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ORIGINAL ARTICLE

Hands-On, Minds-On: The Impact of Home-Based Experiments on Scientific Process Skills of Indonesian Middle School Students

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ABSTRACT

This study investigated the interrelationships among science process skills (SPSs) developed through home-based experiments (HBEs) and examined the correlation between SPS and science literacy (SL) among middle school students. Employing a qualitative correlational design, the study involved 77 seventh-grade students in Aceh Province, Indonesia. Data were collected through test instruments and structured observation sheets. Kendall's tau-b correlation analysis indicated a moderate positive relationship between the observing and hypothesizing components ($\tau = 0.579$, $p < 0.001$) as well as between interpreting data and drawing conclusions ($\tau = 0.478$, $p < 0.001$). A weak yet significant correlation was found between conducting experiments and communicating results ($\tau = 0.380$, $p = 0.001$). In contrast, Spearman's rho revealed no significant association between overall SPS and SL ($\rho = 0.125$, $p = 0.281$). These findings suggest that while HBE effectively facilitates the development of hands-on scientific competencies, it does not necessarily enhance students' text-based SL. The results underscore the distinction between procedural and conceptual scientific understanding, emphasizing the need for integrative approaches in science instruction. In addition, students exhibited high engagement during HBE activities, particularly in the observation and experimentation phases, highlighting the motivational potential of home-based inquiry.

KEY WORDS: Science process skills, home-based experiments, science literacy, middle school students, correlational study

INTRODUCTION

The COVID-19 pandemic has profoundly disrupted educational systems across the globe, prompting a reconfiguration of conventional teaching practices. One of the most pressing challenges faced during school closures was ensuring the continuity of science education, particularly in maintaining students' engagement with hands-on learning experiences (Mbhiza, 2021; Salehi et al., 2023). While digital tools and remote learning platforms provided a temporary solution for content delivery, they were often insufficient for supporting the practical, inquiry-based nature of science instruction. Moreover, unequal access to internet services and digital devices has complicated the implementation of fully remote learning in diverse socioeconomic contexts (Inloes et al., 2023; Meng et al., 2024; Pelikan et al., 2021).

In response to these limitations, many educators have turned to home-based experiments (HBEs) as a flexible alternative to conventional laboratory work (Cattan et al., 2021; Velarde et al., 2022). This approach enables students to perform simple scientific investigations at home using accessible materials, while still engaging in core scientific practices. With teacher guidance, learners designed and conducted experiments, collected data, and drew conclusions – all outside the traditional classroom environment (Dayagbil et al., 2021; Hao, 2023). As such, HBE offers a contextually relevant method for sustaining experiential science learning amid mobility restrictions.

Beyond its practicality, HBE holds promise in supporting the development of science process skills (SPSs), which are foundational to scientific reasoning and science literacy (SL). SPS includes a range of interconnected skills, such as observing, hypothesizing, experimenting, analyzing data, and communicating findings (Alvina et al., 2022; Anjugam and Chellamani, 2024). These competencies are not only central to mastering scientific concepts but are also crucial in equipping students with the cognitive tools needed for critical thinking, evidence-based decision-making, and lifelong learning (García-Carmona, 2023; Gizaw and Sota, 2023; Rini and Aldila, 2023). In this study, SL is defined as the ability to understand, interpret, and apply scientific knowledge in everyday contexts. It is operationalized through a concept test assessing students' grasp of scientific principles addressed during the experiments. This approach aligns with the framework of Fang and Wei (2010), focusing on text-based comprehension and application, thus distinguishing it from the procedural focus of SPS. In the context of HBE, students are given authentic opportunities to practice SPS in familiar settings, thereby linking theoretical knowledge with everyday experiences.

Despite the perceived benefits of HBE, few empirical studies have systematically examined the extent to which HBE supports the development of SPS, especially among middle school students. Furthermore, while it is assumed that engaging in scientific practices fosters conceptual understanding, the relationship between students' SPS and their SL remains unclear. Some evidence suggests that procedural proficiency in experimentation does not always translate into conceptual mastery, raising concerns about how hands-on learning should be integrated with theory-driven instruction (Mellyzar et al., 2022; Robledo et al., 2023).

To further understand this gap, it is important to conceptually distinguish between SPS and SL. SPS refers to a set of cognitive and procedural abilities such as observing, hypothesizing, experimenting, interpreting data, and communicating findings that are essential for engaging in scientific inquiry and reasoning (Anjugam and Chellamani, 2024). Meanwhile, SL involves the capacity to understand scientific concepts, apply them in real-life contexts, evaluate scientific information critically, and make evidence-based decisions understanding (Fang and Wei, 2010). Although interrelated, these constructs develop along different trajectories: SPS focuses on the procedural "doing" of science, while SL emphasizes the conceptual "understanding" of science. The present study adopts a framework that views SPS as foundational but not sufficient for achieving full SL, especially in the absence of explicit reflection and conceptual integration. Previous studies have shown that procedural engagement alone does not guarantee improved literacy outcomes (Gizaw and Sota, 2023), highlighting the need for instructional approaches that integrate hands-on experimentation with deeper scientific reasoning.

Given these gaps, this study seeks to investigate the effectiveness of HBE in supporting the acquisition of SPS and to explore their association with students' SL. To guide this inquiry, the following research questions were formulated:

1. To what extent do HBE support the development of middle school students' SPS?
2. Which components of SPS (e.g., observing, hypothesizing, experimenting, interpreting data, drawing conclusions, and communicating) are most and least developed through HBE?
3. What are the interrelationships among individual SPS components developed during HBE – for example, the relationship between observing and hypothesizing or interpreting data and drawing conclusions?
4. How is students' performance in experimentation related to their ability to communicate scientific findings within the HBE context?
5. Is there a significant correlation between students' overall SPS and their levels of SL?
6. What factors may contribute to the absence of a significant relationship between SPS and SL in the context of HBE?
7. How can instructional design be improved to better integrate hands-on experimental learning with the development of conceptual understanding and SL?

By addressing these questions, the study aims to contribute to the development of more holistic and integrated approaches to science education – approaches that hopefully bridge the gap between "doing" science and "understanding" science.

LITERATURE REVIEW

HBE in Science Education

The emergence of HBE as a pedagogical approach was driven primarily by the unprecedented challenges brought about by the COVID-19 pandemic. With limited access to school laboratories, science educators were compelled to find alternative strategies that preserved the experiential nature of science instruction (Velarde et al., 2022). HBE involves students conducting scientific investigations using readily available household materials under the guidance of teachers, often through remote or asynchronous instruction (Dayagbil et al., 2021; Schultz et al., 2020). This approach emphasizes learner autonomy, creativity, and adaptability – elements that align with the core philosophy of inquiry-based science education.

Several studies have noted that HBE fosters student engagement by encouraging learners to connect scientific concepts with real-world contexts (Hao, 2023; Robledo, 2021). For instance, students may explore chemical reactions using kitchen ingredients or investigate density through common objects. These activities not only sustain motivation during periods of remote learning but also make science more relevant and accessible. Moreover, HBE has been reported to cultivate students' sense of ownership in learning, as it shifts the responsibility for experimentation from the teacher to the learner (Abirin, 2023).

Despite these advantages, HBE presents implementation challenges, including disparities in home resources, varying levels of parental support, and inconsistent teacher guidance (Alea et al., 2020; Cattan et al., 2021). Therefore, while HBE offers promise as an alternative learning model, its effectiveness depends on thoughtful instructional design and equitable access to materials and support systems.

SPS and Their Educational Significance

SPS refers to a set of cognitive and procedural competencies essential for conducting scientific inquiry. These skills include but are not limited to observing, hypothesizing, experimenting, interpreting data, drawing conclusions, and communicating results (Anjugam and Chellamani, 2024). SPS are regarded as foundational to science education because they bridge procedural engagement with conceptual understanding. Students who effectively develop SPS tend to demonstrate stronger abilities in scientific reasoning, critical thinking, and problem-solving – skills that are increasingly vital in the 21st-century knowledge society (García-Carmona, 2023; Rini and Aldila, 2023).

A growing body of literature emphasizes that SPS are not developed in isolation but rather emerge from meaningful engagement with scientific practices in authentic contexts. For example, Wola et al. (2023) argue that observation and measurement activities are most effective when tied to students' investigations of real phenomena. Similarly, hypothesis generation and experimental design require learners to make inferences, evaluate evidence, and revise their thinking – processes that demand both scaffolding and reflection (Gizaw and Sota, 2023). Moreover, scientific communication, often underemphasized, plays a critical role in helping students articulate their reasoning, share findings, and engage in scientific discourse (Mercer-Mapstone and Matthews, 2017).

While traditional laboratory environments are well-suited for cultivating SPS, alternative formats such as HBE have shown potential in developing similar competencies, particularly when instructional support is intentionally embedded.

The Intersection of HBE and SPS: Gaps and Emerging Questions

Although numerous studies have documented the individual benefits of HBE and the importance of SPS in science learning, few have explicitly examined the relationship between the two. Robledo (2021) suggests that HBE provides students with opportunities to practice core SPS in informal settings. However, the extent to which such practice leads to measurable development in SPS remains underexplored, particularly in diverse educational contexts. Furthermore, research remains limited on which specific components of SPS – such as hypothesizing or interpreting data – are most effectively supported through HBE-based activities.

In addition, little is known about how the development of SPS through HBE correlates with broader SL. Some studies suggest that hands-on activities alone do not guarantee conceptual understanding (Cattan et al., 2021). This raises important pedagogical questions about how instructional design can better integrate procedural learning with content-based reflection and communication.

Taken together, these gaps underscore the need for empirical investigation into the specific contributions of HBE to students' scientific development. By exploring the interrelationships among SPS components and their alignment with SL outcomes, this study aims to fill a critical void in the current literature and offer practical implications for science instruction in both remote and blended learning environments.

While previous studies have independently examined the benefits of HBE and the role of SPS in science education, few have investigated the interconnections between these elements. Moreover, the existing literature seldom addresses how HBE impacts the development of SPS in relation to students' SL. This study fills this gap by analyzing the procedural–conceptual interface using a correlational design. It provides novel evidence on how specific SPS components – developed through HBE – relate to conceptual understanding as measured by SL assessments. By doing so, the study offers an integrated perspective that moves beyond fragmented discussions of practice and content in science education.

MATERIALS AND METHODS

Methods

This study employed a quantitative correlational design to investigate the relationships between students' SPS and their conceptual understanding in the context of HBE learning. A correlational design was deemed appropriate as it facilitates the examination of statistical associations between naturally occurring variables without experimental manipulation. Specifically, the research focused on identifying how key SPS components – observing, hypothesizing, experimenting, interpreting data, and communicating – correlate with students' mastery of scientific concepts. This approach enables a comprehensive analysis of the extent to which active engagement in HBE-based practices supports both procedural and conceptual learning outcomes.

Participants

The participants comprised 77 seventh-grade students from three public junior high schools in Aceh Province, Indonesia. One class from each school was purposively selected based on the following criteria: (1) The availability of basic experimental instruction in the science curriculum; (2) accessibility and cooperation from school administrators; and (3) willingness to implement HBE-based instruction. The sample included 25 students from School 1, 30 from School 2, and 22 from School 3. Within each class, the students were organized into collaborative groups of 4–5 members to encourage peer interaction and facilitate cooperative learning during the HBE sessions.

Instruments

Two main instruments were utilized for data collection:

- Science concept test: A paper-based assessment developed to measure students' conceptual understanding related to the subject matter of the experiments. The test items focused on fundamental content in physical and chemical sciences.
- Observation sheet: A structured observation rubric used to evaluate students' SPS during experimental activities. The rubric included such indicators as observing, hypothesizing, experimenting, interpreting data, drawing conclusions, and communicating. Each indicator was rated on a four-point Likert scale, ranging from 1 (not demonstrated) to 4 (consistently demonstrated).

All instruments were validated by subject-matter experts for clarity, relevance, and alignment with research objectives. During the HBE sessions, students engaged with guided worksheets containing theoretical explanations and step-by-step instructions for three experiments: (1) Measuring the density of solid objects, (2) identifying food substances, and (3) producing liquid soap. Trained observers recorded student behaviors corresponding to each SPS component throughout the activities. A post-test was administered at the end of the sessions to evaluate students' conceptual mastery.

Data Analysis

Data were analyzed using IBM Statistical Package for the Social Sciences Statistics version 25. Given that the data were derived from structured observation sheets using a four-point Likert scale, the indicators of students' SPS were treated as ordinal-level variables. Ordinal data, by definition, have a meaningful order but exhibit unequal intervals between values, making them unsuitable for traditional parametric tests which typically assume normal distribution and require interval-level measurement.

Due to the ordinal nature of the observation data, non-parametric statistical procedures were employed to investigate the relationships between key variables, including:

- Kendall's tau-b correlation coefficient to examine the strength and direction of relationships among the pairs of SPS indicators: (1) Observing and hypothesizing, (2) experimenting and communicating, and (3) interpreting data and drawing conclusions
- Spearman's rank-order correlation to assess the relationships between overall SPS scores and students' scientific concept mastery.

To analyze the associations among individual SPS components, Kendall's tau-b correlation coefficient was chosen due to its appropriateness for ordinal data and its robustness in handling tied ranks – common in small-scale educational assessments. Kendall's tau-b was preferred over Spearman's rho for inter-SPS comparisons because of its stronger performance in detecting monotonic relationships in moderate sample sizes where ties may be present. A significance threshold of $p < 0.05$ was applied for the analysis.

Further, to explore the relationships between overall SPS scores and SL scores, Spearman's rank-order correlation was used. Spearman's rho is a widely accepted non-parametric measure that assesses the strength and direction of association between two ranked variables. It was selected for this analysis since it accommodates both ordinal and interval-transformed variables without the need for the assumption of normality.

Before conducting Spearman's correlation, ordinal SPS scores derived from the observation rubric were converted into interval-level data to facilitate more nuanced interpretation. The transformation was conducted using appropriate ordinal-to-interval estimation techniques such as the successive intervals method or normal score transformation, which allow researchers to approximate interval properties from ordered categorical data while preserving the rank order. The Kolmogorov–Smirnov test was then conducted to evaluate the normality of the data. The results indicated that the transformed SPS and literacy scores did not meet the assumptions of normality ($p < 0.05$). In other words, the test confirmed a non-normal distribution, which further validated the use of Spearman's rho as non-parametric statistics for the analysis.

Together, this mixed-method analytical strategy enabled a statistically valid and context-sensitive examination of both within-construct (SPS components) and between-construct (SPS vs. SL) relationships. The methods employed align with the research questions and inherent characteristics of the data, ensuring the validity and reliability of the findings.

RESULTS

SPS Performance by Indicator

The analysis of students' performance on SPS revealed notable variations across the different indicators. As illustrated in Figure 1, the highest mean score was observed in the observing indicator ($M = 3.66$), suggesting that students demonstrated strong abilities in using their senses to identify, describe, and document relevant experimental phenomena. Conversely, the hypothesizing indicator yielded the lowest mean score ($M = 2.88$), indicating greater difficulty among students in formulating predictions based on prior observations. This outcome is consistent with findings from previous studies (Quarfoot and Rabin, 2022; Zorluoğlu et al., 2022).

Correlation between Observing and Hypothesizing

Table 1 presents the results of Kendall's tau-b correlation analysis examining the relationship between students' ability to observe and their skill in hypothesizing. The analysis revealed a moderate positive correlation ($\tau = 0.579$, $p < 0.001$), indicating a statistically significant association between the two variables.

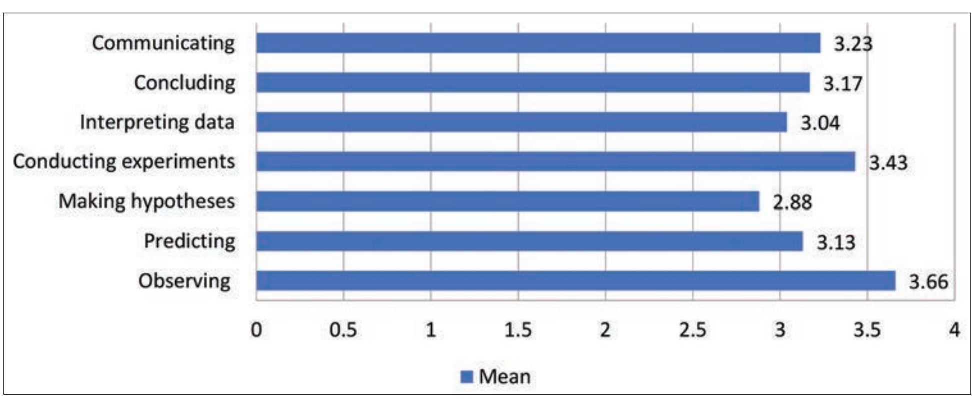

Figure 1: Average student science process skills for each indicator

Table 1: Kendall's tau correlation between observing and hypothesizing

Kendall's tau-b	Observing	Making hypotheses
Kendall's tau-b		
Observing		
Correlation coefficient	1.000	0.579
Significance (two-tailed)		0.000
n	77	77
Making hypotheses		
Correlation coefficient	0.579	1.000
Significance (two-tailed)	0.000	
n	77	77

This result suggests that students who demonstrate greater proficiency in observing experimental phenomena are more likely to formulate relevant and logical hypotheses based on their observations.

Correlation between Conducting Experiments and Communicating

As summarized in Table 2, the Kendall's tau-b correlation analysis revealed a weak yet statistically significant positive correlation between students' ability to conduct experiments and their communication skills ($\tau = 0.380$, $p = 0.001$). While the relationship is significant, the relatively low correlation coefficient indicates that proficiency in executing experimental procedures does not automatically translate into effective communication of scientific findings. This suggests that communication skills may require distinct instructional support beyond procedural competence alone.

Correlation between Interpreting Data and Drawing Conclusions

As shown in Table 3, the Kendall's tau-b correlation analysis demonstrated a moderate positive relationship between students' ability to interpret data and their skill in drawing conclusions ($\tau = 0.478$, $p < 0.001$). This result suggests that students who exhibit strong competence in analyzing experimental outcomes tend to formulate conclusions consistent with scientific reasoning. The finding reinforces the interconnectedness between analytical thinking and evidence-based interpretation in the context of scientific inquiry.

Correlation between SPS and SL

Before conducting the correlation analysis, a normality assessment was performed using the Kolmogorov–Smirnov test. As presented in Table 4, the results indicated that the data for both SPS and SL were not normally distributed ($p < 0.05$), thereby justifying the use of a non-parametric statistical approach. Accordingly, Spearman's rank-order correlation was applied to examine the association between the two constructs.

The analysis revealed no statistically significant correlation between SPS and SL ($\rho = 0.125$, $p = 0.281$), as shown in Table 5. This finding suggests that students' proficiency in SPS

Table 2: Kendall's tau correlation between conducting experiments and communicating

Kendall's tau-b	Conducting experiments	Communicating
Kendall's tau-b		
Conducting experiments		
Correlation Coefficient	1.000	0.380
Significance (two-tailed)	.	0.001
n	77	77
Communicating		
Correlation coefficient	0.380	1.000
Significance (two-tailed)	0.001	
n	77	77

Table 3: Kendall's tau correlation between interpreting data and drawing conclusions

Kendall's tau-b	Interpreting data	Concluding
Kendall's tau-b		
Interpreting data		
Correlation coefficient	1.000	0.478
Significance (two-tailed)	.	0.000
n	77	77
Concluding		
Correlation coefficient	0.478	1.000
Significance (two-tailed)	0.000	
n	77	77

Table 4: Normality test

Kolmogorov-Smirnov	Kolmogorov-Smirnova		
	Statistic	df	Significance
Science literacy	0.152	77	0.000
Science process skills	0.102	77	0.044

Table 5: Spearman's rank correlation between science process skills and science literacy

Spearman's rho	Science literacy	Science process skills
Spearman's rho		
Science literacy		
Correlation coefficient	1.000	0.125
Significance (two-tailed)		0.281
n	77	77
Science process skills		
Correlation coefficient	0.125	1.000
Significance (two-tailed)	0.281	
n	77	77

does not necessarily align with their performance on text-based SL assessments, indicating a potential disconnect between procedural engagement and conceptual understanding. This discrepancy may partly result from the different cognitive domains measured: SPS tasks emphasize procedural execution and observable behavior, whereas SL involves abstract reasoning and language-based interpretation. Clarifying this operational difference strengthens the interpretation that hands-on engagement alone may be insufficient to foster broader SL

DISCUSSION

The implementation of HBE during periods of restricted classroom access has highlighted both the potential and limitations of hands-on science learning in informal environments. Findings from this study demonstrate that HBE can effectively support the development of certain SPS, particularly those rooted in direct observation and practical engagement. Students demonstrated the strongest performance in observation-related tasks, suggesting that concrete, sensory-driven activities are more accessible and intuitive within home-based contexts. This observation is consistent with prior research emphasizing the foundational nature of observation in scientific inquiry (Gizaw and Sota, 2023; Wirayuda, 2023).

In contrast, hypothesizing was the least developed skill. This gap underscores the cognitive demands involved in generating testable predictions, which often require abstract reasoning skills that are not easily cultivated without explicit instructional support (Quarfoot and Rabin, 2022; Zorluoğlu et al., 2022). While observation provides a tangible entry point into scientific thinking, bridging the gap to higher-order skills such as hypothesis formulation may require structured scaffolding and more guided instructional prompts (Grimm et al., 2023).

The analysis also revealed a moderate correlation between students' ability to interpret data and their capacity to draw valid conclusions. This relationship reinforces the interconnected nature of analytical and inferential reasoning skills in scientific practice. Therefore, supporting students in areas such as graph interpretation, pattern recognition, and basic error analysis can be instrumental in improving their ability to synthesize and evaluate evidence (Díaz et al., 2023). These findings suggest that while HBE creates opportunities for students to practice core SPS independently, the quality of their engagement depends significantly on the structure and clarity of the learning tasks provided.

An additional finding of interest is the weaker yet statistically significant relationship between conducting experiments and communicating results. This suggests that performing an experiment does not necessarily lead to the ability to explain or report scientific findings effectively. Communication in science – particularly in written or oral forms – requires a distinct set of skills, including audience awareness, argumentation, and clarity of thought (Cirino et al., 2017). These elements are not always embedded in hands-on tasks. Without explicit integration of communication-focused components, students may struggle to translate procedural understanding into coherent scientific narratives.

One of the most salient findings of this study is the absence of a statistically significant relationship between students' overall SPS performance and their SL levels. This disconnect may stem from fundamental differences in how each construct is assessed. SPS was measured through performance-based activities emphasizing "doing" or procedural engagement, while SL was evaluated through text-based questions that required reading comprehension, conceptual reasoning, and application of scientific knowledge. These findings support the argument that procedural and conceptual competencies, although related, often develop in parallel rather than in direct correspondence (Millar, 2004). This disparity may also reflect the lack of reflective elements in the HBE activities used. Without opportunities to connect practical actions to underlying scientific principles, students may struggle to internalize the broader conceptual frameworks necessary for literacy development. Moreover, individual differences in language proficiency, prior knowledge, and cognitive styles can influence how well students transfer experiential learning into abstract understanding (Fang and Wei, 2010).

Addressing this gap requires a more deliberate instructional design that integrates hands-on inquiry with structured reflection. Strategies such as guided science journals, scaffolded report writing, and post-experiment discussions can help students articulate their observations, justify their conclusions, and relate their findings to scientific concepts. Embedding metacognitive prompts and opportunities for explanation during and after HBE tasks may bridge the gap between doing science and understanding science (Maglajos et al., 2022).

The observed disconnect between procedural engagement and conceptual understanding carries important pedagogical implications, especially in resource-limited educational settings. In such contexts – where laboratory infrastructure, textbooks, and teacher-training programs are often inadequate – home-based or low-cost hands-on activities are frequently adopted as primary instructional tools. However, when these tasks are not accompanied by intentional integration of conceptual scaffolding, students may engage in scientific tasks without fully grasping the underlying principles. This risks reinforcing superficial learning and limits the transferability of scientific knowledge to new contexts. To address this challenge, educators in under-resourced schools should be supported in designing inquiry-based tasks that embed reflective prompts, conceptual explanations, and opportunities for students to articulate reasoning. Teacher professional development should also emphasize strategies to connect experiential learning with cognitive engagement, ensuring that hands-on science serves as a bridge to – not a substitute for – SL.

Finally, this study highlights the importance of integrating both procedural skills and conceptual understanding in science education. While HBE can be a powerful tool for promoting student engagement and independence, its full educational value is realized only when paired with pedagogical strategies that foster deeper scientific reasoning and literacy. Moving forward, science educators and curriculum designers should consider hybrid approaches that combine the experiential strengths of HBE with structured content integration to foster more holistic scientific competence among learners.

CONCLUSION

This study explored the interrelationships among indicators of SPS developed through HBE as well as the association between SPS and SL in the context of middle school science education. The findings reveal that while HBE can effectively facilitate the development of core SPS – particularly in observation, experimentation, and data interpretation – higher-order cognitive skills such as hypothesizing and scientific communication remain comparatively underdeveloped. Moderate correlations were found between observing and hypothesizing and between interpreting data and drawing conclusions, indicating the interdependence of specific SPS components. However, the weak relationship between conducting experiments and communicating results suggests that procedural competence does not automatically translate into proficiency in expressing scientific ideas.

Most notably, the absence of a significant correlation between overall SPS and SL highlights a critical instructional gap: Engaging students in hands-on tasks alone is insufficient to foster conceptual understanding. This underscores the importance of integrating reflective and explanatory components into inquiry-based activities.

Pedagogically, these findings imply that curriculum designers should not only embed SPS-oriented tasks into science programs but also ensure that these tasks are paired with structured opportunities for conceptual reflection, metacognitive prompts, and guided communication exercises. Furthermore, teacher-training programs should emphasize strategies for bridging procedural engagement with literacy development – such as modeling how to scaffold hypothesis generation, interpret experimental results, and link observations to underlying scientific principles. Ultimately, a more holistic instructional model – one that balances hands-on experience with explicit conceptual scaffolding – is essential for advancing both scientific skills and SL in school science education.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization, S.A., M.Z., and S.R.Z.; data curation, S.A., M.Z., and S.R.Z.; formal analysis, S.A., M.Z., and S.R.Z.; investigation, S.A., M.Z., and S.R.Z.; methodology, S.A., M.Z., and S.R.Z.; project administration, S.A., M.Z., and S.R.Z.; resources, S.A., M.Z., and S.R.Z.; software, S.A., M.Z., and S.R.Z.; supervision, S.A., M.Z., and S.R.Z.; validation, S.A., M.Z., and S.R.Z.; visualization, S.A., M.Z., and S.R.Z.; writing – original draft, S.A., M.Z., and S.R.Z.; writing – review and editing, S.A., M.Z., and S.R.Z.

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