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The Role of Guided Inquiry Learning on Students' Science Process Skills and Cognitive Abilities

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Abstract: This experimental study aimed to analyze the science process skills and cognitive abilities of students taught through inquiry and hands-on learning. The independent variables were guided inquiry and hands-on learning, while the dependent variables were students' science process skills and cognitive abilities. The results of the descriptive analysis showed that the average KPS score in the guided inquiry group was 19.96 with a standard deviation of 2.01, while the direct learning group was 15.41 with a standard deviation of 4.04. For cognitive abilities, the average score in the guided inquiry group was 18.56 with a standard deviation of 4.18, while the direct learning group was 14.74 with a standard deviation of 3.40. These results indicate a difference in learning outcomes between the two groups, which can be used as a basis for further analysis. Based on the t-test results, there was a significant difference in cognitive abilities between the experimental and control classes ($p = 0.001$, where $p < \alpha = 0.05$). Similarly, the difference in science process skills (SPS) was also significant ($p = 0.000$). These results indicate that guided inquiry learning plays a significant role in improving science process skills and provides a positive contribution to students' cognitive abilities compared to direct learning.

Keywords: Cognitive abilities; Guided inquiry learning; Process skills

Introduction

Education is the primary means of developing students' potential, both physically and spiritually, so they can live prosperously and thrive in accordance with the demands of the times. In today's era of scientific and technological advancement, education aims not only to instill theoretical knowledge but also emphasizes the importance of critical and analytical thinking skills, as well as the ability to conduct scientific investigations (Wang et al., 2025; Nasution et al., 2023). Therefore, education is a strategic investment in developing quality human resources (Karsimen, 2020). In the Indonesian curriculum, Natural Sciences (IPA) subjects are designed to develop students' ability to understand natural phenomena scientifically and logically, as well as to foster a scientific attitude through observation and investigation. Ministerial Regulation of the Minister of Education, Culture, Research, and Technology Number 8 of 2024 emphasizes the importance of learning oriented toward essential skills, particularly science process skills. This encourages teachers to implement an approach that focuses not only on memorizing concepts but also trains students to think and work like scientists (Rosiningtias et al., 2023).

Physics, as a part of the natural sciences, presents unique challenges due to the involvement of abstract concepts and the use of mathematics in explaining phenomena. Students often struggle to fully grasp physics concepts (Nikolaus et al., 2024; Musengimana et al., 2025). Therefore, a learning approach is needed that bridges theory and students' real-world experiences (De Jong et al., 2023). Real-world examples, such as experiments on friction or air pressure, can help students understand concepts through direct experience (Walsh & Magana, 2023). One relevant approach to bridging this

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gap is guided inquiry learning (Arantika et al., 2019). This approach positions students as active participants in the scientific process: observing, formulating problems, designing and conducting experiments, and drawing conclusions based on the data obtained (Ramlawati, 2024; Alberida et al., 2018). The teacher remains a facilitator, systematically guiding the scientific thinking process (Morris, 2025). Guided inquiry learning is closely related to science process skills (SPS), such as observing, categorizing, measuring, interpreting data, and predicting (Senisum et al., 2022). Cognitive abilities, on the other hand, encompass aspects of remembering, understanding, applying, and analyzing (Lemos et al., 2025; Elim, 2024).

These two aspects are crucial to develop in physics learning. However, in practice, various problems remain, such as student difficulty in selecting formulas, drawing conclusions, and low learning motivation. Previous research has shown that guided inquiry learning has a positive impact on improving SPS and cognitive abilities. Research by Sulistyani et al. (2022), showed that classes using guided inquiry learning achieved better results than classes using conventional learning. Both studies strengthen the argument that this approach is suitable for application in the context of physics learning in science at various levels of education.

Method

This type of research is an experimental study with a Posttest-Only Control Group Design. The variables in this study consist of independent variables, namely guided inquiry learning and direct learning, while the dependent variables, namely science process skills and cognitive abilities of students. This research was conducted at SMPN 2 Bajeng Barat in the odd semester of the 2024/2025 academic year. The subjects of the study consisted of two classes, namely class VIII A as the experimental class given treatment with guided inquiry learning, and class VIII B as the control class using direct learning. The population in this study was all class VIII students at SMPN 2 Bajeng Barat, totaling 112 students. The sample in this study consisted of two classes, namely class VIII A as many as 27 students as the experimental class who received guided inquiry learning, and class VIII C as many as 27 students as the control class who received direct learning. The data analysis techniques used in this study were descriptive statistics and inferential statistics to determine the differences in science process skills and cognitive abilities between the two classes.

Result and Discussion

Research Results

Comparison of Science Process Skills (SPS) and Cognitive Abilities using guided inquiry learning and direct learning is as follows:

Table 1. Statistics on SPS of Students Taught Using Guided Inquiry Learning

Description	VIII A
Sample Size	27
Highest Theoretical Score	26
Lowest Theoretical Score	0
Highest Empirical Score	24
Lowest Empirical Score	16
Mean Score	19.96
Standard Deviation	2.01

Table 2. Frequency Distribution Data of KPS Scores of Students Taught with Guided Inquiry Learning

Interval	Category	Frequency	Percentage (%)
0 - 5	Very low	0	0.00
6 - 10	Low	0	0.00
11 - 15	Currently	4	14.81
16 - 20	Tall	22	81.48
21 - 26	Very high	1	3.70
Total		27	100

Table 2 shows the distribution of the Science Process Skills (KPS) scores of 27 students after guided inquiry learning. The analysis revealed a significant increase in science process skills, as evidenced by the frequency distribution of scores. Nearly all students, 96.29%, were in the moderate to very high category, with 81.48% of students in the high category (scores 18–23) and 3.70% in the very high category (scores 24–26). Furthermore, only 4 students (14.81%) were in the moderate category (scores 12–17). No students were classified as low or very low, indicating that all students had achieved moderate or higher levels of science process skills. The large number of students in the high category indicates that guided inquiry learning effectively improves science process skills, such as observing, interpreting, grouping, and predicting. The score distribution is visualized in Figure 1.

The diagram shows that more students achieved the "High" category in Science Process Skills, with the highest percentage reaching 81.48%. This indicates that guided inquiry learning is quite effective in developing students' science process skills. Only a small number of students are in the "Very Low", "Low", and "Very High" categories. Therefore, the data description and visualization above demonstrate the role of guided inquiry learning as an effective step to encourage students' Science Process Skills.

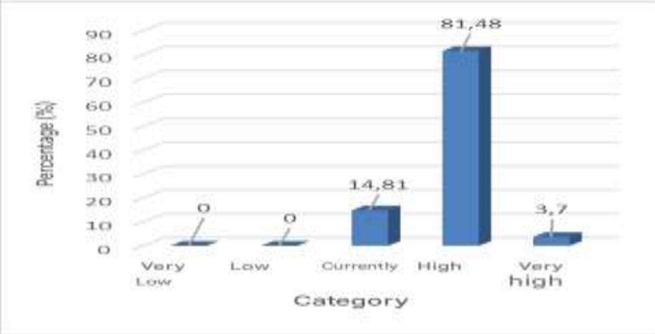

Figure 1. Distribution of students' science process skills scores in guided inquiry learning

Table 3. Statistical Data on Cognitive Abilities of Students Taught with Guided Inquiry Learning

Description	VIII A
Sample Size	27
Highest Theoretical Score	27
Lowest Theoretical Score	0
Highest Empirical Score	25
Lowest Empirical Score	12
Mean Score	18.56
Standard Deviation	4.18

Table 4. Frequency Distribution Data of Cognitive Ability Scores of Students Taught with Guided Inquiry Learning

Interval	Category	Frequency	Percentage (%)
0 - 5	Very low	3	11.11
6 - 11	Low	6	22.22
12 - 17	Currently	8	29.63
18 - 23	Tall	7	25.93
24 - 27	Very high	3	11.11
Total		27	100

Table 4 shows the distribution of cognitive ability scores. The majority of students were in the high (44.44%) and very high (22.22%) categories, while 22.22% were in the moderate category and 11.11% were in the low category. These data indicate that guided inquiry learning can improve cognitive abilities, particularly in logical, analytical, and conceptual thinking. These results are visualized in Figure 2.

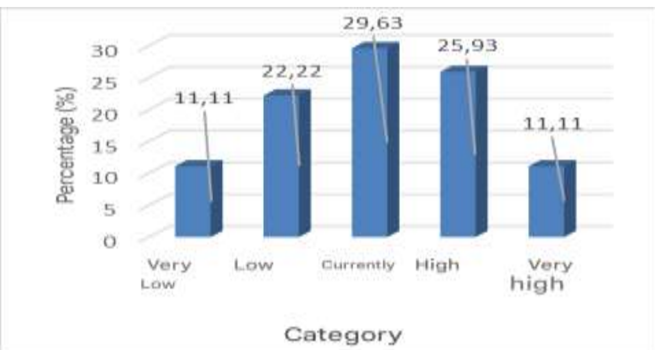

Figure 2. Distribution of student cognitive ability scores in guided inquiry learning

Overall, the distribution of KPS scores and cognitive abilities indicates that the majority of students are in the moderate to very high category. This confirms that guided inquiry learning is effective in improving students' science process skills and cognitive abilities.

Table 5. KPS Statistics for Students Taught with Direct Instruction

Description	VIII C
Sample Size	27
Highest Theoretical Score	26
Lowest Theoretical Score	0
Highest Empirical Score	21
Lowest Empirical Score	8
Mean Score	15.41
Standard Deviation	4.04

Based on Table 5, the average KPS score for class VIII C (the control class with direct learning) was 15.41 out of 26 questions, with the highest theoretical score being 26 and the lowest being 0. The standard deviation of 4.04 indicates that students' KPS learning outcomes were quite varied. This average score falls into the moderate category, according to the frequency distribution in Table 6.

Table 6. Frequency Distribution of KPS Scores for Students Taught with Direct Learning

Interval	Category	Frequency	Percentage (%)
0 - 5	Very low	0	0.00
6 – 11	Low	7	25.63
12 - 17	Currently	14	51.85
18 - 23	Tall	6	22.22
24 - 26	Very high	0	0.00
Total		27	100

Based on Table 6, 33.33% of students taught through direct learning achieved the high category, while the largest proportion (37.04%) were in the medium category. Furthermore, 29.63% were still in the low category. No students achieved the very high or very low category. This distribution is visualized in the following diagram.

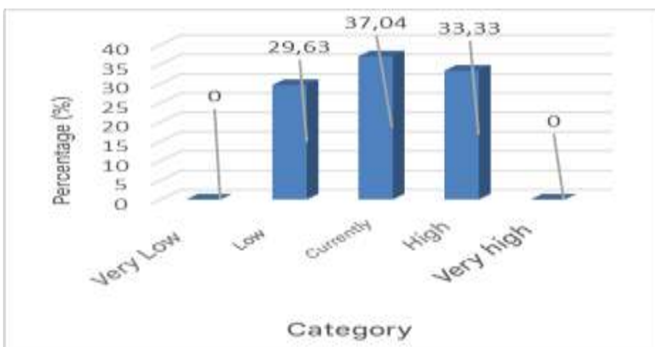

Figure 3. Distribution of students' science process skills scores in direct instruction

The diagram above shows that 33.33% of students are in the high category, while the majority are still in the medium (37.04%) and low (29.63%) categories. This indicates that direct instruction is less than optimal in increasing Science Process Skills evenly, so students' scientific skills still need to be improved. A description of the Cognitive Ability scores of students taught using direct instruction can be seen in Table 7.

Table 7. Statistical Data on the Cognitive Ability of Students Taught Using Direct Instruction

Description	VIII C
Sample Size	27
Highest Theoretical Score	27
Lowest Theoretical Score	0
Highest Empirical Score	22
Lowest Empirical Score	9
Mean Score	14.74
Standard Deviation	3.40

Table 7 presents data on the cognitive abilities of 27 students in grade VIII C taught using direct instruction. Scores varied between 12 and 25, with a mean of 14.74 and a standard deviation of 3.40. This mean falls into the moderate category, according to the frequency distribution in Table 8.

Table 8. Frequency Distribution of Cognitive Ability Scores for Students Taught Using Direct Instruction

Interval	Category	Frequency	Percentage (%)
0 - 5	Very low	0	0.00
6 – 11	Low	7	25.93
12 - 17	Currently	14	51.85
18 – 23	Tall	6	22.22
24 - 27	Very high	0	0.00
Total		27	100

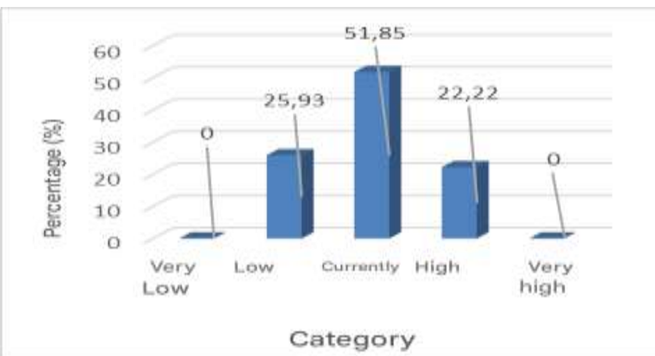

Figure 4. Distribution of student cognitive ability scores in direct learning

Based on Table 8, the majority of students (51.85%) are in the medium category. Furthermore, 25.93% are in the low category and 22.22% are in the high category. No students reached the very high or very low category. This indicates that direct learning is not yet optimally meaningful.

The bar chart in Figure 4 shows that the majority of students (51.85%) fall in the medium category. 25.93% fall in the low category, and 22.22% fall in the high category. This data indicates that direct learning has not been evenly distributed in improving students' cognitive abilities. The difference in average KPS scores between the two learning styles is shown in Table 9.

Table 9. Comparison of Average KPS Scores and Cognitive Ability in Guided Inquiry Learning and Direct Learning

Variables	Guided Inquiry (Average)	Direct Learning (Average)
Science Process Skills (SPS)	19.96	15.41
Cognitive Abilities	18.56	14.74

Table 9 shows the differences in average Science Process Skills (KPS) and cognitive abilities between students taught with guided inquiry and direct instruction. In terms of KPS, the guided inquiry group averaged 19.96, higher than the direct instruction group's 15.41. This indicates that guided inquiry is more effective in developing science process skills. In terms of cognitive abilities, the guided inquiry group also had a higher average of 18.56, compared to 14.74 for direct instruction. Although the difference was not as large as in KPS, these results still demonstrate the superiority of guided inquiry in improving students' understanding and cognitive abilities. These results are visualized in the following diagram.

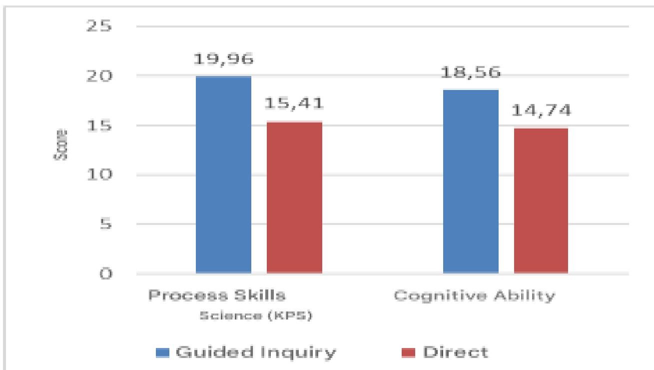

Figure 5. Comparison chart of Average KPS scores and cognitive abilities for guided inquiry learning and direct learning

Overall, the data shows that guided inquiry learning is more effective in developing KPS and produces more consistent results. This supports the belief that exploration-based and problem-solving learning can better develop science process skills. After descriptive analysis (mean, maximum, minimum, range, and standard deviation), a normality test using the

Shapiro-Wilk test was conducted due to the small sample size (27 students). This test was run using SPSS 25. Decision-making guidelines: if the significance value is >0.05, the data are normally distributed; if it is <0.05, the data are not normally distributed. The test results showed a cognitive significance value of 0.298 for the control class; a KPS for the control class of 0.146; a cognitive value of 0.194 for the experimental class; and a KPS for the experimental class of 0.136. All values were >0.05, indicating a normal distribution of the data. A homogeneity test was conducted to determine whether the data from both samples were homogeneous. The homogeneity test was processed using IBM SPSS Statistics Version 25.

The data to be tested for homogeneity were derived from the students' cognitive ability and cognitive skills scores. Data were considered homogeneous if the probability value in the Levene Statistic output was greater than the specified α value, which was 5% (α = 0.05). According to Table 8, the significance value (Sig.) for the homogeneity test for cognitive ability was 0.490 and for science process skills (SPS) was 0.060. Both values were greater than the 0.05 significance level, so H_0 was accepted. This means that the cognitive ability and SPS data had homogeneous variance, or the same distribution across both groups. Once the data were determined to be normally distributed and homogeneous, the next step was to conduct an independent t-test using SPSS version 25. The results of this test can be seen in Table 10.

Based on the results of the t-test for cognitive ability scores, a significance value of 0.001 ($p < 0.05$) was obtained. Because this value is smaller than 0.05, H_0 is rejected. This means that there is a significant difference between the cognitive abilities of students in the experimental class and the control class. Meanwhile, for Science Process Skills (SPS), a significance value of 0.000 ($p < 0.05$) was obtained. Because this value is also smaller than 0.05, H_0 is rejected. Thus, there is a significant difference between the SPS of students in the experimental class and the control class.

Table 10. Results of the KPS t-test and Cognitive Ability

Class	df	Sig. (2-tailed)	Mean Difference
Cognitive Abilities of the Experimental and Control Classes	52	0.001	3.81
	49.94	0.001	3.81
Science Process Skills of the Control and Experimental Classes Class	52	0.000	5.22
	42.15	0.000	5.22

Discussion

The purpose of this study was to analyze the Science Process Skills (SPS) scores and cognitive abilities of students taught using inquiry-based and hands-on learning. It also aimed to compare the differences in Science Process Skills (SPS) and cognitive abilities between two groups of eighth-grade students at SMPN 2 Bajeng Barat on the topics of Motion and Force and Work and Simple Machines in Daily Life. This research was conducted at SMP Negeri 2 Bajeng Barat, Gowa Regency. Table 1 shows that the average SPS score for class VIII A, the experimental class taught using guided inquiry learning, was 19.96 out of 26 questions, with a theoretical maximum score of twenty-six and a theoretical minimum of zero. The empirical score ranged from 16 to 24, with a standard deviation of 2.01. This average SPS score is in the high category. The frequency distribution in Table 2 clarifies that guided inquiry learning is highly effective in facilitating SPS improvement.

Almost all students, namely 96.29%, managed to achieve the medium to very high category. In detail, 4 people (14.81%) were in the medium category with a score of 11-15, 22 people (81.48%) achieved the high category (score 16-20), and 1 person (3.70%) was in the very high category (score 21-26). Importantly, no students were in the low or very low category. The dominance of the high category and the absence of scores in the low/very low categories indicate that guided inquiry learning successfully formed and strengthened essential scientific skills. This indicates that guided inquiry learning encouraged students' active involvement in the scientific process, which led to the development of good KPS. A visual depiction of the frequency distribution of students' KPS scores can be seen in the Bar Chart Figure 1. The diagram shows that more students obtained the "High" category in Science Process Skills, with the highest percentage reaching 81.48%. This indicates that guided inquiry learning is quite effective in developing students' science process skills. Only a small proportion of students fell into the "Very Low," "Low," and "Very High" categories.

Therefore, the data description and visualization above demonstrate the role of guided inquiry learning as an effective measure to promote students' Cognitive Performance Indicators (KPS). Table 3 presents statistical data on the cognitive abilities of 27 class VIII A students taught using guided inquiry learning. The data reveals that the highest possible theoretical score is 27, while the lowest theoretical score is 0. Empirically, students achieved the highest score of 25 and the lowest score of 12. The cognitive ability of students in this group had an average score of 18.56 with a standard deviation of 4.18, indicating a spread between the scores. This average cognitive ability score falls within the high category in the frequency distribution table shown in Table 4.

Table 4, a frequency distribution of students' cognitive ability scores, shows that the majority of students achieved a satisfactory level of cognitive ability, ranging from moderate to very high. Specifically, 8 (29.63%) students were in the moderate category, with scores ranging from 12 to 17. This is the highest proportion among all categories, indicating that most students were able to understand and apply cognitive concepts quite well. Furthermore, 7 (25.93%) students achieved the high category, with scores ranging from 18 to 23, reflecting increasingly complex and in-depth cognitive development. Three (11.11%) students even achieved the very high category (scores of 24–27), indicating exceptional achievement in more complex thinking skills. Although several students were in the low (6 or 22.22%) and very low (3 or 11.11%) categories, the overall data indicates that most students demonstrated adequate to excellent cognitive mastery.

The dominant composition in the moderate to very high category underscores the role of guided inquiry learning in encouraging students to effectively develop logical, analytical, and conceptual thinking skills. To provide a clearer visual depiction of the distribution of cognitive ability scores for students, see Diagram 2. The distribution diagram of students' Cognitive Ability scores in guided inquiry learning shows that the majority of students fall into the "Medium" (29.63%) and "High" (25.93%) cognitive ability categories. The percentage distribution for the "Very Low" and "Very High" categories is relatively similar, at 11.11% each, while the "Low" category has a percentage of 22.22%. This indicates that most students have moderate to high levels of cognitive ability in guided inquiry learning. Based on the description and visualization above, it strengthens the view that guided inquiry learning successfully facilitates active engagement and the development of students' thinking skills in the learning process (Umam et al., 2025).

The description of the Science Process Skills (SPS) scores of students taught with direct learning can be seen in Table 5. Based on Table 5, it was obtained that the average SPS score of class VIII C as a control class taught using direct learning was 15.41 out of 26 questions with the highest score of twenty-six and the lowest score of zero theoretically. The empirical score range was wider, namely 8 to 21, with a standard deviation of 4.04. This larger standard deviation indicates that the learning outcomes (SPS) of students in this group are more heterogeneous or varied. There is a greater difference between the scores of one student and another. The average SPS score is in the medium category in the frequency distribution table listed in Table 6. Based on the frequency distribution table of KPS scores of students taught with direct learning in Table 6, it shows that, although there is a fairly large proportion of students (22.22%) who successfully achieved KPS in the high category, indicating effectiveness for certain individuals or in mastering basic concepts. However, this data also highlights weaknesses in this learning, where the largest proportion of students (51.85%) are actually in the medium category. In addition, 25.93% of students are still in the low category, and no students reached the very high or very low category as can be seen in the following diagram (Figure 3).

Based on the diagram above, it shows that there are students who obtained high scores (22.22%). However, direct learning does not seem to be able to effectively encourage the full cognitive potential of students. Furthermore, the fact that the largest proportion (51.85%) is still in the "Medium" category and 25.93% in the "Low" category indicates that the majority of students have not been fully stimulated to go beyond the intermediate cognitive level or master the material in depth. Based on the data analysis above and the distribution visualization in Diagram 3, it is clear that direct instruction was less than optimal in facilitating the development of SLP evenly and in-depth for all students, thus their scientific skills still need further improvement. A description of the cognitive ability scores of students taught using direct instruction can be seen in Table 7. Table 7 presents statistical data on the cognitive abilities of 27 grade VIII C students taught using direct instruction.

The data shows that students' cognitive ability scores varied from 9 to 22, with an average of 14.74 and a standard deviation of 3.40. This average cognitive ability score falls into the medium category in the frequency distribution table presented in Table 8. Based on the data in Table 8, the frequency distribution of cognitive ability scores of students taught using direct instruction shows that the majority of students (51.85%) fall into the medium category. This indicates that most students have an intermediate level of cognitive understanding. However, there are also significant proportions in the low (25.93%) and high (22.22%) categories. No students achieved the "Very High" or "Very Low" category, indicating that although no students performed very poorly, this direct learning was also not able to encourage students to achieve their very superior cognitive potential. A visual depiction can be seen in Figure 4.

The bar chart of the distribution of cognitive ability scores of students in Direct Learning (Figure 4) clearly shows that the majority of students have cognitive abilities in the medium category, reaching 51.85%. This means that more than half of the students are at the medium level of ability. In addition, the graph also shows that about a quarter of students are in the low category (25.93%) and the rest are in the high category (22.22%). Based on the description of the descriptive data analysis and visualization through the bar chart of the distribution of students' cognitive ability scores above, it indicates that although direct learning can facilitate the development of cognitive abilities for some suitable students (Barta et al., 2022), its effectiveness is less evenly distributed in encouraging all students to achieve optimal understanding and mastery of the material (Widyasari & Hermanto, 2023).

Comparison of Average Science Process Skills (KPS) Scores and Cognitive Abilities: The differences in average KPS scores and cognitive abilities between the two learning styles indicate significant differences, as illustrated in Table 9. Table 9 provides a clear picture of the average achievement of Science Process Skills (KPS) and Cognitive Abilities of students between the groups taught using guided inquiry and direct instruction. These data indicate a significant difference in the cognitive achievement of the two groups. For the Science Process Skills (KPS) aspect, students who participated in guided inquiry demonstrated a higher average score of 19.96. This figure significantly exceeded the average KPS score of the direct instruction group, which was only 15.41. This difference indicates that the guided inquiry method is more effective in facilitating and developing students' science process skills compared to direct instruction (Almoslamani, 2022).

Similarly, for cognitive abilities, the guided inquiry group also had a higher average score of 18.56. Meanwhile, the average cognitive ability score in the direct learning group was 14.74. Although the difference was not as large as in the guided inquiry learning group, the average superiority in guided inquiry learning still confirms that this learning plays a greater role in fostering increased understanding and cognitive application in students (Acosta-Gonzaga & Ramirez-Arellano, 2022). We can visually illustrate this in the following diagram (Figure 5). Overall, these data provide strong evidence that guided inquiry learning plays a greater role in developing students' cognitive ability in general and is also more successful in creating consistency in results across students (Shi & Qu, 2021). This supports the idea that learning involving active exploration and problem-solving is more conducive to developing essential science process skills (Yu, 2024).

For cognitive ability, guided inquiry learning produced a higher average score (18.56) compared to direct learning (14.74). This indicates that, on average, guided inquiry plays a greater role in improving cognitive ability. Guided inquiry specifically had a higher proportion of students in the high and very high categories (a total of 37.04%) compared to direct learning (a total of 22.22% for the high and very high categories). It is noteworthy that in direct learning, approximately one-quarter of students (25.93%) remained in the low category, with none in the very low category. Meanwhile, in guided inquiry, although there was a larger proportion in the low (22.22%) and very low (11.11%) categories compared to direct learning, this learning also demonstrated success in bringing a significant proportion of students to more complex cognitive levels (the high and very high categories). This suggests that guided inquiry, while not yet fully addressing students in the low category, is more capable of encouraging students to reach their peak cognitive potential.

Discussion based on descriptive analysis consistently shows that guided inquiry learning is superior in facilitating the development of science process skills and cognitive abilities compared to direct instruction (Van Der Graaf et al., 2019). For science process skills, guided inquiry resulted in higher mean scores, smaller standard deviations (indicating consistency), and a very large proportion (96.29%) of students in the moderate to very high category, indicating its exceptional effectiveness in developing essential scientific skills (Atmojo et al., 2024). Similarly, for cognitive abilities, although not completely eliminating the low category, the higher mean scores and greater proportion in the high to very high category in guided inquiry indicate that this learning is able to promote a more comprehensive understanding and application of concepts (Dewanto et al., 2024).

Overall, through descriptive analysis, guided inquiry learning was shown to contribute more to students' science process skills and cognitive abilities compared to direct instruction. Guided inquiry learning, which actively engages students in discovering knowledge and solving problems, appears to be more conducive to skill development and in-depth understanding (Hsu & Chen, 2025). This study provides strong evidence that student-centered learning strategies, such as guided inquiry, can produce optimal learning performance in science process skills and cognitive abilities (Aulia et al., 2018). A normality test was conducted to determine whether the data obtained from the research results were normally distributed (Hamasha et al., 2022; Khatun, 2021). This test is essential before proceeding to parametric statistical analysis, one of which is the t-test. In this study, the normality test was conducted using the Shapiro-Wilk test using SPSS version 25. The decision-making guidelines for the normality test based on the significance value (Sig.) are: if the Sig. value is > 0.05, the data are normally distributed; conversely, if the Sig. value is < 0.05, the data are not normally distributed.

The results of the normality test showed that the significance value for cognitive ability in the control class was 0.298, the control class's cognitive ability was 0.146, the experimental class's cognitive ability was 0.194, and the experimental class's cognitive ability was 0.136. All four significance values were greater than 0.05, thus concluding that the data from each group, both the control and experimental, were normally distributed. This indicates that the research data is suitable for further analysis using parametric statistical techniques such as the independent t-test (Abdi, 2023). The normal distribution of each variable indicates that the data collected from both groups of students (control and experimental) had a reasonable distribution and did not deviate significantly from the normal distribution. This strengthens the validity of the research results because it indicates that the learning process implemented in both groups proceeded according to normal learning conditions without any significant outliers (Huber & Bannert, 2024).

In addition to the normality test, a homogeneity test was also conducted to determine whether the data variance between the two groups was similar (homogeneous) (Calle-Saldarriaga et al., 2021). The homogeneity test in this study was conducted using SPSS version 25 using Levene's Test for Equality of Variances. The decision-making criteria for the homogeneity test are: if the significance value is >0.05, the data are homogeneous, and if it is <0.05, the data are not homogeneous. The homogeneity test results show that the significance value for cognitive ability is 0.486, while for KPS it is 0.059. Both are greater than the 0.05 significance limit, so it can be concluded that the cognitive ability and KPS data from the control and experimental classes have homogeneous variances (Arrofa et al., 2025). Data homogeneity is crucial in a t-test because the basic assumption of a t-test is uniform variance between the two groups. The existence of this homogeneity strengthens the validity of the comparison results, as it indicates that any differences found in the t-test are not caused by differences in data distribution, but rather by the different learning treatments received by each group.

Based on the t-test results presented in Table 4.12, the significance value (Sig. 2-tailed) for cognitive ability was 0.001, which is smaller than 0.05. This indicates that there is a statistically significant difference between the cognitive abilities of students in the experimental class and the control class. The mean difference value of 3.815 indicates that the average cognitive ability of the experimental class is higher than that of the control class. However, when compared to the average value (experimental class 18.56 and control class 14.48), this difference, although statistically significant, can still be considered practically in the context of relatively short learning and an inquiry approach that emphasizes the scientific thinking process rather than direct mastery of the material (Arifin et al., 2025). Several factors that may have influenced these results include the diversity of student learning styles, initial motivation levels, and understanding of prerequisite material prior to treatment (Brühwiler & Blatchford, 2011).

Furthermore, learning environment conditions such as facility availability, class size, and teacher competency in implementing learning approaches can also be determining factors in the effectiveness of the methods used (Hanaysha et al., 2023). Therefore, although there are statistically significant differences, these results need to be interpreted taking into account the complex learning context. Meanwhile, the t-test results for science process skills obtained a significance value of 0.000, which is also less than 0.05. This indicates a highly significant difference between the experimental and control classes in terms of science process skills. The mean difference value of 5.222, with an average SQU of 19.96 for the experimental class and 15.41 for the control class, confirms the finding that guided inquiry learning is significantly more effective in improving students' SQU. The guided inquiry approach, which emphasizes observing, formulating hypotheses, conducting experiments, processing and interpreting data, and drawing conclusions, provides ample opportunity for students to actively develop scientific skills (Sa'adah et al., 2023).

Thus, it can be concluded that guided inquiry-based learning significantly contributes to improving students' science process skills and also positively impacts cognitive abilities, although its effectiveness is influenced by various contextual factors (AlAli & Al-Barakat, 2024). This supports the learning direction in the 2013 Curriculum, which emphasizes the importance of a scientific approach, exploration, and discovery in students' learning processes (Ramdhani et al., 2017).

Conclusion

This study also identified that differences in scores, especially in cognitive abilities, can be influenced by several factors, including: Shorts learning duration; The main focus of guided inquiry learning on the scientific process; Internal student factors (learning style, motivation); External factors of the learning environment (class size, facilities, teacher skills). Overall, the main conclusion of this study is that guided inquiry learning is superior to direct learning in improving students' Science Process Skills (SPS) and cognitive abilities.

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The authors declare no conflict of interest.

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