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The Effect Of The Inquiry-Based Learning Model And Learning Motivation On The Learning Outcomes Of Grade 11 High School Students

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Abstract:
Aims. This study investigated the effects of inquiry-based learning models and learning motivation on Grade 11 students' Biology learning outcomes, with particular emphasis on the interaction between instructional models and students' motivation levels.
Methods. The study employed a quantitative quasi-experimental approach using a 2 × 2 factorial, posttest-only design. The participants comprised 60 Grade 11 students at SMA Negeri 1 Gedung Aji during the second semester of the 2025/2026 academic year, selected through total sampling. Students were assigned to two existing classes implementing open inquiry and guided inquiry learning models. Data were collected using a learning outcomes test and a learning motivation questionnaire, both of which underwent validity and reliability testing. Data were analyzed using two-way analysis of variance (ANOVA), followed by Tukey's test for further comparisons.
Result. The results demonstrated that the inquiry-based learning model significantly affected students' learning outcomes ($F = 25.447$, $p < 0.001$), while learning motivation also had a significant effect ($F = 155.321$, $p < 0.001$). A significant interaction between the inquiry-based learning model and learning motivation was identified ($F = 120.541$, $p < 0.001$), indicating that the instructional model's effectiveness depended on students' motivation levels.
Conclusion. Students with high learning motivation achieved significantly better outcomes through open inquiry than through guided inquiry, whereas students with low learning motivation achieved better outcomes through guided inquiry.
Implementation. These findings highlight the importance of aligning the degree of inquiry-based instructional guidance with students' motivational characteristics to optimize Biology learning outcomes.

Keywords: inquiry-based learning; open inquiry; guided inquiry; learning motivation; learning outcomes

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INTRODUCTION

Education is an effort to improve the intellectual capacity of the nation and to develop individuals who embody the values of Pancasila. Law of the Republic of Indonesia No. 20 of 2003 concerning the National Education System also states that “National Education functions to develop abilities and shape the character and civilization of a dignified nation in order to educate the life of the nation, with the aim of developing students’ potential to become individuals who have faith in and devotion to God Almighty, possess noble character, are healthy, knowledgeable, competent, creative, independent, and become democratic and responsible citizens” (Kilay & Farhana, 2024).

One indicator of educational success is the learning outcomes achieved by students after participating in the learning process. Learning outcomes reflect the level of mastery of knowledge, skills, and attitudes acquired by students as a result of interactions between students and their learning environment (Hermansyah et al., 2025). However, in recent years, learning loss has significantly affected students’ learning outcomes. Learning loss refers to a condition in which students experience a decline in knowledge and skills due to interruptions or suboptimal learning processes. Previous research shows that learning loss can reduce students’ academic achievement, ultimately contributing to lower learning outcomes (Kuhfeld et al., 2020).

Learning outcomes are also closely associated with learning motivation. Learning motivation encourages students to engage actively in the learning process and show a high level of interest in the material being studied. The higher students' level of learning motivation, the greater their opportunity to achieve optimal learning outcomes. Conversely, low learning motivation may reduce attention to the learning process, which can lead to lower learning outcomes. Abdurrahman (2019) reported that learning motivation has a positive and significant effect on students’ learning outcomes, with highly motivated students tending to achieve better learning outcomes than those with low motivation.

A preliminary study at SMA Negeri 1 Gedung Aji found that learning loss was high across all indicators: material comprehension, the learning process, learning motivation, self-confidence, and learning independence. As previously stated, learning loss among students is closely associated with low learning outcomes. This is evident in the low Biology learning outcomes at SMA Negeri 1 Gedung Aji. Based on the Learning Objective Achievement Criteria (LOAC) established for Grade 11, with a minimum criterion of 74,

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only approximately 26.7% of students achieved Biology scores above the LOAC. If left unaddressed, this problem may continue to negatively affect students' learning outcomes. Therefore, one approach to making learning more engaging and creating a conducive learning environment is to implement an appropriate learning model.

Teachers' competence in implementing learning is also a factor that affects students' learning outcomes. Teachers are expected to manage the classroom effectively, select appropriate learning models, teaching methods, and instructional strategies, and demonstrate positive attitudes and characteristics in managing the teaching and learning process to ensure its effectiveness (Alam & Darmawan, 2025). Learning success is influenced by the learning models and instructional media teachers use. Engaging learning models and media can improve students' understanding. Conversely, when teachers an not implement an appropriate learning model, some students may have difficulty understanding the learning material (Lilo et al., 2025). Therefore, it is necessary to implement a more student-centered learning approach, such as the inquiry-based learning model, which emphasizes investigation and concept discovery to foster critical thinking and improve students' understanding and learning outcomes (Yusnarti et al., 2025).

This study's novelty lies in integrating the inquiry-based learning model with learning motivation levels among Grade 11 high school students, providing a more contextual approach to understanding the learning process. Unlike previous studies, which have generally focused only on the overall effectiveness of inquiry-based learning models on learning outcomes, this study specifically examines how differences in students' levels of learning motivation (high and low) interact with the implementation of inquiry-based learning, including guided inquiry and open inquiry. Thus, this study examines the main effect of the learning model and the interaction effect between the learning model and learning motivation on students' learning outcomes.

METHODS

This study employed a quasi-experimental design. The study used a 2 × 2 factorial, posttest-only design with two experimental groups. Experimental Group 1 was taught using the open inquiry learning model, whereas Experimental Group 2 was taught using the guided inquiry learning model. The study population comprised 60 Grade 11 students from SMA Negeri 1 Gedung Aji who participated in Biology learning during the second semester of the 2025/2026 academic year.

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According to school records, Grade 11 consisted of only two classes, namely Class XI. A with 30 students and Class XI.B with 30 students. Therefore, all Grade 11 students were included as the research sample, with no selection or grouping based on specific criteria. Accordingly, total sampling was considered the most appropriate sampling technique because the sample represented the entire population.

This study involved two types of variables: independent and dependent variables. The independent variables (X) consisted of two variables, namely X1 and X2, while the dependent variable (Y) was one variable. Table 1 presents the research variables.

Tabel 1. Desain Penelitian Faktorial 2x2

Variabel Bebas (X_1) / Variabel Bebas (X_2)		Model Pembelajaran (A)	
		Model Inkuiri Bebas (A_1)	Model Inkuiri Terbimbing (A_2)
Motivasi Belajar (B)	Motivasi Belajar Tinggi (B_1)	A_1B_1	A_2B_1
	Motivasi Belajar Rendah (B_2)	A_1B_2	A_2B_2

The instruments used in this study consisted of a learning outcomes test and a learning motivation questionnaire. The learning outcomes test comprised posttest items administered after the treatment to determine students' learning outcomes following the learning process. The learning motivation questionnaire measured students' levels of learning motivation. Before data collection, all instruments underwent a pilot test to determine their suitability as research measurement instruments. Instrument testing included validity and reliability tests.

The validity of the learning outcomes instrument was assessed using biserial correlation, whereas the validity of the learning motivation instrument was assessed using product-moment correlation. The Kuder–Richardson 21 (KR-21) formula was used to assess the reliability of the learning outcomes instrument, which consisted of objective multiple-choice items scored 1 for correct responses and 0 for incorrect responses. Meanwhile, the reliability of the learning motivation instrument was assessed using Cronbach's Alpha.

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Before hypothesis testing, the data were first subjected to the prerequisite tests for analysis, namely the normality test using the Kolmogorov–Smirnov test and the homogeneity test using Levene's test. Because the data met the assumptions of normality and homogeneity, hypothesis testing was conducted using parametric statistics, specifically two-way analysis of variance (ANOVA), using SPSS version 29.

RESULT

The normality test was conducted to determine whether the learning outcomes data were normally distributed as a prerequisite for applying parametric statistical tests. The Kolmogorov–Smirnov test was used because the sample size was less than 50. Table 2 presents the normality test results.

Tabel 2. Hasil Uji Normalitas

Kelompok	Statistic	Df	Sig
Model Inkuiri Bebas (A_1)	0.154	16	0.200*
Model Inkuiri Terbimbing (A_2)	0.147	16	0.200*
Motivasi Tinggi (B_1)	0.132	16	0.200*
Motivasi Rendah (B_2)	0.123	16	0.200*
Model Inkuiri Bebas + Motivasi Tinggi (A_1B_1)	0.162	8	0.200*
Model Inkuiri Bebas + Motivasi Rendah (A_1B_2)	0.171	8	0.200*
Model Inkuiri Terbimbing + Motivasi Tinggi (A_2B_1)	0.250	8	0.200*
Model Inkuiri Terbimbing + Motivasi Rendah (A_2B_2)	0.222	8	0.200*

The normality test results, based on the Kolmogorov–Smirnov test at a 5% significance level and presented in Table 2, showed that all data groups in this study met the criteria for a normal distribution. These findings indicate that the distribution of students' learning outcomes data across each treatment group and motivation level satisfied the assumption of normality. Since the normality assumption was met for all groups, the research data were considered suitable for analysis using parametric statistical techniques.

Homogeneity Test

In this study, homogeneity of variance was assessed using Levene's test, which is an appropriate method for testing homogeneity of variance in normally distributed data.

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Levene's test was used to examine homogeneity of variances across the data groups, an important assumption for parametric statistical analyses such as two-way analysis of variance (ANOVA). Table 3 presents the homogeneity test results.

Tabel 3. Hasil Uji Homogenitas

		Levene Statistic	df1	df2	Sig
Hasil Belajar	Based on Mean	0.530	3	28	0.665
	Based on Median	0.519	3	28	0.673
	Based on Median and with adjusted df	0.519	3	25.472	0.673
	Based on trimmed mean	0.502	3	28	0.684

Hasil uji homogenitas varians pada Tabel 3 menunjukkan nilai signifikansi sebesar 0,665, yang lebih besar dari 0,05. Hal ini mengindikasikan bahwa varians data antarkelompok dalam penelitian ini bersifat homogen, sehingga asumsi homogenitas sebagai prasyarat analisis statistik telah terpenuhi. Dengan terpenuhinya asumsi homogenitas varians, data penelitian ini layak dianalisis lebih lanjut menggunakan analisis ANAVA dua arah, sehingga perbandingan antarkelompok perlakuan dapat dilakukan secara valid dan dapat dipertanggungjawabkan secara statistik.

Uji Hipotesis

Setelah data dinyatakan memenuhi uji prasyarat analisis, langkah selanjutnya adalah melakukan uji hipotesis untuk mengetahui pengaruh model pembelajaran dan motivasi belajar terhadap hasil belajar peserta didik. Pengujian ini dilakukan dengan menggunakan analisis ANAVA dua arah yang memungkinkan peneliti mengidentifikasi pengaruh masing-masing variabel serta interaksinya. Hasil uji ANOVA dua arah disajikan pada Tabel 4.

Tabel 4. Hasil Uji ANAVA Dua Arah

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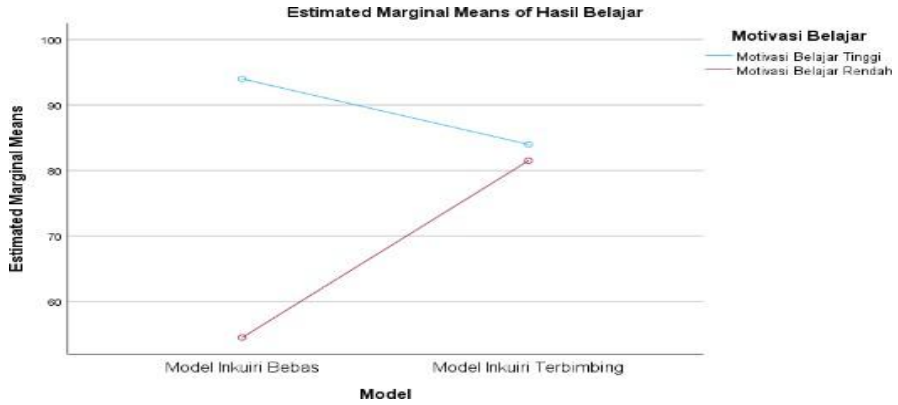
Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	6844.000[a]	1	2281.333	100.436	<,001
Intercept	197192.000	1	197192.000	8681.409	<,001
Model Inkuiri	578.000	1	578.000	25.447	<,001
Motivasi Belajar	3528.000	1	3528.000	155.321	<,001
Model Inkuri* Motivasi Belajar	2738.000	1	2738.000	120.541	<,001
Eror	636.000	28	22.714		
Total	204672.000	32			
Corrected Total	7480.000	31			

The first hypothesis stated that the inquiry-based learning model affected students' learning outcomes on the Circulatory System topic in both the guided inquiry and open inquiry classes. Based on the analysis of variance presented in Table 4, the results showed a significance value of <0.001, which was lower than 0.05, with an F-value of 25.447. This result indicates that the inquiry-based learning model significantly affected students' learning outcomes.

The second hypothesis stated that learning motivation affected students' learning outcomes. Based on the analysis of variance presented in Table 4, the results showed a significance value of <0.001, which was lower than 0.05, with an F-value of 155.321. This result indicates that learning motivation significantly affected students' learning outcomes.

The third hypothesis stated that the inquiry-based learning model and learning motivation had an interaction effect on students' learning outcomes. Based on the analysis of variance presented in Table 4, the results showed a significance value of <0.001, which was lower than 0.05, with an F-value of 120.541. This result indicates a significant interaction effect between the inquiry-based learning model and learning motivation on students' learning outcomes. Figure 1 presents the interaction pattern between the inquiry-based learning model and learning motivation.

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Gambar 1. Interaksi Antara Model Inkuiri dengan Hasil Belajar Peserta Didik

The results supported the first, second, and third hypotheses; therefore, the analysis continued by testing the fourth and fifth hypotheses. These follow-up analyses used Tukey's test to identify more specific differences among the treatment groups and determine which groups showed statistically significant differences in learning outcomes. Table 5 presents the results of Tukey's test for the fourth hypothesis.

Tabel 5. Hasil Uji Tukey Hipotesis Empat

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	400.000	1	400.000	19.444	<.001
Intercept	126736.000	1	126736.000	6160.778	<.001
Model Inkuiri pada Motivasi Belajar Tinggi	400.000	1	400.000	19.444	<.001

The fourth hypothesis stated that, among students with high learning motivation, those who learned using the open inquiry model achieved higher learning outcomes than those who learned using the guided inquiry model. Based on the analysis of variance presented in Table 5, the results showed a significance value of <0.001, which was lower than 0.05, with an F-value of 19.444. This result indicates that, among students with high learning motivation, those who learned using the open inquiry model achieved higher learning outcomes than those who learned using the guided inquiry model. The results of Tukey's test for the fifth hypothesis are presented in Table 6.

Tabel 6. Hasil Uji Tukey Hipotesis Lima

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Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	2916.000a	1	2916.000	117.310	<.001
Intercept	73984.000	1	73948.000	2976.368	<.001
Model Inkuiri pada Motivasi Belajar Rendah	2916.000	1	2916.000	117.310	<.001

The fifth hypothesis stated that, among students with low learning motivation, those who learned using the open inquiry model achieved lower learning outcomes than those who learned using the guided inquiry model. Based on the analysis of variance presented in Table 6, the results showed a significance value of <0.001, which was lower than 0.05, with an F-value of 117.310. This result indicates that, among students with low learning motivation, students who received the open inquiry treatment achieved lower learning outcomes than those who learned using the guided inquiry model.

DISSCUSION

Based on the two-way ANOVA results, which showed a significance value of <0.001 (lower than $\alpha = 0.05$) and an F-value of 25.447, the inquiry-based learning model had a significant effect on students' learning outcomes. This finding confirms that differences in implementing inquiry-based learning models, both open inquiry and guided inquiry, significantly contributed to students' learning outcomes. The inquiry-based learning model affects students' learning outcomes because it can significantly increase learning activity. In the inquiry process, students do not merely receive information; they actively engage in learning activities, including observing, formulating problems, proposing hypotheses, conducting investigations, and drawing conclusions. This finding is consistent with Yuliani et al. (2021), who reported that students' cognitive learning outcomes improved through the use of the inquiry-based learning model in Biology learning on the respiratory system. Implementing the inquiry-based learning model can increase both teacher and student learning activities and improve students' Biology learning outcomes.

Based on the two-way ANOVA results, which showed a significance value of <0.001 (lower than $\alpha = 0.05$) and an F-value of 155.321, learning motivation significantly affected students' learning outcomes. This finding indicates that students' motivation level is an important factor in determining learning success. Learning motivation is an internal factor

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that plays an important role in determining students' success in achieving learning outcomes because it provides the drive, direction, and persistence necessary to sustain learning activities. This finding aligns with Abdurahman (2024), who reported that students with high learning motivation tend to engage more actively in the learning process, such as being more persistent in understanding the material, making greater efforts to complete assignments effectively, and being motivated to achieve optimal academic performance. Conversely, students with low learning motivation tend to be less enthusiastic, give up more easily, and participate less effectively in the learning process. Theoretically, motivation functions as a driving force, directing factor, and stimulus for learning activities; therefore, the higher the level of learning motivation, the greater the opportunity for students to achieve better learning outcomes.

The two-way ANOVA results, which showed a significance value of <0.001 (lower than $\alpha = 0.05$) and an F-value of 120.541, indicate an interaction effect between the inquiry-based learning model and learning motivation on students' learning outcomes. This means that the effectiveness of the inquiry-based learning model does not operate independently but is influenced by students' levels of learning motivation. The findings demonstrate an interaction between the inquiry-based learning model and learning motivation in relation to students' learning outcomes. This indicates that the effectiveness of the inquiry-based learning model does not apply uniformly but depends on students' level of learning motivation. This finding is consistent with Pardede et al. (2016), who reported a significant interaction between the learning model and learning motivation on students' learning outcomes. They found that vocational high school students with high learning motivation achieved more optimal learning outcomes when participating in inquiry-based learning, particularly in subjects requiring conceptual understanding and analytical skills.

Students with high learning motivation tend to achieve better learning outcomes, particularly when an inquiry-based learning model that provides more opportunities for exploration is implemented. In contrast, students with low learning motivation require more structured guidance to remain engaged in the learning process. Thus, high learning outcomes are determined not only by learning motivation but also by the compatibility between the learning model used and students' motivation levels. This finding is consistent with Saragih & Sitanggang (2026), who stated that the interaction between the learning model and learning motivation indicates that a learning model's effectiveness depends substantially on students' psychological readiness.

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The results of Tukey's test for the fourth hypothesis showed a significance value of <0.001 (lower than $\alpha = 0.05$), with an F-value of 19.444, indicating that among students with high learning motivation, the learning outcomes of those in the open inquiry group were higher than those of students in the guided inquiry group. These findings demonstrate that the effectiveness of open inquiry and guided inquiry learning models differs depending on students' levels of learning motivation. Specifically, the results showed that among students with high learning motivation, the open inquiry model was more effective in improving learning outcomes. This finding is consistent with Handaka & Sunarno (2018), who argued that, theoretically, this difference can be explained through a constructivist approach that positions students as active agents in constructing their own knowledge. The open inquiry model provides students with greater freedom to formulate problems, develop hypotheses, conduct investigations, and draw conclusions. This freedom helps students develop critical, creative, and independent thinking skills. However, its effectiveness depends considerably on students' internal readiness, particularly their learning motivation. Highly motivated students tend to manage their learning processes more effectively and, consequently, achieve better learning outcomes.

Other studies have reported that open inquiry provides students with substantial opportunities to develop higher-order thinking skills and deep conceptual understanding, but it also requires a high level of independence and motivation. Consistent with this perspective, students' readiness and learning motivation strongly influence the success of open inquiry, with highly motivated students demonstrating better inquiry performance than students with low learning motivation (Wulandari et al., 2023).

Tukey's test for the fifth hypothesis showed a significance value of <0.001 (lower than $\alpha = 0.05$) and an F-value of 117.310, indicating that among students with low learning motivation, those in the open inquiry group achieved lower learning outcomes than those in the guided inquiry group. Among students with low learning motivation, the guided inquiry model had a more significant effect on learning outcomes than the open inquiry model. This finding indicates that low-motivation students tend to require clearer guidance, support, and instructional structure to participate optimally in the learning process. This aligns with Sukerti et al. (2017), who stated that in guided inquiry, teachers play an active role in providing guidance, leading questions, and systematic steps that help students stay focused and avoid losing direction during the inquiry process. This condition enables students with low learning motivation to remain engaged in learning, thereby facilitating better conceptual

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understanding and ultimately improving their learning outcomes.

Theoretically, this finding aligns with the concept of scaffolding in learning, in which gradually provided assistance can enhance students' learning abilities, particularly for those with limitations in self-regulation and motivation. Students with low learning motivation generally tend to be less independent, become confused more easily, and show less initiative in learning; therefore, they may be less suited to immediately engaging in open inquiry, which requires a high level of independence (Wahida et al., 2022). Accordingly, guidance through guided inquiry becomes an important factor in increasing student engagement, facilitating understanding, and ultimately producing significant improvements in learning outcomes among students with low motivation. According to Erlina et al. (2022), guided inquiry actively engages students in learning activities through observing, asking questions, gathering information, planning investigations, using equipment to collect data, analyzing and drawing conclusions from data, providing answers, and communicating the results.

Other studies further support these findings, showing that students with low motivation experience greater improvements in learning outcomes when provided with highly guided instruction. Lilo et al. (2025) emphasized that the effectiveness of inquiry-based learning is strongly influenced by the availability of instructional support, particularly for students who are not yet prepared for independent learning. Without clear guidance, low-motivation students may struggle to manage their learning processes effectively, which may limit conceptual understanding. Novita et al. (2025) show that the Inquiry-Based Learning model can improve students' understanding of static electricity materials. This study suggests applying the IBL model as a more effective learning alternative to understanding junior high school physics material.

The research subjects were fourth-grade students of SDN 1 Manislor, totaling 17 people. In the pre-cycle research, the percentage obtained was 50% and increased to 84% in cycle 2. Based on these percentage results, the use of paper-based Quizizz media can increase the learning motivation of fourth-grade students of SDN 1 Manislor (Nur Aulia et al., 2025). Inquiry-based learning is generally effective in improving learning outcomes; however, its success depends heavily on how teachers support students throughout the learning process (Alam & Darmawan, 2025). Thus, this study's findings align with previous research emphasizing the importance of matching the learning model to students' characteristics. Yulianita et al. (2025) found that the credibility of communicators in the

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Visiting Lecturer Collaboration Program plays an essential role in strengthening the motivation of Indonesian–Malaysian students, highlighting its importance in enhancing the effectiveness of international academic collaboration. Herpi et al.'s (2024) findings showed that using Macromedia Flash learning media significantly affected students' motivation to learn about enthalpy change.

CONCLUSION

Based on the findings of this study, the inquiry-based learning model was found to have an effect on students' learning outcomes on the Circulatory System topic. In addition, learning motivation affected students' learning outcomes, with students at different motivation levels demonstrating different achievement levels. Furthermore, an interaction effect was found between the inquiry-based learning model and learning motivation on students' learning outcomes, indicating that the learning model's effectiveness is influenced by students' motivation levels. Specifically, among students with high learning motivation, those who learned using the open inquiry model achieved higher learning outcomes than those who learned using the guided inquiry model. Conversely, among students with low learning motivation, those who learned using the open inquiry model achieved lower learning outcomes than those who learned using the guided inquiry model.

Suggestions

It is recommended that teachers combine open inquiry and guided inquiry models in the learning process, for example, by giving students with high learning motivation greater autonomy while providing more intensive guidance to students with low learning motivation. In this way, the learning process can be conducted more effectively and can optimally improve learning outcomes among all students.

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