Journal of Biology Learning
Vol. 7., No. 2, September 2025, pp. 43-52
ISSN 2623-2243 (print), 2623–1476 (online)
http://journal.univetbantara.ac.id/index.php/jbl/index

The Relationship Between Science Process Skills and Concept Mastery Using Practical Methods in Senior High School Students

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Received July 29, 2025; accepted September 29, 2025; published September 30, 2025

ABSTRACT

Science process skills and conceptual mastery are two crucial aspects. Conceptual mastery involves understanding scientific concepts, while science process skills encompass the ability to conduct scientific work, apply concepts, predict and inquire, interpret and communicate, hypothesize, conclude, plan, and conduct experiments. The aim of this study is to determine the relationship between science process skills and conceptual mastery through practical methods. The research method employed is quantitative with a correlational design. The study population includes all 11th-grade MIPA students at SMA Negeri 1 Bumi Agung, Lampung, with cluster random sampling used to select Class XI MIPA 1 as the sample. Data collection involved observation sheets and tests. Data analysis was conducted using Pearson product-moment correlation coefficient. The correlation analysis began with testing prerequisites such as normality and linearity, confirming that the data were normally distributed and linear. The correlation between science process skills and conceptual mastery yielded an pearson correlation coefficient (r) of 0.940 with N = 32. The critical value (r-table) was 0.349. Since 0.940 > 0.349 and the significance value (2-tailed) was 0.00 < 0.05, H0 was rejected and H1 was accepted, indicating a very strong relationship between science process skills and conceptual mastery through practical methods. Theoretically, these findings affirm the importance of practice-based learning in strengthening conceptual understanding. Practically, the results recommend integrating structured laboratory activities to enhance students' scientific inquiry skills and conceptual mastery.

KEYWORDS

Science Process Skills,
Concept Mastery,
Practical Methods

1. Introduction

Science process skills and conceptual mastery are two crucial aspects (Juniardi & Nurita, 2019). Conceptual mastery involves understanding scientific concepts (Rahmawati & Kusuma, 2019). while science process skills refer to the ability to engage in scientific work (Sari et al., 2019) apply concepts, predict, and inquire (Widyanti et al., 2020), interpret, communicate, hypothesize (Astra & Wahidah, 2017), conclude, plan, and conduct experiments (Kurniawati, 2018). Science process skills not only demonstrate understanding or learning difficulties (Putri et al., 2022) but also evaluate learning outcomes and support the development of thinking patterns (Fitriana et al., 2019; Rosalia et al., 2021), helping students become creative, innovative, critical, and competitive (Mutmainnah et al., 2019; Siswono, 2017).

Science process skills encompass cognitive abilities, practical skills, and social interactions in scientific contexts used by students in learning (Darmaji et al., 2022; Sumarti et al., 2018). These skills are not just about speaking but enable students to act (Dari & Nasih, 2020; Hasanah et al., 2018), enhancing motivation and learning outcomes by actively and efficiently involving students in learning (Bulkini & Nurachadijat, 2023), science process skills help students complete learning tasks, develop skills, and deepen conceptual understanding (Bariyah & Sugandi, 2022; Ratnawati, 2020).

Practical methods strengthen the connection between science process skills and conceptual mastery (Nuai & Nurkamiden, 2022). Through practical activities, students can master concepts, facts,

ISSN 2623-2243 (print), 2623–1476 (online)
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and scientific processes more deeply and concretely, discovering scientific concepts (Suryaningsih, 2017; Syafi'ah et al., 2022). Science process skills play a crucial role in discovering and understanding concepts (Trihono, 2022), actively engaging students through practical work, promoting scientific development (Putri et al., 2022; Siswono, 2017). Practical work enhances students' interest in learning materials and reinforces understanding; through engaged sensory observation, students interpret experiences and respond to objects (Darmaji et al., 2022; Rabiudin Ergouna, 2023). Although science process skills, conceptual mastery, and practical methods have been studied individually, there is limited research that examines how practical methods specifically mediate the relationship between science process skills and conceptual mastery, especially in rural senior high school settings like SMA Negeri 1 Bumi Agung. This gap hinders a comprehensive understanding of how these elements interact in real learning environments, making it necessary to investigate their relationship to improve science education effectiveness in such contexts

Previous research has shown that practical methods positively contribute to conceptual understanding (Nisa, 2018). Science process skills influence conceptual mastery (Siswono, 2017), strongly correlating with learning outcomes (Lestrai et al., 2020), and can determine levels of knowledge (Irwanto et al., 2019; Sucahyo, 2020),. Therefore, an analysis of the relationship between science process skills and conceptual mastery through practical methods is necessary.

2. Method

Data collection involved observation sheets and a "Food Substance Testing" test consisting of 30 multiple-choice questions to measure conceptual mastery. The relationship between science process skills and conceptual mastery was analyzed using Pearson correlation in SPSS Version 16.0 for Windows. This study is a non-experimental research employing a quantitative correlational approach to examine the relationship between science process skills and conceptual mastery. The population of this study consisted of all 11th-grade science (MIPA) students at SMA Negeri 1 Bumi Agung, Lampung, totaling 128 students. Cluster random sampling was employed to select Class XI MIPA 1 as the sample group. The sample size consisted of 32 students, representing the selected class. The criteria of results were based on the correlation coefficient intervals. Correlation testing begins with prerequisite tests such as normality and linearity tests (Table 1) (Sarwono, 2006).

Table 1. Interval of Correlation Coefficient Relationships

Correlation Coefficient	*Criteria*
0	No correlation
0 – 0,25	Very weak correlation
0,25 – 0,5	Weak correlation
0,5 – 0,75	Strong correlation
0,75 – 0,99	Very strong correlation
1	Perfect correlation

Table 1 presents the interpretation criteria for the correlation coefficient values used in this study. The correlation coefficient (r) indicates the strength and direction of the linear relationship between two variables. An r value of 0 signifies no correlation, whereas an r value of 1 indicates a perfect correlation. Values between 0 and 1 are categorized into levels of association, ranging from very weak to very strong. These criteria were applied in this study to determine the degree of relationship between the analyzed variables.

3. Results and Discussion

Correlation testing begins with prerequisite tests such as normality and linearity tests, with the following results obtained

Table 2 . Normality Test

N	*Kolmogorov-Smirnov Z*	*Asymp. Sig. (2-tailed)*
32	0.627	0.827

Based on the Kolmogorov-Smirnov test results (Table 2), the significance value obtained was 0.827, which is greater than the threshold of 0.05. Therefore, the null hypothesis (H_0), stating that the data are normally distributed, is not rejected. This finding confirms that the dataset meets the assumption of normality and is suitable for subsequent parametric statistical analyses.

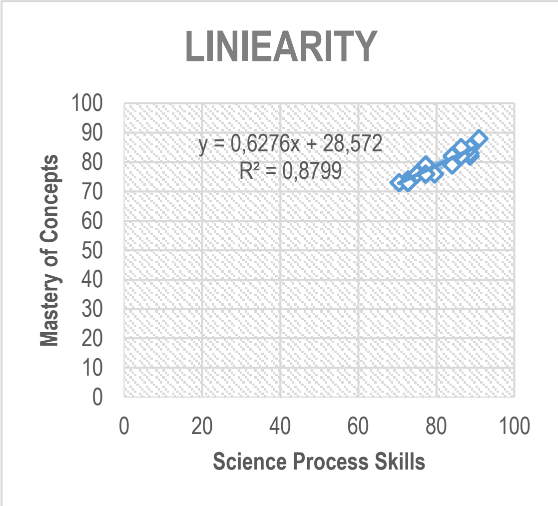

Figure 1. Linearity Test

Figure 1 The analysis results show that the coefficient of determination (R^2) value is 0.8799, which indicates that 87.99% of the variation in students' concept mastery can be explained by science process skills. This finding strengthens the results of the Pearson correlation test, where the relationship between the two variables is not only statistically significant but also has a high explanatory power for data variation. Subsequently, a product moment correlation test was conducted after verifying that the data are normally distributed and linear.

Tabel 3. Pearson Correlation Test

		X	*Y*
X	Pearson Correlation	1	.940**
	Sig. (2-tailed)		.000
	N	32	32
Y	Pearson Correlation	.940**	1
	Sig. (2-tailed)	.000	
	N	32	32
**. Correlation is significant at the 0.01 level (2-tailed).			

The results of the Pearson correlation test (Table 3) between science process skills and mastery of concepts yielded an empirical correlation coefficient (r) of 0.940 with a sample size (N) of 32. The critical value of the product moment correlation coefficient at a 5% significance level ($\alpha = 0.05$) is r_critical = 0.349. Since 0.940 > 0.349, and the p-value (2-tailed) of 0.00 < 0.05, we reject the null hypothesis (H0) and accept the alternative hypothesis (H1). This indicates a very strong relationship between science process skills and mastery of concepts. These findings are consistent with previous studies showing that I emphasizes contextual and hands-on approaches significantly enhance students' science process skills in environmental science topics (Hermanto et al., 2022). This finding further supports the strong correlation between science process skills and conceptual understanding obtained in this study.

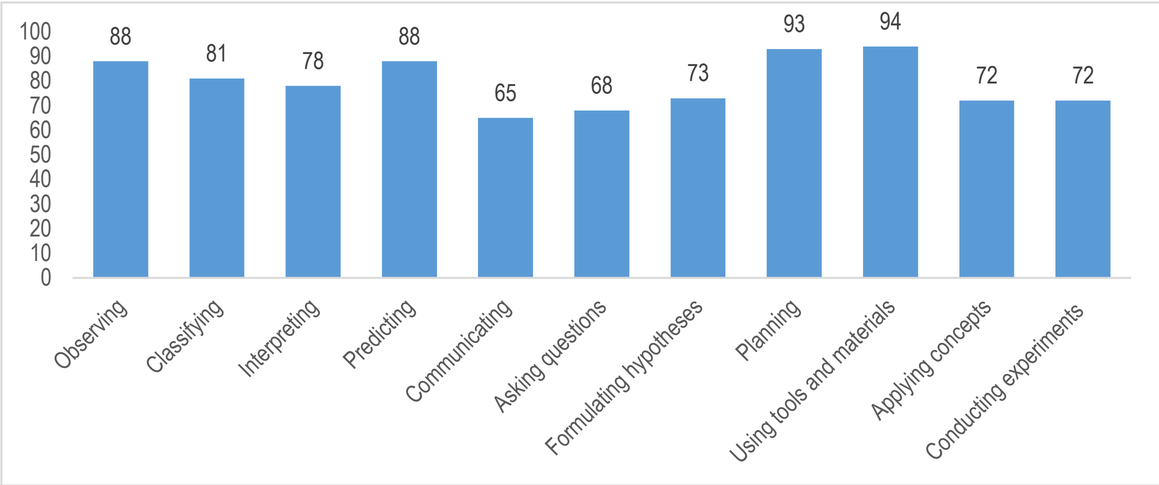

Figure 2. Results of Science Process Skills by Indicator

Figure 2 shows science process skills across indicators: observing at 88% with very high criteria, classifying at 81% with very high criteria, interpreting at 78% with very high criteria, predicting at 88% with very high criteria, communicating at 65% with high criteria, questioning at 68% with high criteria, hypothesizing at 73% with high criteria, planning experiments at 93% with very high criteria, using tools and materials at 94% with very high criteria, applying concepts at 72% with high criteria, and conducting experiments at 72% with high criteria.

Figure 3 illustrates the level of students' concept mastery across six indicators (C1–C6). Each indicator reflects varying levels of achievement, ranging from moderate to very high criteria, thereby providing a comprehensive overview of students' conceptual understanding in the assessed material.

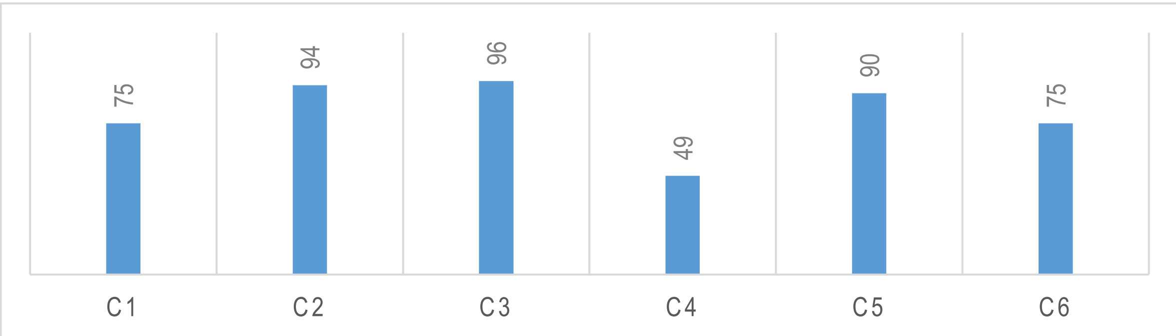

Figure 3. Results of Concept Mastery by Indicator

Figure 3 shows the results of students' concept mastery across six indicators (C1–C6). The analysis reveals that C1 (75%) and C6 (75%) fall into the high criteria, while C2 (94%), C3 (96%), and C5 (90%) are categorized as very high. In contrast, C4 (49%) is the lowest, falling into the moderate category. These findings indicate that students generally demonstrate strong mastery of concepts, particularly in C2, C3, and C5, although difficulties remain in C4, which suggests the need for further reinforcement in that specific aspect of learning.

This research was conducted at SMA Negeri 1 Bumi Agung to investigate the relationship between science process skills and conceptual mastery through the practicum method. Based on the research results, data on science process skills were obtained through observation, and conceptual mastery was assessed through tests. The correlation test began with prerequisite tests of normality and linearity, which resulted in data showing normal and linear distributions. Subsequently, the parametric Pearson correlation test revealed a strong positive relationship between science process skills and conceptual mastery through the practicum method. This means that higher science process skills correspond to higher conceptual mastery, while lower science process skills correspond to lower conceptual mastery. A strong correlation between the two variables indicates a significant relationship, suggesting that changes in one variable tend to coincide with proportional changes in the other variable. Significant correlations can be positive, where both variables move in the same direction, or negative, where they move in opposite directions (Mustafa, 2023). The direction is expressed in terms of a positive relationship ($0 \leq r \leq 1$) or a negative relationship ($-1 \leq r \leq 0$) (Vusvitasari et al., 2021).

The practicum method significantly contributes to the development of science process skills and conceptual understanding among students. Science process skills are crucial keys that students must possess to measure and manage the steps and preparations needed during the learning process. Essentially, students with structured and effective learning strategies will achieve optimal conceptual understanding. In the context of biology, science process skills enable students to observe, classify, interpret, predict, communicate, formulate questions, hypothesize, plan experiments, use tools and materials, apply concepts, and conduct experiments (Anita & Turatea, 2022).

Concept mastery is a primary indicator of learning success. In biology education, specifically, concept mastery requires students to understand concepts, principles, and facts based on their experience (Harisanti et al., 2024). Each indicator of science process skills is linked to indicators of concept mastery. For instance, the concept mastery indicator of remembering (C1) achieves a high category, which can be attained through science process skills indicators such as observing and grouping, both of which also obtain very high percentages. Understanding (C2) of concept mastery achieves a very high category, which can be accomplished through interpreting and predicting, also scoring very high. This aligns with research conducted by (Trihono, 2022), which posits that understanding scientific concepts is a sign or measure of success in learning. This necessitates students' abilities to understand concepts, principles, and facts based on their experiences. Meanwhile, science process skills enable students to conduct observation, measurement, data collection, data analysis, and conclusion. The applying indicator (C3) achieves a very high category, which can be accomplished through communication indicators, asking questions, and proposing hypotheses that obtain high categories. This is in line with research conducted by (Sulastri et al., 2024) which learning with the practical method, students are invited to carry out experiments and can interact more with the environment because in essence, in science learning, students are invited to get to know the natural surroundings. The analysis (C4) achieved a moderate category, which should be achieved through trial planning indicators and using tools and materials that actually achieved very high categories. Students had difficulties in several aspects, such as parsing the material to find a comprehensive connection, sorting information into relevant and irrelevant parts, identifying information so that it was structured in an organized structure, as well as finding the pattern of relationships between parts of each structure of information (Saraswati & Agustika, 2020). Synthesizing (C5) achieved a very high category, which was achieved through applying concepts that were also very high, and evaluating (C6) achieved a high category, which was achieved through implementing experiments that were also high, and can be interpreted all indicators of science process skills have a very strong and positive relationship with the mastery of concepts through practicum methods, this is in accordance with research (Santoso & Kolonial Prodjosantoso, 2021) measurement results of cognitive aspects demonstrate high category schools typically have high levels of cognitive mastery and process compared to medium and low category schools.

The results of this conducted research indicate a strong positive correlation between science process skills and concept mastery through practical methods. This means that there is a significant relationship between students' science process skills and their concept mastery, as evidenced by the coefficient correlation (r) value indicating a very strong relationship. Therefore, it can be concluded that higher science process skills correlate with higher concept mastery. This finding is consistent with research conducted by (Trihono, 2022), which the research results illustrate a positive correlation between science process skills and conceptual understanding. This is supported by research (Tenri K et al., 2022), indicating that effective application of science process skills can significantly enhance students' mastery

ISSN 2623-2243 (print), 2623–1476 (online)
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of science concepts in elementary school. Additionally, (Sumadiyo et al., 2020) found that problem-based learning significantly improves both concept mastery and science process skills compared to conventional teaching methods. This learning model specifically strengthens science process skills, ultimately deepening overall concept understanding.

Science process skills can be developed through practical methods, as indicated by the results of the study where all science process skill indicators emerged in the food substance testing practical such as the observation indicator achieving a very high category through the practical method. Students observed various types of food like tofu, rice, eggs, bananas, and sweetened condensed milk that were being tested. The grouping indicator also achieved a very high category through the practical method, where students categorized tools and materials ranging from biuret, Benedict's solution, iodine, oil paper, tofu, rice, eggs, bananas, and sweetened condensed milk used in the experiment. The observation/observation indicator influences the level of concept mastery, with the remembering indicator (C1) achieving a high category. Students' observation and categorization in science process skills received very high percentages, thereby resulting in high remembering (C1) percentages as well. The interpreting indicator achieved a very high category through the practical method, where students determined the colors expected to appear in the food tests: iodine resulting in purple, biuret resulting in blue, and Benedict's solution resulting in brick yellow/green.The predicting indicator also achieved a very high category through the practical method, as students correctly placed food items such as rice, tofu, bananas, eggs, and sweetened condensed milk into the apparatus used in the experiment. Similarly, the understanding indicator (C2) achieved a very high category, which relates to the interpreting and predicting indicators also achieving very high categories. This aligns with research by (Trihono, 2022) indicating that understanding scientific concepts is a crucial indicator of learning success. Understanding concepts in learning requires students to comprehend principles and facts based on their own experiences. Teaching science process skills enables students to perform observations, measurements, data collection, data analysis, and draw conclusions.

The communication indicator achieved a high category through the practical method, where students filled out tables and engaged in sequential question-answer activities. However, the percentage was somewhat lower because students inputted their test results at the end of the experiment. The questioning indicator also achieved a high category because students actively inquired about the importance of nutrients such as carbohydrates, proteins, vitamins, and fats in daily life, similar to formulating hypotheses. The applying (C3) indicator achieved a very high category, which is related to the communication, questioning, and hypothesis-formulating indicators that also achieved high categories. This is consistent with research by (Ariyansyah & Nurfathurrahmah, 2022)
indicating an improvement in all concept mastery indicators, albeit still in a relatively low category. Despite cognitive aspects showing improvement across the same category, the highest improvement occurred in the concept mastery aspect. The applying (C3) indicator, on average, achieved a very high percentage. The planning experiment indicator achieved a very high category through the practical method, where students selected tools/materials starting from the distribution of iodine, Benedict's solution, biuret, and oil paper. Students began matching the liquids to be used to test food substances like carbohydrates, proteins, fats, and vitamins, applying the experimental concept with great enthusiasm, indicating an increased curiosity in science process skills. The analyzing (C4) indicator achieved a moderate category. This percentage is related to the planning experiment and using tools and materials, which were very high. This aligns with research conducted by (Aripin & Suryaningsih, 2021), showing that students' concept mastery improved within a moderate criteria interval.

The applying concept indicator achieved a high category, with students observing the results of the experiment. The conducting experiment indicator also attained a high category through the practical method, where students inserted, retrieved, and left the tools and materials of the experiment until the trial exhibited the predetermined color. The synthesizing (C5) indicator obtained a very high category, correlating with the applying concept indicator. Meanwhile, the evaluating (C6) indicator received a high category, which relates to the conducting experiment indicator. All these science process skills indicators are correlated with students' concept mastery indicators, as found through scientific methods in practical sessions. Research conducted by (Santoso & Kolonial Prodjosantoso, 2021) indicates that higher scores in cognitive aspect measurements are typically associated with schools categorized as high, compared to those categorized as moderate or low. These high categories stem from schools where science learning activities often incorporate laboratory practical sessions.

The results show that most indicators of science process skills and concept mastery fall into the very high category, although the communicating indicator and analyzing indicator are still lower compared to other indicators such as observing, predicting, and applying. These two indicators are interrelated within the flow of scientific thinking. Weak analysis makes it difficult for students to break down data and identify patterns, resulting in less structured outcomes being presented.These research results are consistent with the study conducted by (Trihono, 2022) on grade VIII students at SMPN 1 Playen, which showed that the relationship between science process skills and concept understanding in the learning process indicates a significant positive correlation, similar to the findings of (Siahaan et al., 2020) showing a positive correlation between science process skills and students' mastery of science concepts.

4. Conclusion

Based on the findings, it can be concluded that there is a very strong and positive correlation between science process skills and students' conceptual mastery through practical methods in the subtopic of food substance testing. The Pearson correlation coefficient obtained was $r = 0.940$ ($N = 32$, $p < 0.05$), which is significantly higher than the critical value ($r = 0.349$), confirming that students with higher science process skills tend to achieve better conceptual mastery.

Theoretically, these results reinforce the notion that science process skills serve as a foundation for building deeper scientific understanding, thereby supporting learning theories that emphasize inquiry and experiential approaches. Practically, the findings highlight the importance of integrating structured laboratory activities into biology learning, as they not only strengthen students' scientific inquiry skills but also enhance their conceptual understanding. Nevertheless, this study was limited to a single class with a relatively small sample size, which may restrict the generalizability of the findings. Future research should involve larger and more diverse samples, explore different biological topics, and examine additional variables—such as critical thinking or scientific attitudes—to provide a more comprehensive understanding of how practical methods contribute to meaningful science learning.

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