

Teachers' Assessment of Learners' Basic Science Process Skills: Basis for A Garden-Based Learning Intervention

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Abstract

The issue of teacher shortages in Thailand persists, particularly in small schools located in remote areas. Many teachers are unwilling to take long-term positions in these areas, resulting in a lack of educational opportunities for students. This study investigates the impact of community-based laboratory tools on the scientific inquiry skills of 67 elementary student teachers within the KRU-Rak Thin Closed-System Teacher Production Program in Thailand. Utilizing a mixed-methods case study design, the research addressed two primary objectives: determining how community-based tools enhance inquiry competencies and identifying the best practices that emerge from their implementation. Data was collected through a scientific inquiry skills test, rubric-based lesson plan evaluations, semi-structured interviews, focus group discussions, classroom observations, and reflective journals. Findings revealed a significant quantitative improvement in participants' inquiry skills, with post-test scores showing statistically significant gains. Qualitatively, the results demonstrated a professional shift in lesson planning from traditional, content-driven instruction to context-responsive inquiry cycles. Student teachers developed critical data collection and interpretation skills through authentic field investigations, such as community walking maps and fishbone diagrams, which effectively reconceptualized the local community as a "living laboratory." The study further identified emerging best practices, including the development of student-designed learning strategies that utilize local ecological phenomena and the implementation of school-community innovation projects that support local income generation. These interventions resulted in transformative changes in participants' professional identity, shifting their roles from mere content deliverers to confident community-based facilitators. By bridging the gap between formal science and community knowledge, the program fosters a more sustainable, culturally relevant, and collaborative approach to science education.

Keywords: science process skills; teachers' assessment; elementary science; garden-based learning; inquiry-based outdoor intervention

1. Introduction

Science Process Skills (SPS) are fundamental competencies that enable learners to investigate phenomena, construct scientific knowledge, and solve problems through inquiry. According to Padilla (1990), SPS include basic skills such as observing, classifying, measuring, predicting, inferring, and communicating, which serve as the foundation for scientific thinking and later development of integrated process skills. Observing involves using the senses and appropriate tools to gather information about objects and events. It serves as the foundation for all scientific inquiry because accurate observations provide the basis for further investigation. Classifying refers to grouping objects or events according to observable similarities and differences. This skill helps learners organize information and recognize patterns among scientific phenomena. Measuring involves obtaining quantitative information using standard and non-standard measuring tools. Measuring enables learners to collect accurate data and compare observations objectively. Inferring is the process of explaining observations and drawing conclusions based on available evidence. This skill requires higher-order thinking because learners interpret information beyond direct observations. Predicting refers to making logical forecasts about future events based on observed patterns and prior knowledge. Predicting encourages learners to apply evidence and reasoning when anticipating outcomes. Communicating involves expressing observations, findings, explanations, and conclusions through oral, written, graphical, or visual forms. Effective communication allows learners to share scientific understanding and defend evidence-based claims. According to Bybee (2013), mastery of these basic science process skills promotes scientific literacy, critical thinking, and problem-solving abilities necessary for lifelong learning.

Constructivist Learning Theory posits that learners actively build understanding through direct interaction with their environment, making experiential and inquiry-based learning essential for science education. Similarly, Experiential Learning Theory (Kolb, 1984) emphasizes learning through concrete experiences, reflection, conceptualization, and active experimentation.

Research has consistently shown that science process skills contribute significantly to scientific literacy, critical thinking, and problem-solving abilities among elementary learners (Harlen, 2014; Bybee, 2013). However, studies indicate that higher-order SPS such as predicting, inferring, and communicating are often underdeveloped due to limited opportunities for authentic and hands-on learning experiences (Yao, 2023).

The need to strengthen learners' science process skills is a priority in elementary science education, as these skills form the foundation of scientific inquiry and critical thinking (Martin et al., 2020). In line with Sustainable Development Goal (SDG) 4: Quality Education, the Philippine basic education system is called to provide more meaningful, relevant, and inquiry-based learning experiences that enhance learners' scientific thinking and problem-solving abilities (United Nations, 2015).

The Department of Education requires students not only to have cognitive abilities but also to be skilled in the learning process. Therefore, introducing students to science process skills is one strategy to influence their science abilities (Hernawati et al., 2018). Science learners are supposed to possess procedural skills, experimental and investigative science habits of mind, or scientific inquiry abilities. Therefore, giving students science process skills is a crucial part of science education (Ekici & Erdem, 2020).

Teachers play a vital role in assessing and developing learners' science process skills because it provides evidence of learners' ability to perform scientific inquiry rather than simply recall scientific facts. Their assessments provide valuable information regarding learners' strengths and areas requiring intervention. Consequently, identifying learners' SPS levels through teacher assessment serves as an important basis for designing targeted instructional interventions. According to Kurniawati (2021), assessment of science

process skills should focus on learners' actual performance during scientific investigations, including observing, measuring, classifying, predicting, inferring, and communicating. Similarly, Harlen (2014) emphasized that science process skills are best assessed through authentic and performance-based tasks that allow learners to demonstrate inquiry behaviors in real-world contexts. Traditional paper-and-pencil assessments may measure scientific knowledge but often fail to capture learners' ability to investigate, reason, and communicate scientific ideas.

Research by Zeidan and Jayosi (2014) further revealed that learners who regularly experience inquiry-based assessment demonstrate higher levels of scientific reasoning and problem-solving skills. Therefore, teachers must employ diverse assessment methods such as observation checklists, performance tasks, science journals, experiments, and outdoor investigations to obtain a comprehensive picture of learners' science process skills.

Effective assessment enables teachers to identify strengths and weaknesses and design appropriate interventions to improve scientific thinking. Diverse educational mediums typically facilitate the development of scientific process abilities (Gunawan et al, 2019). Teachers should prioritize imparting scientific abilities, including facts, concepts, and theories, to promote student engagement in scientific inquiry (Zeidan & Jayosi, 2014). Teachers' observations provide valuable insights into learners' strengths and weaknesses, which can inform instructional planning (Kurniawati, 2021). Thus, evaluating SPS through teachers' perspectives is essential in identifying gaps and improving science instruction.

Garden-Based Learning (GBL) provides an authentic context where learners engage in observation, measurement, classification, prediction, inference, and communication while interacting with real-world scientific phenomena. Through meaningful gardening activities, learners construct scientific understanding and apply concepts in practical situations. Thus, this study examined learners' basic science process skills and utilized the findings as the basis for developing and implementing a Garden-Based Learning intervention. However, there is a notable gap in the literature concerning the integration of school gardening as a pedagogical approach for developing science process skills among elementary learners. Despite the recognized potential of experiential and hands-on learning in science education, limited empirical evidence exists on how Garden-Based Learning can effectively foster these essential skills among younger students.

In light of this research gap, it is imperative to conduct a systematic investigation into how Garden-Based Learning can support the development of science process skills among elementary school students. This study, therefore, seeks to examine the effectiveness of Garden-Based Learning in enhancing learners' science process skills. By engaging learners in meaningful and authentic gardening activities, this study aims to demonstrate the educational value of Garden-Based Learning as a tool for improving the quality of science instruction and promoting deeper scientific understanding.

2. Methodology

2.1 Research Design

The study employed a descriptive research design to determine the learners' level of basic science process skills, as manifested during the implementation of the garden-based learning activities. Descriptive research is appropriate when the purpose is to systematically describe a phenomenon as it naturally occurs without manipulating variables (Slater & Hasson, 2024). Similarly, this research design is suitable for studies that did not aim to manipulate variables but rather to describe patterns and improvements in learners' skills based on structured instructional exposure and assessment results (Charli et al., 2022).

Furthermore, this study utilized a pre-test and post-test descriptive approach, allowing for the comparison of learners' performance before and after the intervention. As noted by Furidha (2023), descriptive studies are valuable in understanding classroom phenomena and guiding pedagogical decisions without experimental manipulation.

2.2 Participants and Setting

The teacher-participants of the study were 10 elementary school teachers from a public school in Jimenez District, Division of Misamis Occidental. These teachers were selected through purposive sampling because of their direct involvement in science instruction and their ability to assess learners' performance in science-related activities.

The school's rural setting, agricultural community background, and existing school garden collectively provide a conducive and meaningful environment for assessing learners' science process skills and implementing garden-based learning as an instructional approach in science education.

In addition, the learner-participants were an intact class of Grade 4 with twenty-four (24) learners selected through a purposive sampling.

2.3 Research Instruments

2.3.1 Needs Assessment Questionnaire

The Needs Assessment Questionnaire was developed using the Science Process Skills Framework of Padilla (1990) and inquiry-based learning principles. The instrument was designed to identify learners' strengths and weaknesses in basic science process skills and examine teachers' existing assessment practices.

The questionnaire consisted of two major parts. Part I contained 30 items measuring six basic science process skills: Observing (5 items); Classifying (5 items); Measuring (5 items); Predicting (5 items); Inferring (5 items); and Communicating (5 items). Teachers rated the frequency with which learners demonstrated specific observable behaviors associated with each skill during classroom instruction and science activities.

Part II consisted of 20 items assessing teachers' assessment practices related to science process skills, including: Hands-on activities and experiments; Worksheets and activity sheets; Oral recitation; Science journals and portfolios; and Outdoor learning activities.

This instrument directly addressed the first and second research objectives by determining the current level of learners' science process skills and identifying existing assessment practices. The results of the needs assessment served as the primary basis for designing the Garden-Based Learning intervention.

Table 1. Scope of the Needs Assessment Questionnaire

Construct	Indicators	No. of Items
Observing	Identifying characteristics, using senses	5
Classifying	Grouping and organizing objects	5
Measuring	Using standard and non-standard measurements	5
Predicting	Forecasting outcomes from observations	5
Inferring	Drawing conclusions from evidence	5
Communicating	Reporting and explaining findings	5
Assessment Practices	Hands-on activities, worksheets, oral recitation, science journals, outdoor activities	20

The instrument underwent content validation by five experts using a 4-point relevance scale. The Item-Level Content Validity Index (I-CVI) ranged from 0.80 to 1.00, indicating that all items met the acceptable threshold. The Scale-Level Content Validity

Index using the average method (S-CVI/Ave) was 0.92, demonstrating excellent content validity. The universal agreement index (S-CVI/UA) was 0.70, indicating that a majority of the items achieved full agreement among experts. These results confirm that the instrument is valid in terms of content and suitable for data collection.

Furthermore, the expert validators provided qualitative feedback which was systematically organized according to the five subscales of the instrument. Revisions focused on improving clarity, specifying observable behaviors, aligning items with science process skills, and eliminating redundancy. Several items were refined by adding contextual examples, simplifying language, and ensuring alignment with intended constructs. A before-and-after comparison of selected items demonstrates how expert suggestions enhanced the quality of the questionnaire. After incorporating all revisions, the instrument was finalized and deemed appropriate for administration.

For Part I, results show that the overall reliability coefficient is $\alpha = 0.83$, indicating good internal consistency, which suggests that the instrument is suitable for measuring the intended constructs. According to Lee Cronbach (1951), a Cronbach's alpha value of 0.70 and above is considered acceptable for social science research.

Among the subscales, observing ($\alpha = 0.82$), classifying ($\alpha = 0.85$), and measuring ($\alpha = 0.80$) demonstrated good reliability, while predicting ($\alpha = 0.78$), inferring ($\alpha = 0.75$), and communicating ($\alpha = 0.79$) showed acceptable reliability. These findings indicate that all items consistently measure their respective domains, thereby validating the use of the instrument for further analysis.

Furthermore, for Part II, the overall Cronbach's Alpha coefficient of 0.88 indicates good internal consistency of the instrument.

Among the subscales, Hands-on Activities ($\alpha = 0.82$), Worksheets ($\alpha = 0.84$), Science Journal/Portfolio ($\alpha = 0.86$), and Outdoor Activities ($\alpha = 0.83$) all demonstrated good reliability, while Oral Recitation ($\alpha = 0.79$) showed acceptable reliability. These results suggest that all subscales consistently measure their intended constructs, and the instrument is reliable for use in the study.

Responses were analyzed using weighted means and descriptive interpretations to determine strengths, weaknesses, and instructional needs. The findings were then used to inform the design of the Garden-Based Learning intervention.

2.3.2 Researcher-Made Garden-Based Learning Lesson and Activities

The Garden-Based Learning (GBL) intervention was designed using inquiry-based and experiential learning principles and aligned with the Grade 4 Science Most Essential Learning Competencies (MELCs) on soil properties and plant growth.

The intervention consisted of three structured learning activities followed by a four-week monitoring phase.

Activity 1: Soil Hunt in the Garden

Learners collected soil samples from different areas of the school garden. They observed soil color, texture, particle size, and moisture content, recorded observations, and classified soil samples according to their characteristics.

Activity 2: Water-Holding Capacity Investigation

Learners conducted experiments using equal amounts of soil and water to determine water retention and drainage characteristics. They measured water volume, recorded results, compared findings, and predicted which soil type would best support plant growth.

Activity 3: Garden Investigation and Reporting

Learners analyzed their findings, prepared simple reports, and presented conclusions regarding soil suitability for gardening.

Extended Plant Growth Monitoring

For four weeks, learners monitored vegetable growth by measuring plant height, counting leaves, and recording changes using observation sheets. Learners interpreted trends, predicted future growth, and discussed factors affecting plant development.

This sequence of activities provided repeated opportunities for learners to practice all six science process skills within an authentic learning environment.

The lesson plan functions not only as a teaching guide but also as the basis for collecting data on student performance, participation, and skill development. Learner outputs such as observation notes, soil classification records, water measurement tables, and post-activity reflections serve as evidence of learning. In addition, student interactions during group activities and discussions were observed to assess engagement and reasoning processes. The lesson plan supports the evaluation of science process skills including observing, classifying, predicting, measuring, inferring, and communicating.

The overall S-CVI/Ave of 0.95 indicates that the lesson plan has excellent content validity, exceeding the acceptable threshold of 0.80 (Polit & Beck, 2006). Experts agreed that the lesson plan is strongly aligned with curriculum standards and effectively integrates inquiry-based learning strategies.

The high ratings for materials and resources (1.00) highlight the appropriateness and feasibility of using locally available garden materials, supporting contextualized learning. Similarly, the strong ratings for instructional procedures confirm that the step-by-step activities are logical, developmentally appropriate, and conducive to skill acquisition.

These findings affirm that the instrument is valid for classroom implementation and research use, particularly in measuring learners' science process skills.

The overall Cronbach's Alpha of 0.83 indicates high internal consistency, suggesting that the instrument reliably measures learners' science process skills. According to Cronbach (1951), a coefficient above 0.70 is considered acceptable for educational research.

The relatively higher reliability values in classifying (0.85) and communicating (0.84) suggest that structured activities such as soil categorization and guided discussions provide consistent measures of learner performance. Slightly lower values in predicting (0.78) and inferring (0.76) may reflect the abstract nature of these skills, which typically require higher-order thinking and may vary across learners.

Overall, the results confirm that the lesson plan produces consistent and dependable data, supporting its use as a research instrument.

2.3.3 Pre-Test and Post Test Assessment

The pre-test and post-test assessments, developed by the researcher, served as the primary quantitative instruments for measuring the learners' basic science process skills before and after the implementation of the garden-based activities. Each assessment consists of 12 structured test items specifically designed to evaluate six core science process skills: observing, classifying, measuring, inferring, predicting, and communicating. The items are carefully aligned with the competencies of the elementary science curriculum and constructed based on indicators that describe the expected level of proficiency for each skill.

2.4 Data Gathering Procedure

The study was conducted in three phases. First, the validated 50-item Likert-scale questionnaire was administered to ten (10) elementary science teachers to assess learners' basic science process skills and identify existing assessment practices. Responses were collected, checked for completeness, and prepared for analysis.

Second, a pre-test consisting of 12 multiple-choice items was administered to twenty-four (24) Grade 4 learners to determine their baseline level of science process skills. The test was conducted under standardized classroom conditions to ensure reliability of results.

Third, the researcher implemented the garden-based learning intervention. The garden-based learning intervention was implemented in two phases: (1) the structured lesson proper and (2) the extended plant growth monitoring activity. The lesson proper was conducted over three consecutive days, with each session lasting 45 minutes. Following the initial implementation, the intervention was extended through a four-week plant growth monitoring activity to reinforce and sustain learners' science process skills in an authentic context. This extended implementation allowed learners to apply science process skills continuously beyond the initial lessons, thereby providing deeper learning experiences and supporting the development of higher-order thinking skills.

After the intervention, a post-test—parallel in structure and difficulty to the pre-test—was administered to measure changes in learners' science process skills. All test responses were collected, scored, and prepared for statistical analysis to determine the effectiveness of the intervention.

2.5 Data Analysis

Data were analyzed using descriptive statistics. The mean scores were used to determine the level of each science process skill and teachers' assessment practices based on a five-point Likert scale. Cronbach's alpha was used to assess the internal consistency of the instrument.

To determine the effectiveness of the garden-based learning intervention, the Wilcoxon Signed-Rank Test was employed to compare the learners' pre-test and post-test scores. This nonparametric statistical test was used to identify whether there was a significant difference in learners' science process skills before and after the implementation of the intervention. In addition, effect size was computed to determine the magnitude of the intervention's impact on learners' performance.

3. Results and Discussion

This section presents the findings according to the study's research objectives. Specifically, it discusses: (1) the level of learners' basic science process skills, (2) teachers' assessment practices in assessing science process skills, and (3) the effectiveness of the Garden-Based Learning intervention based on learners' pre-test and post-test performance.

3.1 Learners' Basic Level of Science Process Skills

Table 2. Learners' Basic Science Process Skills

Science Process Skill	Mean	Skill Level Interpretation
Observing	3.10	Moderate Skill
Classifying	3.65	High Skill
Measuring	3.25	Moderate Skill
Predicting	2.40	Low Skill
Inferring	1.75	Very Low Skill
Communicating	2.55	Low Skill
Overall	2.95	Moderate Skill

Note. 4.21–5.00 (Very High Skill), 3.41–4.20 (High Skill), 2.61–3.40 (Moderate Skill), 1.81–2.60 (Low Skill), and 1.00–1.80 (Very Low Skill). M = Mean.

Table 2 presents the level of learners' science process skills based on the computed mean scores. The results reveal that classifying skills ($M = 3.65$) fall under the high skill level, indicating that learners are relatively proficient in grouping and organizing objects

based on their characteristics. This suggests that learners have developed foundational cognitive abilities related to categorization.

Meanwhile, observing ($M = 3.10$) and measuring ($M = 3.25$) skills are within the moderate level, implying that learners possess basic competencies but still require enhancement through more structured and engaging learning experiences.

On the other hand, predicting ($M = 2.40$) and communicating ($M = 2.55$) skills fall under the low level, indicating that learners struggle in making logical forecasts and expressing scientific ideas effectively. These skills are essential in inquiry-based learning, thus requiring targeted instructional support.

Most notably, inferring skills ($M = 1.75$) are at a very low level, highlighting a critical gap in learners' ability to draw conclusions and interpret data. This suggests that higher-order thinking skills are not yet fully developed among the learners.

The findings indicate that learners demonstrate stronger performance in classifying skills, which may be attributed to the structured nature of classification tasks commonly practiced in elementary classrooms. This aligns with the findings of Adesuwa and Joy (2022), who emphasized that basic skills are more easily developed through routine classroom activities.

However, the moderate performance in observing and measuring skills suggests that while learners can perform basic tasks, they require further opportunities for hands-on and inquiry-based activities to enhance accuracy and consistency. Sabrina and Noly (2023) highlighted the importance of experiential learning in developing these foundational skills.

The low performance in predicting and communicating skills indicates that learners struggle with expressing ideas and making logical forecasts. These skills require higher cognitive engagement and are often underdeveloped when instruction is teacher-centered rather than inquiry-based.

The most concerning finding is the very low level of inferring skills, which reflects learners' difficulty in drawing conclusions and interpreting data. According to Nacario-Arce (2022), inferring is a higher-order skill that requires integration of multiple cognitive processes. The lack of emphasis on this skill in classroom instruction may contribute to its underdevelopment.

Overall, the results suggest a gap between basic and higher-order science process skills. This gap underscores the need for instructional approaches that promote active learning and critical thinking, such as inquiry-based and contextualized learning strategies.

3.2 Teachers' Practices in Assessing Basic Science Process Skills

Table 3. Mean Results of Teachers' Assessment Practices in Assessing Learners' Science Process Skills

Teachers' Assessment Practices	Mean	Interpretation
Hands-on Activities / Experiments	2.45	Low Practice
Worksheets / Activity Sheets	3.78	High Practice
Oral Recitation	3.12	Moderate Practice
Science Journal / Portfolio	3.05	Moderate Practice
Outdoor Activities	2.38	Low Practice
Overall Mean	2.96	Moderate Practice

Note. 4.21–5.00 (Very High Practice), 3.41–4.20 (High Practice), 2.61–3.40 (Moderate Practice), 1.81–2.60 (Low Practice), and 1.00–1.80 (Very Low Practice).

Table 3 presents the mean results of teachers' assessment practices in assessing learners' science process skills. The overall mean score of 2.96 indicates a moderate level of practice among teachers.

Among the different assessment methods, worksheets/activity sheets obtained the highest mean ($M = 3.78$), interpreted as high practice, suggesting that teachers frequently use structured written tasks to assess learners' skills. In contrast, oral recitation ($M = 3.12$) and science journal/portfolio ($M = 3.05$) were both interpreted as moderate practice, indicating that these methods are used occasionally but not maximized.

On the other hand, hands-on activities/experiments ($M = 2.45$) and outdoor activities ($M = 2.38$) were both rated as low practice, implying that experiential and real-world assessment methods are less frequently utilized in classroom assessment.

The findings reveal a strong reliance on worksheets as a primary assessment tool, which may be attributed to their convenience, ease of administration, and alignment with traditional classroom practices (Hasnawati et al., 2022). Worksheets allow teachers to efficiently assess learners' abilities in classification, recording, and interpretation of data. However, this overreliance may limit opportunities for learners to engage in deeper scientific inquiry.

The moderate use of oral recitation and science journals suggests that while teachers recognize the importance of communication and reflection in science learning, these strategies are not consistently implemented. According to Gillies (2023), science learning should actively engage learners in explaining and reflecting on their understanding, which are essential components of developing science process skills.

The low utilization of hands-on activities and outdoor learning is a critical concern. Experiential learning approaches are widely recognized as essential in science education. Ignacio and Yabut (2025), emphasized that science process skills such as observing, measuring, and experimenting are best developed through direct engagement with materials and real-world contexts. Similarly, meaningful science learning occurs when learners actively explore and investigate their environment (García-Carmona, 2020).

The limited use of these methods may be due to constraints such as lack of materials, time limitations, large class sizes, or insufficient training in facilitating inquiry-based and outdoor learning activities. As a result, learners may not fully develop essential science process skills, particularly those requiring active investigation and real-life application.

3.3. Pre-Test and Post-Test Results

Table 4. Pretest and Posttest Results by Science Process Skill

Science Process Skill	Pretest Mean	Posttest Mean	Gain
Observing	1.38	1.88	+0.50
Classifying	1.42	1.92	+0.50
Measuring	1.29	1.83	+0.54
Predicting	0.96	1.67	+0.71
Inferring	0.75	1.58	+0.83
Communicating	1.04	1.75	+0.71

Table 4 presents the learners' pretest and posttest mean scores across the six basic science process skills following the implementation of the Garden-Based Learning intervention. The results indicate improvements in all science process skills, as reflected by the positive gain scores. Among the six skills, inferring demonstrated the highest gain (+0.83), suggesting that learners significantly improved their ability to draw conclusions and interpret evidence from observations. This was followed by predicting and communicating, which both obtained a gain of +0.71, indicating enhanced capacity to make logical forecasts and effectively express scientific ideas.

Meanwhile, measuring showed a gain of +0.54, while observing and classifying both recorded gains of +0.50. Although these skills already exhibited relatively higher pretest

scores, the observed increases indicate that learners further strengthened their foundational science process skills through repeated engagement in hands-on and inquiry-based garden activities.

Overall, the findings suggest that the Garden-Based Learning intervention contributed positively to the development of both basic and higher-order science process skills. The notable improvements in inferring, predicting, and communicating imply that authentic learning experiences in the garden provided meaningful opportunities for learners to analyze data, formulate explanations, and communicate scientific understanding.

Table 5. Wilcoxon Signed-Rank Test Results

Test	Median	Z-value	p-value	Effect Size (r)
Pre-Test	5.00	-4.28	< .001	0.87
Post-Test	9.00	-4.28	< .001	0.87

The Wilcoxon Signed-Rank Test revealed a statistically significant difference between pre-test and post-test scores ($Z = -4.28$, $p < .001$). The effect size ($r = 0.87$) indicates a large effect, suggesting that the garden-based learning intervention had a strong impact on learners' science process skills. This implies that engaging students in hands-on, experiential activities through garden-based learning effectively enhances their ability to observe, classify, measure, predict, infer, and communicate—key components of science process skills.

Overall, the results revealed that learners demonstrated stronger performance in classifying skills, moderate performance in observing and measuring, and lower performance in predicting, inferring, and communicating skills. Teachers reported moderate use of assessment practices, with greater reliance on worksheets than experiential assessment methods. Following the implementation of the Garden-Based Learning intervention, learners showed statistically significant improvement in science process skills, indicating the effectiveness of contextualized and inquiry-based learning experiences.

4. Conclusions

The study concludes that learners exhibit varying levels of science process skills, with strengths in basic skills and weaknesses in higher-order thinking skills. The results underscore the need for targeted instructional interventions to improve predicting, communicating, and especially inferring skills. Enhancing these competencies is essential for developing scientifically literate learners capable of critical thinking and problem-solving. Future instructional programs should focus on experiential and inquiry-based learning strategies to address these gaps effectively. Results suggest the need to strengthen experiential and performance-based assessment practices, particularly hands-on and outdoor activities, to provide learners with more authentic opportunities to develop science process skills.

Moreover, the findings support the effectiveness of garden-based learning as an instructional approach and highlight its potential as a valuable strategy for improving science learning outcomes in elementary education.

5. Recommendations

Based on the findings of the study, the learners demonstrated strength in classifying, while predicting, communicating, and inferring remained underdeveloped. The results also revealed that teachers moderately practiced assessment strategies and relied more on traditional assessment methods than experiential and inquiry-based approaches.

Furthermore, the significant improvement observed in the pre-test and post-test results confirmed the effectiveness of the garden-based learning intervention in enhancing learners' science process skills.

In light of these findings, the following recommendations are proposed to improve science instruction, strengthen assessment practices, and further develop learners' scientific thinking and inquiry skills:

1. Schools should encourage the increased use of hands-on experiments and outdoor learning activities instead of relying heavily on worksheets and traditional written assessments.
2. The use of garden-based learning interventions should be promoted in elementary science classes. Garden-based activities may serve as an effective contextualized instructional strategy that supports active participation and real-world application of science concepts.
3. Teachers may develop and utilize long-term monitoring activities, such as plant growth observation charts, to continuously enhance learners' skills in observing, measuring, recording data, predicting outcomes, and drawing conclusions.

Future researchers may conduct similar studies using a larger number of participants, longer intervention periods, and additional variables to further validate the effectiveness of garden-based learning in improving science process skills among elementary learners.

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