicator of Perceptions of Learning Models	Mean Score (%)	Category
1	Clarity of Teacher Instruction	60.61	Moderate
2	Student Engagement	58.83	Moderate
3	Relevance of Learning Materials to Students	57.58	Moderate
4	Ease of Student Understanding	58.36	Moderate
Total	37 Valid Items	58.84	Moderate

3.3 The Influence of Self-Efficacy on Science Critical Thinking Skills

Descriptive statistics for self-efficacy were obtained from a questionnaire administered to 90 student respondents. The findings revealed a mean score of 66.37, a standard deviation of 15.238, a median of 66.50, and a mode of 68. The maximum and minimum scores were 104 and 35, respectively. The instrument comprised 22 statement items, each with a maximum score of 5 points.

Table 5.
Distribution of Self-Efficacy Data

Statistics		
Science Critical Thinking Skills		
N	Valid	90
	Missing	0
Mean		66.37
Median		66.50
Mode		68
Std. Deviation		15.238
Minimum		35
Maximum		104

The descriptive analysis indicates that the self-efficacy among public middle school learners situated in South Tangerang City can be categorized as moderate. This finding is reflected in the mean score of 66.37, representing 60.34% of the maximum possible score. The complete descriptive statistics are presented in the appendix. To facilitate a clearer understanding of the data distribution, the results are displayed in the following histogram.

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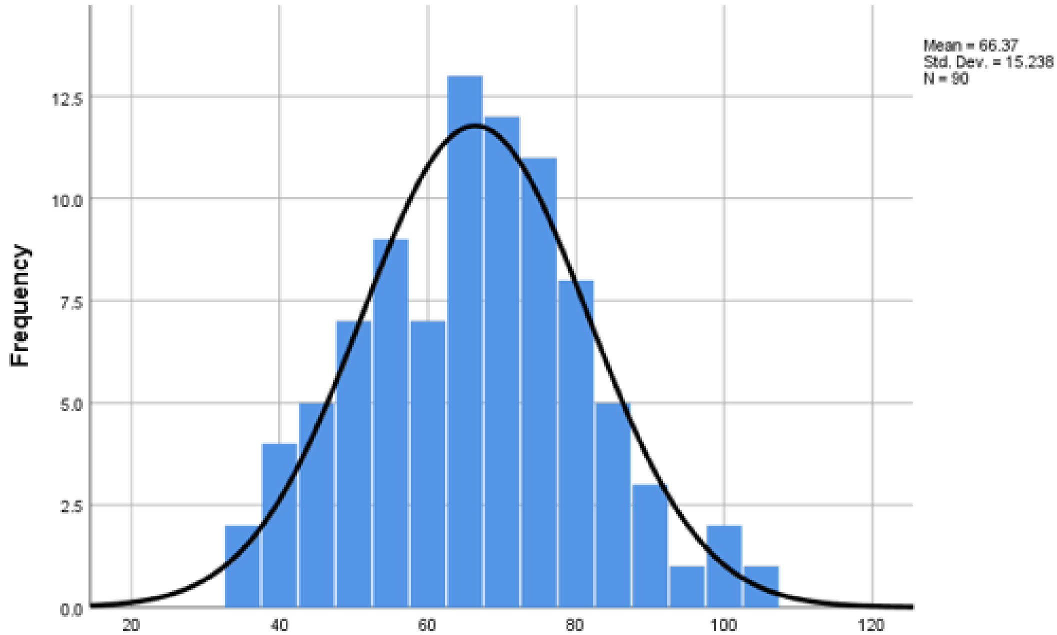
Figure 3

Histogram of the Frequency Distribution of Self-Efficacy



A normal distribution pattern is evident in the self-efficacy scores of state junior high school students across South Tangerang City, as depicted by the preceding histogram and frequency polygon. To examine how each core self-efficacy component was achieved, a detailed descriptive overview is structured in the table below.

Table 6.

Distribution of Mean Scores by Self-Efficacy Indicator

No	Self-Efficacy Indicator	Mean Score (%)	Category
1	Level	60.70	Moderate
2	Generality	60.81	Moderate
3	Strength	59.73	Moderate
Total	22 Valid Items	60.41	Moderate

Several prerequisite tests were carried out prior to the hypothesis testing stage, consisting of normality, regression linearity, multicollinearity, heteroscedasticity, and residual normality analyses. To evaluate whether the data met the normality assumption, the Kolmogorov–Smirnov test was performed using SPSS version 26. The corresponding analysis results are provided in Table 7.

Table 7
Normality Test of Data

One-Sample Kolmogorov Smirnov Test

		Perceptions of Learning Models	Self-Efficacy	Science Critical Thinking Skills
N		90	90	90
Normal Parameters[a,b]	Mean	108.69	66.37	71.41
	Std. Deviation	23.537	15.238	15.251
Most Extreme Differences	Absolute	.056	.039	.047
	Positive	.045	.039	.031
	Negative	-.056	-.035	-.047
Test Statistic		.056	.039	.047
Asymp. Sig. (2-tailed)		.200[c,d]	.200[c,d]	.200[c,d]

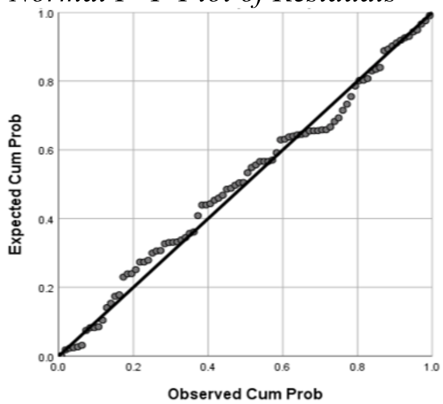
a. Test distribution is Normal.
b. Calculated from data.
c. Liliefors Significance Correction.
d. This is a lower bound of the true significance.

Table 8
Multicollinearity Test

	Model	Collinearity Statistics	
		Tolerance	VIF
1	Constant		
	Perceptions of Learning Models	.999	1.001
	Self-Efficacy	.999	1.001

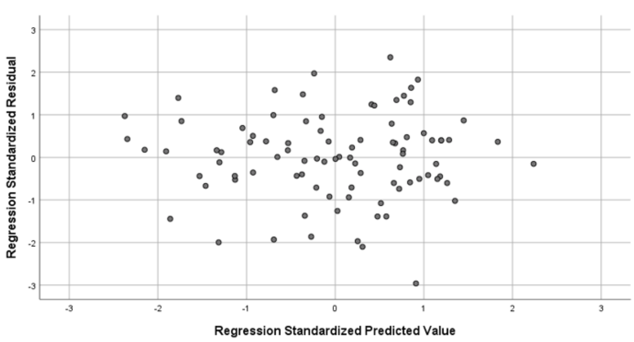
The diagnostic normality testing yielded significance values of 0.200 (>0.05) across all variables, confirming that the dataset conforms to a normal distribution and satisfies a fundamental prerequisite for executing regression modeling. In other words, all samples included in this study exhibit a normal distribution. Visual verification of this distribution is provided via the Normal P–P Plot of Residuals displayed below, which serves to reinforce the initial normality test outcomes.

Figure 4
Normal P–P Plot of Residuals



Heteroscedasticity was assessed through a scatterplot analysis of the predicted values and standardized residuals. The findings demonstrated that the plotted data points were distributed randomly without forming a clear pattern, suggesting that heteroscedasticity was not present in the regression model. The scatterplot of the science critical thinking skills data is shown below.

Figure 4
Scatterplot of the Heteroscedasticity Test



3.4 The Influence of Perceptions of Learning Models and Self-Efficacy on Science Critical Thinking Skills

Empirical evidence from this investigation demonstrates that learners' views on educational frameworks and their self-efficacy concurrently dictate critical thinking skills within science education. This outcome is verified by a significance value of 0.000 (< 0.05) and an F-value of 32.696. In addition, the coefficient of determination of 42.9% suggests that variations in science critical thinking skills can be accounted for by these two variables, whereas the remaining 57.1% may be attributed to other factors that were not examined in the present study.

These findings suggest that science critical thinking skills are not solely associated with students' cognitive aspects but are also influenced by how students perceive the learning process and the extent to which they believe in their own abilities. A positive perception of learning is commonly associated with more active student involvement during instructional activities, whereas higher levels of self-efficacy are generally related to greater confidence in managing academic challenges and resolving problems.

The regression equation, $Y = 6.923 + 0.307X_1 + 0.469X_2$, indicates that both perceptions of learning models and self-efficacy contribute positively to science critical thinking skills. The larger regression coefficient of self-efficacy suggests that internal psychological factors play a substantial role in supporting students' critical thinking abilities.

This overlap between perception and self efficacy is consistent with Bandura's Social Cognitive Theory, which posits that self efficacy is dynamically shaped by the learning environment through mastery experiences, vicarious learning, and verbal persuasion. A learning model that students perceive as engaging and well structured is likely to simultaneously build a favorable perception of the model and greater confidence in students' own reasoning ability, since successfully completing a well designed learning task is itself a mastery experience that reinforces self efficacy. This mechanism explains why perception and self efficacy move together rather than functioning as fully independent predictors, and why their combined explanatory power (42.9%) is lower than the sum of their individual associations (58.48% and 60.41%, respectively).

This overlap between perception and self efficacy is consistent with Bandura's Social Cognitive Theory, which posits that self efficacy is dynamically shaped by the learning, and verbal persuasion. A learning model that students perceive as engaging and well structured is likely to simultaneously build a favorable perception of the model and grater confidence in students' own reasoning ability, since successfully completing a well designed learning task is itself a mastery experience that reinforces self efficacy. This mechanism explains why perceptions and self efficacy move together rather than functioning as fully independent predictors, and why their combined explanatory power (42.9%) is lower than the sum of their individual asspciations (58.48% and 50.41%, respectively).

From contructivist perspective, critical thinking is not transmitted directly but constructed through active engagement with problems. Students' perception of the learning environment reflects how much epistemic agency they feel they have within that process, when students perceive the model as one that invites them to construct and test their own reasoning, this perceptions itself becomes a proximal condition for critical thinking to develop, as it requires students to externalize, defend, and revise their reasoning, processes captured directly in Facione's Critical Thinking Framework (interpretation, analysis, evaluation, inference, explanation, and self regulation).

The relatively moderate combined contribution of 42.9% also indicates that most of variance in critical thinking skills lies outside these two variables. Therefore, efforts aimed at enhancing science critical thinking skills should focus not only on providing meaningful learning experiences but also on reinforcing students' psychological characteristics.

The analysis of science critical thinking skills score distribution showed that all indicators fell within the moderate category, with a mean overall achievement score of 59.51%. The inference indicator achieved the highest score (60.94%), followed by interpretation (59.72%), explanation (59.39%), self-regulation (59.22%), analysis (58.94%), and evaluation (58.83%). These findings suggest that students' critical thinking skills across all dimensions have still fallen short of their full potential. This condition further supports the finding that improving critical thinking skills requires interventions that focus not only on cognitive aspects but also on affective and perceptual factors, such as self-efficacy and perceptions of learning.

The findings are consistent with those of Ipa and Nggaba (2025), who emphasized that efforts to strengthen critical thinking skills should be accompanied by learning strategies that enhance students' self-efficacy. Students who possess high self-efficacy generally demonstrate greater independence, confidence, and persistence when solving problems through logical reasoning. In addition, Nugraheni and Pramugita (2025) reported that self-efficacy makes a significant contribution to science critical thinking skills together with other influencing factors, including learning interest and mathematics anxiety. These findings provide further evidence that self-efficacy serves as an important psychological factor within science learning contexts.

Therefore, the implications of this study highlight the need to integrate innovative learning models with strategies aimed at strengthening students' self-efficacy. Learning approaches such as Problem-Based Learning (PBL) can serve as effective alternatives because they not only encourage active student participation but also provide meaningful learning experiences that enhance students' confidence. Through the combination of appropriate pedagogical strategies and psychological reinforcement, students' science critical thinking skills are expected to develop more effectively and sustainably.

3.5 The Effect of Perceptions of Learning Models on Science Critical Thinking Skills

The findings indicate that perceptions of learning models significantly influence students' science critical thinking skills. This conclusion is evidenced by a significance value of 0.000 (< 0.05) and a t-value of 5.843. The results further imply that more positive student perceptions toward the implemented learning model are associated with higher levels of critical thinking skills.

Positive perceptions are more likely to emerge when students experience active participation during the learning process, clearly understand the objectives of learning activities, and recognize how classroom content relates to practical, real-world contexts. These conditions motivate students to ask questions, engage in discussions, and gain a more comprehensive understanding of the subject matter. Through such learning experiences, the development of critical thinking skills can occur more effectively.

These findings align with previous studies indicating that student-centered instructional approaches, including Problem-Based Learning, contribute to the improvement of science critical thinking skills through activities involving problem solving, collaborative discussions, and the investigation of contextual issues. Therefore, teachers should continuously develop instructional strategies that create meaningful learning experiences and encourage active student participation.

However, dissecting the overall spread of perception scores more closely demonstrates that all indicators remain within the moderate category, with an overall mean score of 58.84%. The indicator of clarity of teacher instruction obtained a score of 60.61%, student engagement 58.83%, relevance of learning materials 57.58%, and ease of understanding 58.36%. These findings suggest that although students demonstrate relatively positive perceptions, the level achieved has not yet reached an optimal condition. Consequently, there remains room for improvement in the implementation of learning models, particularly in enhancing instructional clarity, increasing active student participation, connecting learning materials to real-life contexts, and facilitating conceptual understanding. Such improvements are important because more positive perceptions are likely to lead to greater improvements in critical thinking skills.

The current data align seamlessly with prior literature, reinforcing the notion that Problem-Based Learning serves as a potent vehicle for cultivating scientific critical thinking skills. Putri et al. (2025) reported that PBL significantly improves learning outcomes by enabling students to investigate possible solutions, develop creative thinking abilities, and collaborate with peers, resulting in a learning environment that is more active and intellectually stimulating. Likewise, Rizkiwati et al. (2024) found that the implementation of reflective pedagogy-based PBL contributed positively to the development of critical thinking skills. Similar evidence was reported by Lee (2025), who showed that students exposed to PBL experienced significantly greater improvements in critical thinking and problem-solving abilities compared with students taught through lecture-based approaches. Furthermore, Rahman et al. (2024) also identified improvements in science critical thinking scores among students who participated in learning activities based on PBL.

Accordingly, students' perceptions of learning models, particularly active learning approaches such as Problem-Based Learning, may be regarded as an essential factor contributing to the enhancement of science critical thinking skills. Positive perceptions not only reflect students' acceptance of the learning process but also function as an internal driving force that enhances engagement and the quality of thinking processes. Consequently, teachers should optimize the implementation of innovative, interactive, and contextual learning models to foster positive student perceptions and maximize the development of science critical thinking skills.

3.6 The Effect of Self-Efficacy on Science Critical Thinking Skills

A substantial portion of the variance in students' scientific critical thinking skills is uniquely driven by self-efficacy, a pattern verified by a reported significance output of 0.000 (< 0.05) and a t-value of 5.783. These findings suggest that students who possess stronger beliefs in their own abilities tend to demonstrate better critical thinking skills than those with lower levels of self-efficacy.

Self-efficacy has an important influence on how students deal with learning challenges, sustain their efforts when encountering difficulties, and accomplish tasks that involve higher-order thinking skills. Students who possess strong self-efficacy generally show greater willingness to express ideas, raise questions, and critically examine information. On the other hand, students with lower self-efficacy are more likely to avoid demanding tasks and tend to give up more easily when faced with obstacles.

From a theoretical perspective, these findings are consistent with Bandura's concept of self-efficacy, as cited by Geovani and Waluya (2025) which explains self-efficacy as a person's belief in their capacity to arrange and perform the actions needed to attain specific goals. In science learning contexts, self-efficacy influences how students approach challenges, persist in completing tasks, and confidently express ideas and arguments. Students with high self-efficacy tend to demonstrate perseverance, active participation, and better regulation of their thinking processes. Such characteristics provide direct support for the development of critical thinking skills, as students are encouraged not simply to receive information passively but to actively analyze and evaluate it.

According to the descriptive findings, students' self-efficacy was classified within the moderate category, with a mean score of 60.41%. These findings indicate that students' confidence levels still have the potential to be enhanced through learning experiences that offer opportunities for achievement, constructive feedback, and active engagement during the learning process. Strengthening self-efficacy is expected to provide positive contributions toward the development of science critical thinking skills.

Previous studies support these findings by demonstrating that self-efficacy represents a psychological factor with a substantial influence on the development of critical thinking skills. Ipa and Nggaba (2025) emphasized that efforts to strengthen science critical thinking skills should be accompanied by strategies that enhance self-efficacy, enabling students to learn independently, confidently, and consistently in solving problems. Similarly, Nugraheni and Pramugita (2025) reported that self-efficacy has a significant influence on science critical thinking skills, contributing 21.9% together with other related variables. These findings provide evidence that self-efficacy serves as an important factor affecting students' critical thinking abilities. Therefore, strategies aimed at improving science critical thinking skills should not be limited to instructional approaches alone but should also include systematic efforts to enhance students' confidence in their own capabilities.

Overall, the findings indicate that the improvement of science critical thinking skills is influenced not only by students' cognitive abilities but also by their perceptions of learning models and levels of self-efficacy. Therefore, teachers are encouraged to apply student-centered learning approaches, such as Problem-Based Learning, while simultaneously providing learning experiences that enhance students' confidence in their own capabilities. Such approaches are expected to establish learning environments that are more active, reflective, and supportive in promoting the development of critical thinking skills.

This study, however, has several limitations that need to be recognized. One limitation is that the research involved only two public junior high schools in South Tangerang City, which means that caution is required when applying the findings to broader contexts. Second, the study examined only perceptions of learning models and self-efficacy, whereas other factors that may influence critical thinking skills, such as learning motivation, family support, learning environment, and teacher competence, were not investigated. Future research is suggested to extend the geographic range of the study and to include a wider set of variables, so that a more thorough understanding can be achieved regarding the factors that affect students' science-related critical thinking skills.

4. Conclusion

The generated data reveal that approximately 42.9% of the variance in scientific critical thinking capacities among public middle school learners in South Tangerang City is collectively explained by self-efficacy and their assessment of instructional frameworks. Beyond this joint impact, distinct individual evaluations confirmed that both predictors also exert statistically significant partial influences, demonstrating that self-efficacy and learning model perceptions each uniquely dictate students' science-related critical thinking outcomes.

These results suggest that the development of science critical thinking skills is determined not only by instructional practices but also by students' confidence in their own capabilities. Consequently, active, contextual, and student-centered learning approaches should be combined with strategies aimed at enhancing self-efficacy to promote the optimal development of students' critical thinking skills.

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