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SCIENCE INSTRUCTIONAL PRACTICES OF SENIOR HIGH SCHOOL STEM TEACHERS: A QUANTITATIVE STUDY USING THE SIPS INSTRUMENT

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ABSTRACT

The adoption of inquiry-based science instruction is a key objective of modern education, including the Philippine K to 12 curriculum. However, quantitative evidence on the actual teaching practices of Senior High School STEM teachers remains scarce. This study addresses this gap by employing the Science Instructional Practices Survey (SIPS) to assess the frequency of instructional practices among 30 STEM teachers in Davao City. Results show that traditional instruction and activation of prior knowledge were implemented most frequently, while student-centered practices like modeling and student-led investigation occurred less often. Teacher background variables – years of experience, educational attainment, and professional development hours – did not significantly predict the frequency of inquiry-based practices. The findings indicate that while foundational and analytical skills are addressed, the full implementation of student-driven, inquiry-based learning is not yet realized. The study recommends targeted professional development and systemic support to better align classroom practices with contemporary science education frameworks.

KEYWORDS: *Science Instruction, Instructional Practices, STEM Education, Inquiry-Based Learning, SIPS Instrument, Quantitative Research*

INTRODUCTION

Global science education has progressively shifted its focus towards inquiry-based, evidence-driven, and student-centered learning paradigms. These approaches are central to frameworks like the Next Generation Science Standards (NGSS), which advocate for classrooms where students actively engage in scientific practices such as investigation, modeling, and argumentation (Photo, 2025). Such pedagogical shifts aim to develop scientific literacy and align student learning with the complex demands of the 21st century.

In the Philippines, the K to 12 curriculum explicitly identifies science as a cornerstone of the STEM strand and promotes constructivist, inquiry-based teaching methods (DepEd, 2016). However, a persistent gap exists between this curricular vision and classroom reality. Studies indicate that traditional, lecture-based instruction often remains dominant, despite policy directives (Bioco & Echaure, 2022; Lopez, 2021). This inconsistency highlights a critical need to systematically investigate the actual teaching practices employed by STEM educators.

Previous research in the Philippine context has identified barriers to inquiry-based learning, including inadequate laboratory facilities and limited professional development (Lopez, 2021). However, many of these studies have been qualitative or focused on the basic education level, leaving a quantitative gap in understanding the practices of Senior High School STEM teachers. This study addresses this gap by utilizing the Science Instructional Practices Survey (SIPS), a validated instrument, to quantitatively measure the frequency of instructional practices across six domains.

Grounded in Constructivist Learning Theory, which posits that knowledge is built through active experience, and Bandura's Social Cognitive Theory, which emphasizes the role of self-efficacy and environmental factors in shaping behavior, this study explores how teacher background influences practice.

The study was guided by the following objectives:

1. Determine the level of frequency of science instructional practices across six domains: instigating an investigation, data collection and analysis, critique and argumentation, modeling, traditional instruction, and activation of prior knowledge.
2. Examine differences in the level of instructional practices when teachers are grouped according to years of teaching experience, educational attainment, and professional development hours.
3. Examine the relationship between teachers' background variables (years of teaching experience, educational attainment, and professional development hours) and their use of science instructional practices.
4. Identify significant predictors of science instructional practices among Senior High School STEM teachers.

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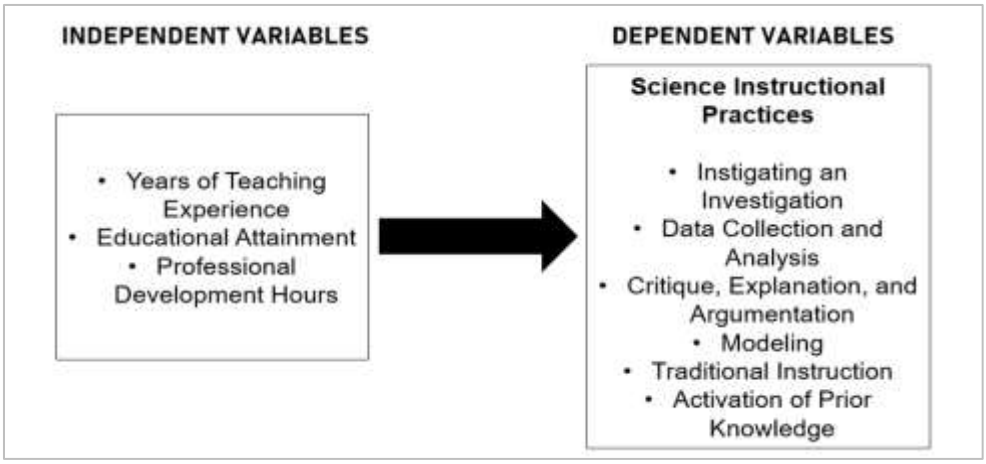
Conceptual Framework



The framework proposes that a teacher's background variables (Input) directly influence their implementation of various instructional practices (Process). The strength and nature of these relationships are what the study seeks to measure. The theoretical foundation underpins this entire relationship, suggesting that more experienced or highly educated teachers may have greater confidence, deeper pedagogical knowledge, or more refined skills, making them more likely to employ complex, student-centered inquiry methods.

The conceptual framework guides the investigation by hypothesizing that differences in teachers' years of service, education level, and training exposure will correlate with measurable differences in how frequently they use inquiry-based versus traditional instructional methods in their science classrooms.

METHODOLOGY

Research Design

This study utilized a quantitative descriptive–correlational research design. The descriptive component aimed to determine the frequency of science instructional practices among Senior High School STEM teachers across six instructional domains. The correlational component examined the relationships between selected teacher background variables and the use of inquiry-based instructional practices. Inferential analyses were further employed to determine group differences and identify predictors of inquiry-based instruction.

Participants and Sampling

The participants consisted of 30 Senior High School STEM teachers teaching science subjects such as Biology, Chemistry, and Physics in Davao City. Respondents were selected through purposive sampling, with inclusion criteria requiring that teachers be currently assigned to the STEM track and have at least one year of teaching experience.

Most respondents were aged 26–30 years, predominantly female, and largely held bachelor's degrees, with fewer having completed graduate studies. Teaching experience was mainly within the 0–10 years range, while participation in professional development activities varied across all reported categories. These characteristics indicate a largely early- to mid-career teaching population. A summary of respondent demographics is presented in Table 1.

Research Instrument

Data were gathered using the Science Instructional Practices Survey (SIPS) developed by Hayes et al. (2016). The instrument contains 24 items distributed across six domains of science instruction: instigating an investigation, data collection and analysis, critique and argumentation, modeling, traditional instruction, and activation of prior knowledge.

Responses were rated using a 5-point Likert scale, ranging from 1 (Never) to 5 (Daily or almost daily), with higher scores indicating more frequent use of the instructional practice. A supplementary demographic section collected data on years of teaching experience, highest educational attainment, and professional development hours attended.

Data Collection Procedure

Approval to conduct the study was secured from school administrators prior to data collection. The survey was administered to respondents in electronic form (Google Form). Participation was voluntary, and confidentiality of responses was assured. Completed questionnaires were reviewed for completeness before analysis.

Data Analysis

Descriptive statistics, including means and standard deviations, were computed to determine the frequency of instructional practices across the six domains. One-way analysis of variance (ANOVA) was used to examine differences in instructional practices when teachers were grouped according to years of service, educational attainment, and professional development hours.

To determine relationships between teacher background variables and inquiry-based instructional practices, Pearson product–

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moment correlation analysis was conducted. Multiple linear regression analysis was then employed to identify which background variables significantly predicted the use of inquiry-based instructional practices. All statistical analyses were tested at the 0.05 level of significance.

RESULTS AND DISCUSSION

Table 1. Demographic Profile of Respondents

Category	Group	Frequency	Percentage (%)
Age	20 – 25	5	16.67
	26 – 30	15	50.00
	30 – 35	6	20.00
	36 – 40	2	6.67
	41 years old and above	2	6.67
Gender	Male	12	40.00
	Female	18	60.00
Highest Educational Attainment	Bachelor's	24	80.00
	Master's	5	16.67
	Others	1	3.33
Years in Service	0-5 years	12	40.00
	6-10 years	12	40.00
	11-15 years	4	13.33
	16 years and up	2	6.67
Professional Development hours attended	0 – 30 hours	9	30.00
	31 – 60 hours	4	13.33
	61 – 90 hours	8	26.67
	91 hours and up	9	30.00

The demographic profile in Table 1 shows that most respondents were aged 26–30 years and were predominantly female. A large proportion held a bachelor's degree, with fewer teachers having pursued graduate studies. In terms of experience, the majority had 0–10 years in service, indicating a relatively young teaching workforce. Despite this, many teachers reported substantial participation in professional development activities, with an equal proportion attending either minimal (0–30 hours) or extensive (91 hours and above) training.

This profile suggests a teaching population that is still in the early to middle stages of professional growth. Such characteristics are relevant because early-career teachers often demonstrate openness to adopting innovative instructional strategies, including inquiry-based approaches, while still refining classroom practices through experience and training.

1. What is the level of frequency of science instructional practices among Senior High School STEM teachers across the following six domains?
   a. Instigating an investigation
   b. Data collection and analysis
   c. Critique and argumentation
   d. Modeling
   e. Traditional instruction
   f. Activation of prior knowledge

Table 2. Level of Science Instructional Practices

Domains	Mean	SD	Interpretation
Instigating an Investigation	4.22	0.57	Very High
Data Collection and Analysis	3.93	0.66	High
Critique and Argumentation	4.31	0.54	Very High
Modelling	3.87	0.72	High
Traditional Instruction	4.47	0.49	Very High
Activation of Prior Knowledge	4.71	0.49	Very High
OVERALL	4.25	0.46	Very High

In Table 2, the results indicate a generally high level of science instructional practices across all six domains, with an overall mean of 4.25. Among the domains, activation of prior knowledge obtained the highest mean, suggesting that teachers consistently connect new concepts to students' existing understanding. This practice is essential in science learning, as it supports conceptual change and deeper comprehension.

Traditional instruction also recorded a high mean, indicating that teacher-centered approaches remain a frequent component of classroom practice. This finding suggests that inquiry-based

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strategies are often integrated alongside, rather than replacing, conventional methods. Critique and argumentation and instigating an investigation also yielded high mean scores, reflecting teachers' efforts to engage students in reasoning, questioning, and evidence-based discussions.

In contrast, modeling and data collection and analysis obtained relatively lower mean scores, although still within a high range. This may indicate challenges related to time constraints, limited resources, or the complexity of designing and facilitating student-centered investigations that require data interpretation and model construction.

2. Is there a significant difference in the level of science instructional practices when teachers are grouped according to:
   a. Years of teaching experience
   b. Educational attainment
   c. Professional development (PD) hours attended?

Table 3. Differences in Instructional Practices by Background Variables

		Sum of Squares	df	Mean Square	F	*p*-value
Years in Service	Between Groups	1.53	3	0.51	2.84	0.057
	Within Groups	4.68	26	0.18		
	Total	6.21	29			
Educational Attainment	Between Groups	1.08	2	0.54	2.83	0.077
	Within Groups	5.14	27	0.19		
	Total	6.21	29			
Professional Development hours attended	Between Groups	0.67	3	0.22	1.05	0.388
	Within Groups	5.54	26	0.21		
	Total	6.21	29			

*significant at 0.05 level

Analysis of variance results in Table 3 revealed no statistically significant differences in the level of science instructional practices when teachers were grouped according to years of service, educational attainment, or professional development hours attended. Although the p-values for years of service and educational attainment approached significance, they did not meet the 0.05 threshold.

These findings suggest that teachers, regardless of experience, degree level, or amount of professional development attended, tend to implement science instructional practices at comparable levels. This may indicate the presence of shared curricular standards, common teaching expectations, or institutional support that promotes consistency in instructional approaches across different teacher groups.

3. Is there a significant relationship between teachers' background variables—specifically years of teaching experience, educational attainment, and professional development hours—and their use of inquiry-based instructional practices?

Table 4. Relationship Between Background Variables and Inquiry-Based Practices

Independent Variable	Dependent Variable (Use of Inquiry-based Instructional Practices)	
	Pearson's r	*p*-value
Years in Service	0.49	0.006*
Educational Attainment	0.38	0.038*
Professional Development hours	0.02	0.924

*significant at 0.05 level

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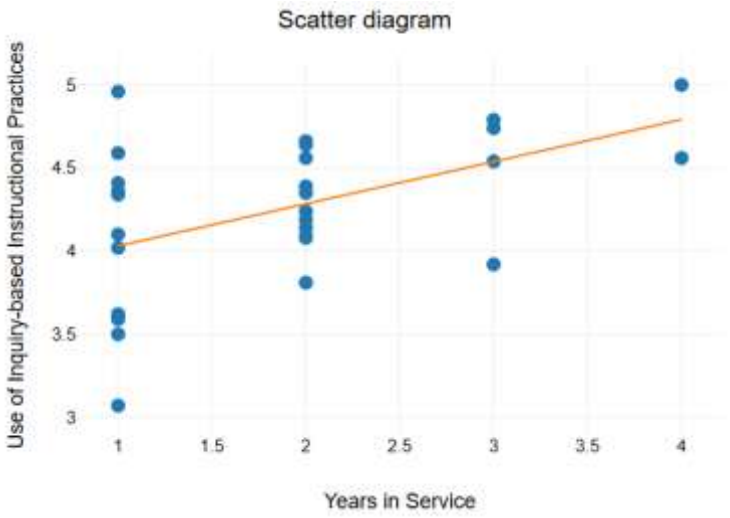
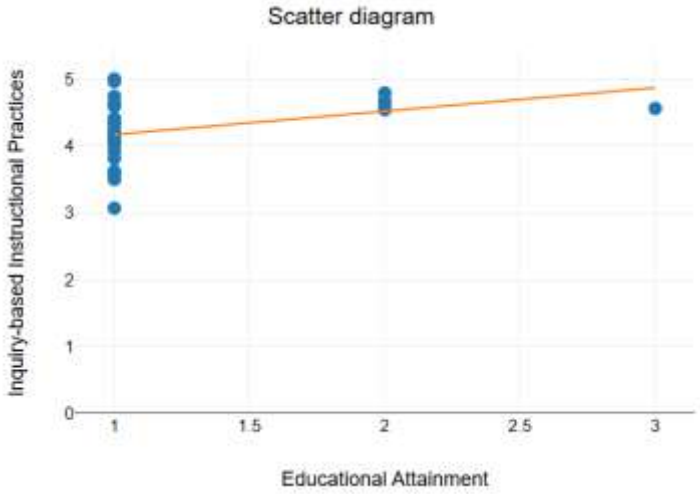
Correlation Plots



Note: 1-0 to 5 Years, 2-6 to 10 years, 3-11 to 15 years, 4-16 years and up



Note: 1-Bachelor's, 2-Master's, 3-Other's

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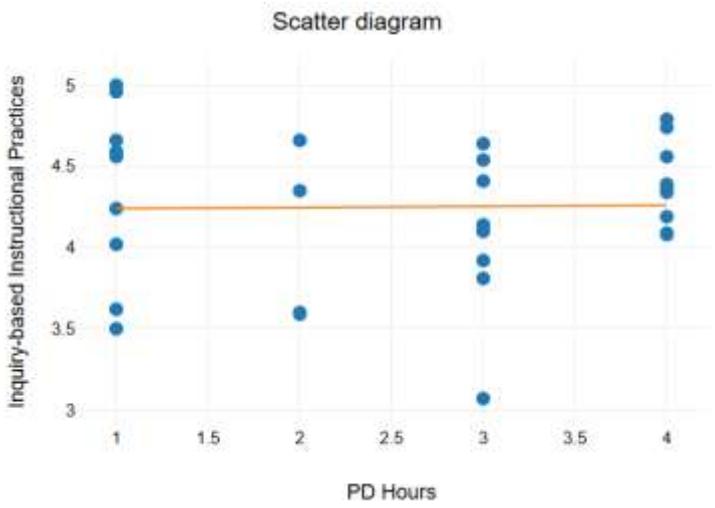

Note: 1-0 to 30 hours, 2-31 to 60 hours, 3-61 to 90 hours, 4-91 hours and up

For Table 4. Correlation analysis revealed significant positive relationships between years of teaching experience and inquiry-based instructional practices, as well as between educational attainment and inquiry-based practices. This indicates that teachers with more experience and higher educational qualifications tend to use inquiry-based strategies more frequently. Experience may contribute to increased confidence in managing student-centered activities, while advanced education may enhance pedagogical content knowledge and familiarity with inquiry-oriented methods.

In contrast, professional development hours showed no significant relationship with inquiry-based practices. This finding suggests that the quantity of professional development alone may not be sufficient to influence classroom practice. The relevance, quality, and alignment of training activities with actual classroom needs may play a more critical role than the number of hours attended.

4. Which among the teachers' background variables (years of teaching experience, educational attainment, and professional development hours) significantly predict their use of inquiry-based instructional practices?

Table 5. Predictors of Inquiry-Based Instructional Practices

	Unstandardized Coefficients	Standardized Coefficients	Standard error	t	p-value
Constant	3.66		0.28	13.07	<.001
Years in Service	0.21	0.4	0.1	2.01	0.055
Educational Attainment	0.16	0.17	0.18	0.84	0.409
PD Hours	0	0.01	0.06	0.05	0.963

Note: $F(3,26)=3.1$, p-value=0.042, $R^2=0.26$, Adjusted $R^2=0.18$

Table 5. Regression analysis showed that, collectively, years of service, educational attainment, and professional development hours significantly explained a portion of the variance in inquiry-based instructional practices. However, none of the individual predictors reached statistical significance at the 0.05 level when considered independently. Years of service came close to significance, indicating that experience may still have a meaningful, albeit modest, and influence.

The overall model suggests that inquiry-based teaching is shaped by the combined interaction of multiple teacher characteristics rather than a single factor. This highlights the complexity of instructional practice and implies that sustained experience, formal education, and professional learning opportunities work together to support effective inquiry-based instruction.

CONCLUSION AND RECOMMENDATIONS

This study provides a quantitative view of science instructional practices among Senior High School STEM teachers at a specific institution. The findings reveal a blended instructional approach where traditional, teacher-centered methods coexist with frequent opportunities for student analysis and argumentation. However, the full spectrum of inquiry-based learning, particularly student-designed investigations and model development, is less commonly implemented.

The study concludes that while STEM teachers are successfully integrating important elements of inquiry, such as evidence-based reasoning, there remains a significant opportunity to foster more authentic, student-driven scientific practices in the classroom.

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Based on these conclusions, the following recommendations are offered:
School administrators should design and implement targeted training programs focused on enhancing teachers' skills and confidence in facilitating open-ended investigations and model-based reasoning. Workshops could provide practical experience in designing and managing student-led projects.

Future studies should expand to a larger, more diverse sample across multiple institutions to improve generalizability and statistical power. A mixed-methods approach could provide deeper insights into the reasons behind teachers' instructional choices, exploring the barriers and facilitators in greater depth.

Curriculum planners and policymakers should consider providing more explicit support and resources, such as ready-to-use kits for investigative activities and model-building, to reduce the practical barriers teachers face in implementing high-level inquiry practices.

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