INTERNATIONAL MULTIDISCIPLINARY JOURNAL OF RESEARCH FOR INNOVATION, SUSTAINABILITY AND EXCELLENCE (IMJRISE)
Online ISSN: 3028-032X | Print ISSN: 3028-0370
PUBLISHED BY: RISEJOURNALS.ORG
Volume 2, Issue no. 8 | 77

Scientific Literacy Skills of Senior High School Students in the New Normal Education

DOI: 10.5281/zenodo.16900316

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Abstract:

This study assessed the scientific literacy skills of Senior High School students in the context of the new normal education in a large public secondary school in Central Philippines. Using a descriptive-comparative research design, the study measured students' proficiency in six basic science process skills—observing, classifying, communicating, measuring, inferring, and predicting—using the Test of Scientific Literacy Skills (TOSLS). A stratified random sample of 298 Grade 11 and 12 students from different academic tracks and socioeconomic backgrounds participated in the study. Descriptive statistics revealed that students across all groups demonstrated very low levels of scientific literacy, with *measuring*, *inferring*, and *predicting* identified as the weakest skills. Inferential tests showed no statistically significant differences in scientific literacy levels when grouped by sex, grade level, track, or socioeconomic status, highlighting the widespread nature of the learning gap. Significant differences, however, were found between specific skill domains. These findings point to systemic instructional challenges exacerbated by the disruptions of the COVID-19 pandemic. The study recommends the development of contextualized task cards and inquiry-based interventions to address skill-specific gaps and enhance student engagement in science learning.

*Keywords***:** scientific literacy, process skills, senior high school, new normal education, contextualized instruction, inquiry-based learning, learning loss, pandemic education, Philippines

Introduction:

In the 21st century, scientific literacy has become a foundational competency for individuals navigating an increasingly complex and information-driven world. Defined as the ability to apply scientific knowledge, reason scientifically, and interpret data and evidence (National Research Council et al., 2012), scientific literacy equips individuals with the tools to make informed decisions on public and personal issues such as climate change, health, and technological advancements (OECD, 2023). As societies become more dependent on science and technology, equipping young people with scientific literacy is no longer optional—it is essential for civic participation, lifelong learning, and global competitiveness (Clough, 2011; Osborne et al., 2023).

The significance of scientific literacy has been brought to the forefront by global crises such as the COVID-19 pandemic, which underscored the need for a scientifically literate public capable of critically evaluating health information, understanding disease transmission, and interpreting scientific data (Levy, 2021). However, the same pandemic that revealed the importance of science also disrupted educational systems worldwide. In the Philippines, extended school closures and a rapid shift to remote learning modalities contributed to learning losses that continue to affect students' foundational competencies, particularly in science and mathematics (Chi, 2023; Schleicher, 2020).

The Philippine Department of Education's response to the pandemic included the adoption of modular distance learning and blended learning to ensure educational continuity (DepEd, 2020). While these measures were necessary, they were not without limitations. Studies have shown that the quality of science education was compromised due to the lack of hands-on experiments, teacher interaction, and immediate feedback—critical elements in cultivating scientific reasoning and inquiry skills (Nurwidodo et al., 2023; Kotsis, 2024). Consequently, students were often left to learn abstract scientific concepts through printed modules with minimal engagement or real-world application.

Scientific literacy does not only entail content knowledge but also process skills, such as observing, classifying, communicating, measuring, inferring, and predicting (Gormally et al., 2012; Holbrook & Rannikmae, 2009). These basic science process skills form the foundation for higher-order thinking and problem-solving. However, these competencies are not uniformly developed among students. Recent evidence suggests that Filipino learners struggle significantly with skills involving measurement and inference, pointing to a pedagogical gap that limits students' ability to fully engage with scientific inquiry (Hernandez et al., 2024; Fishtrom et al., 2022).

Socioeconomic disparities further compound these challenges. Research has consistently found that students from lower-income households have reduced access to learning materials, digital technologies, and conducive home environments for studying (Munir et al., 2023; Hussar et al., 2020). While public education systems have made efforts to mitigate these disparities, the impact of socioeconomic status (SES) on science performance remains pronounced. In the 2022 Programme for International Student Assessment (PISA), only 23% of Filipino students demonstrated basic proficiency in science, with a significant performance gap between high- and low-SES students (Chi, 2023; OECD, 2023).

The structural factors influencing scientific literacy extend beyond SES. Gender and academic track also affect how students engage with science. While global studies often show male students outperforming females in science assessments, other research suggests that with adequate support and contextualized instruction, these gender gaps can be minimized (Makarova et al., 2019; Liu & Wang, 2019). Moreover, the academic track a student pursues—whether STEM, HUMSS, or TVL—can shape their exposure to science content and practice. Yet, findings have been mixed regarding whether these tracks significantly influence science literacy, especially in settings where instructional quality is uneven (Oliver et al., 2019).

Adding to these complexities is the concept of the "new normal" in Philippine education. No longer a temporary adjustment, the new normal refers to the enduring educational landscape shaped by hybrid modalities—blended learning, online instruction, and intermittent classroom interactions (Lugtu, 2022; Itorralba, 2022). While these modalities offer flexibility, they also demand greater learner autonomy and teacher adaptability, which are not always present. Consequently, the "new normal" may entrench educational inequalities unless intentional pedagogical innovations are introduced (Lu, 2023).

In this context, there is a growing call to reimagine science instruction through tools that are both learner-centered and contextually grounded. One such innovation is the use of contextualized task cards—modular instructional tools designed to connect scientific concepts to local and real-life experiences. Task cards have shown promise in fostering student engagement, improving reading comprehension, and enabling learners to apply scientific reasoning to authentic problems (Clarke & Roche, 2018; Arevalo et al., 2023; Sambayon et al., 2023). However, for such interventions to be meaningful, a clear understanding of learners' baseline scientific literacy is needed.

Despite increasing interest in science literacy, few empirical studies in the Philippines have directly assessed students' science process skills across different tracks, grade levels, and socioeconomic backgrounds in the post-pandemic context. Most research either focuses on content knowledge or overlooks the nuances introduced by the new normal education. This represents a significant gap in both scholarship and practice. Without accurate, localized data on learners' scientific literacy levels, efforts to redesign science instruction may be misaligned with actual needs.

Therefore, this study aims to measure the scientific literacy skills of Senior High School students in a large rural secondary school in Central Philippines during the academic year 2023–2024. It evaluates proficiency in basic science process skills—observing, classifying, communicating, measuring, inferring, and predicting—and examines whether these skills differ based on students' sex, grade level, academic track, and socioeconomic status. The findings will inform the development of contextualized task cards for Earth and Life Science, contributing to the broader goal of enhancing science education in the new normal.

Methodology:

This study employed a descriptive-comparative research design, which is appropriate for examining existing conditions and identifying variations across groups without manipulating variables (Creswell & Creswell, 2017). Specifically, the study sought to measure the scientific literacy skills of Senior High School students and determine whether significant differences exist when grouped by sex, grade level, academic track, and socioeconomic status. This design allowed for an objective analysis of student competencies in science process skills under the prevailing conditions of the "new normal" educational context in the Philippines.

The research was conducted in a large public secondary school located in a rural municipality in Central Philippines. The school, established in 1978, offers both Junior and Senior High School programs and serves a diverse student population from various socioeconomic backgrounds. The school implements three academic strands in the Senior High School level: Science, Technology, Engineering, and Mathematics (STEM); Humanities and Social Sciences (HUMSS); and the Technical-Vocational-Livelihood (TVL) track, which includes specializations such as Cookery, Beauty Care, Computer Systems Servicing, and Shielded Metal Arc Welding.

A total of 298 Grade 11 and Grade 12 students enrolled in the second semester of the 2023–2024 academic year were selected as respondents. The stratified random sampling technique was used to ensure representation across subgroups categorized by sex, grade level, academic track, and socioeconomic status. Stratification was based on student enrollment data provided by the school administration, and random sampling was applied within each stratum to obtain proportional representation (Nguyen et al., 2019). This method ensured that the sample reflected the diversity of the student body and increased the generalizability of the findings.

To measure scientific literacy, the study used the Test of Scientific Literacy Skills (TOSLS) developed by Gormally, Brickman, and Lutz (2012). The instrument is composed of 28 multiple-choice questions that assess basic science process skills, including observing, classifying, communicating, measuring, inferring, and predicting. The test has been widely used in prior research and was selected for its established content validity and practical applicability in high school contexts. Since the TOSLS is a standardized instrument, no additional validation process was required for content validity (Gormally et al., 2012).

The reliability of the instrument was established through a pilot test involving 30 Grade 11 and 12 students from a nearby school not included in the main study. Using Cronbach's Alpha, the reliability coefficient was calculated at 0.725, indicating an acceptable level of internal consistency (Taber, 2017). The results confirmed that the instrument was sufficiently reliable for assessing students' scientific literacy skills in the chosen setting.

The data collection process was carried out from March to June 2024. Prior to the administration of the test, formal permission was secured from the school principal, assistant principal, and senior high school coordinator. Class advisers assisted in coordinating the schedule of test administration to minimize disruption to regular classes. During the testing sessions, the researcher provided a standardized orientation, including an explanation of the study's objectives, instructions for answering the test, and reassurances regarding anonymity and confidentiality. Each student was given 35 minutes to complete the test in a controlled classroom environment.

Data were analyzed using both descriptive and inferential statistical techniques. For descriptive statistics, the Mean Percentage Score (MPS) was calculated for each science process skill. The results were interpreted using the Department of Education's mastery level scale (DepEd Order No. 160, s. 2012), which classifies scores into categories such as Mastered, Closely Approximating Mastery, and Very Low, among others. To test for differences in scientific literacy skills based on demographic variables, the Kruskal-Wallis test was employed for non-parametric comparisons across independent groups (e.g., academic tracks, SES levels), while the Wilcoxon signed-rank test was used to assess differences across paired science process skills within the same group of students.

The study adhered to ethical standards in accordance with institutional research protocols and national guidelines. Informed consent was obtained from all participants through signed consent forms that clearly stated the voluntary nature of participation, the purpose of the research, and assurances of confidentiality and anonymity. No personal identifying information was collected, and participation had no bearing on academic grades or standing. The study also upheld principles of beneficence and justice, ensuring that no harm came to the participants and that the research findings would be used to improve science education practices. Ethical clearance was granted by the Institutional Research Ethics Committee of La Consolacion College Bacolod.

Results:

Table 1 presents the level of scientific literacy skills of the 298 Senior High School students when taken collectively and when grouped according to sex, grade level, academic track, and socioeconomic status. Across all categories, the median score was consistently interpreted as Very Low based on the Department of Education's mastery level scale (DepEd Order No. 160, s. 2012).

The data indicate that there is a widespread deficiency in scientific literacy among students across all demographic categories. The slightly higher median scores for STEM and middle to upper-middle SES groups did not significantly change the overall interpretation, which remains in the "Very Low" mastery level.

Table 1.
Level of Scientific Literacy Skills by Demographic Variables

Variables	Median	IQR	Interpretation
Sex			
Male (n = 154)	8.00	3.00	Very Low
Female (n = 144)	8.00	3.00	Very Low
Grade Level			
Grade 11 (n = 164)	8.00	3.00	Very Low
Grade 12 (n = 134)	8.00	3.00	Very Low
Academic Track			
HUMSS (n = 184)	8.00	3.00	Very Low
STEM (n = 22)	9.00	2.00	Very Low
TVL (n = 92)	8.00	4.00	Very Low
Socioeconomic Status (SES)			
Poor (n = 110)	8.00	3.00	Very Low
Low Income (n = 114)	8.00	4.00	Very Low
Lower Middle (n = 52)	9.00	3.25	Very Low
Middle Class (n = 18)	9.50	4.25	Very Low
Upper Middle (n = 4)	9.50	4.00	Very Low
Overall (n = 298)	**8.00**	**3.50**	**Very Low**

To assess which specific science process skills were most and least developed, mean percentage scores were calculated for each skill category. As shown in Table 2, the highest-performing skill was Classifying (31.37%), followed by Communicating (30.70%) and Observing (30.16%). The weakest areas were Measuring (24.75%), Inferring (26.02%), and Predicting (26.67%).

Table 2.
Mean Percentage Score in Scientific Literacy Skills

Scientific Literacy Skill	Mean Percentage (%)
Classifying	31.37
Communicating	30.70
Observing	30.16

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Volume 2, Issue no. 8

Predicting	26.67
Inferring	26.02
Measuring	24.75

All six skills fall within the "Low" to "Very Low" mastery brackets, further emphasizing the need for targeted instructional interventions. Measurement skills emerged as the most critical area for improvement.

Table 3 shows the results of the Kruskal-Wallis test for scientific literacy levels when grouped by sex and grade level. The results reveal no statistically significant difference between males and females (p = 0.133), and between Grade 11 and Grade 12 students (p = 0.110), with both p-values greater than the 0.05 alpha level.

Table 3.
Significant Differences by Sex and Grade Level

Variable	Median	IQR	p-value	Significance (α = 0.05)	Decision
Sex	8	3	0.133	Not Significant	Do Not Reject H_0
Grade Level	8	3	0.11	Not Significant	Do Not Reject H_0

These findings indicate that both male and female students, as well as students across both grade levels, exhibit comparable levels of scientific literacy skills.

Similarly, the Kruskal-Wallis test was used to determine differences in scientific literacy when grouped by academic track and socioeconomic status. As shown in Table 4, the results were not statistically significant, with p-values of 0.053 for track and 0.051 for SES—both slightly above the 0.05 significance threshold.

Table 4.
Significant Differences by Academic Track and SES

Variable	χ^2	df	p-value	Significance (α = 0.05)	Decision
Academic Track	5.884	2	0.053	Not Significant	Do Not Reject H_0
Socioeconomic Status	9.439	4	0.051	Not Significant	Do Not Reject H_0

These results suggest that neither the students' chosen academic tracks nor their socioeconomic backgrounds significantly influenced their scientific literacy levels.

The Wilcoxon signed-rank test was applied to evaluate significant differences between the six specific scientific literacy skills. Results in Table 5 show several statistically significant pairwise differences, notably between:

- Observing and Measuring (p < .001),
- Observing and Inferring (p < .001),
- Classifying and Measuring (p < .001),
- Communicating and Measuring (p = .001), among others.

Table 5.

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Wilcoxon Signed-Rank Test Between Scientific Literacy Skills

Skill Comparison	z-score	p-value	Significance	Decision
Observing vs. Measuring	4.48	<.001	Significant	Reject H_0
Observing vs. Inferring	3.431	<.001	Significant	Reject H_0
Classifying vs. Measuring	3.808	<.001	Significant	Reject H_0
Communicating vs. Measuring	3.264	0.001	Significant	Reject H_0
Classifying vs. Inferring	3.557	<.001	Significant	Reject H_0
Predicting vs. Communicating	-2.678	0.007	Significant	Reject H_0

The results confirm that while all skills are underdeveloped, some are significantly weaker than others—particularly *Measuring* and *Inferring*—highlighting the need for differentiated instructional strategies targeting specific areas of difficulty.

These findings reveal a consistent pattern of underperformance across all demographic groups, with critical gaps in measurement and inference skills. The lack of significant differences across sex, grade level, academic track, and socioeconomic status suggests that the challenges are systemic and widespread, necessitating targeted curriculum innovations such as contextualized task cards to support active learning and skill mastery in science.

Discussion:

The findings of this study reveal a consistent and critical deficiency in the scientific literacy skills of Senior High School students in the context of the new normal education. Across all demographic groups—sex, grade level, academic track, and socioeconomic status—the students scored within the "Very Low" mastery level, indicating an alarming underdevelopment of fundamental science process skills. This widespread underperformance suggests that systemic challenges, rather than individual or subgroup characteristics, are contributing to low levels of scientific literacy.

The lack of significant differences across sex and grade levels reinforces prior studies indicating that when instructional resources and learning opportunities are similarly limited, performance across demographic groups tends to converge (Makarova et al., 2019; Liu & Wang, 2019). In this study, male and female students performed equally poorly, suggesting that gender-based instructional biases or opportunities may not be the primary source of variance. Similarly, Grade 11 and 12 students performed at the same low level, indicating that advancement in grade level alone is insufficient to improve scientific literacy without corresponding improvements in instructional quality and engagement.

In terms of academic tracks, students from STEM, HUMSS, and TVL strands also exhibited similar low proficiency levels. This finding contradicts the commonly held assumption that STEM students perform better in scientific tasks due to curricular focus. Instead, it supports the observation of Oliver et al. (2019) that the effectiveness of science instruction is more dependent on how scientific thinking is cultivated rather than on academic specialization alone. The minimal performance advantage of STEM students in this study may reflect differences in exposure to science content but does not translate into significant gains in core scientific process skills.

Socioeconomic status (SES), a variable often associated with educational outcomes (Munir et al., 2023; Hussar et al., 2020), also showed no statistically significant impact on students' scientific literacy in this sample. Although students from middle and upper-middle-income groups had slightly higher median scores, the difference was not significant. This aligns with findings by Hwang et al. (2018) and Easterbrook et al. (2020), who argue that SES may be mediated by the quality of instruction and access to contextualized learning rather than by income alone. The results suggest that even students with relatively better resources struggled in the pandemic-altered educational environment, indicating that curriculum design and pedagogical methods must be re-examined.

The disaggregated skill analysis revealed that Measuring, Inferring, and Predicting were the most underdeveloped areas among the students, while Classifying, Communicating, and Observing fared slightly better. These findings point to an uneven development of cognitive processes. Measuring, a skill requiring the application of numerical reasoning and procedural knowledge, may have been particularly affected by the absence of hands-on laboratory work and practical experiences during distance learning (Nurwidodo et al., 2023; Kotsis, 2024). Similarly, inferring and predicting, which require critical thinking and abstract reasoning, are higher-order cognitive skills that typically benefit from teacher scaffolding and iterative practice—conditions that were difficult to replicate in modular or blended setups (Hernandez et al., 2024).

The significant differences identified among specific scientific skills through the Wilcoxon signed-rank test suggest that while students may engage in basic classification and communication tasks, they struggle to apply more complex reasoning. This supports Holbrook and Rannikmae's (2009) assertion that scientific literacy goes beyond knowledge acquisition—it requires the integration of process skills with conceptual understanding in meaningful, problem-based contexts. The absence of differentiated instructional strategies likely contributed to these discrepancies in skill development.

These results must also be interpreted in the context of the "new normal" education in the Philippines, characterized by a blend of face-to-face, modular, and online instruction. While intended to provide continuity during school closures, these modalities lacked uniform implementation, often resulting in cognitive overload or disengagement among learners (Lugtu, 2022; Lu, 2023). The loss of routine classroom experiences and the limited capacity for teacher-guided inquiry-based learning may have stunted the development of scientific reasoning and process skills (Chi, 2023; Schleicher, 2020).

This study's findings affirm the urgency of enhancing science instruction through innovations that promote active, contextualized learning. One promising intervention is the development of contextualized task cards, which anchor scientific concepts in students' lived experiences and local environments. Research has shown that contextualized tasks improve engagement, retention, and the ability to transfer knowledge to new situations (Clarke & Roche, 2018; Arevalo et al., 2023; Sambayon et al., 2023). By directly addressing gaps in skills such as measuring and inferring, these tools can help scaffold learning and bridge theoretical concepts with practical application.

Grounded in experiential learning theory (Kolb, 1984) and the principles of Dale's Cone of Experience (Dale, 1969), these instructional strategies prioritize learning through doing and reflection. They also align with Bandura's (1977) social learning theory, which highlights the importance of modeling and feedback—elements that were notably absent in pandemic-era learning. By reintroducing these components through interactive, peer-collaborative, and problem-based task cards, educators can help reverse the cognitive stagnation observed in the data.

In summary, this study confirms a systemic decline in the scientific literacy skills of Senior High School students in the post-pandemic landscape. The lack of differentiation across demographic groups underscores the pervasiveness of instructional gaps, while the pronounced weaknesses in specific skills point to a need for targeted, context-sensitive interventions. As the education sector transitions toward recovery and resilience, prioritizing the development of scientific literacy through integrative and experiential pedagogies is both timely and necessary.

Conclusion:

This study set out to evaluate the scientific literacy skills of Senior High School students in the context of the new normal education, focusing on the fundamental science process skills of observing, classifying, communicating, measuring, inferring, and predicting. Drawing from the experiences of 298 students in a large rural public secondary school in the Central Philippines, the findings revealed a concerning pattern: across all demographic variables—including sex, grade level, academic track, and socioeconomic status—students demonstrated very low proficiency in scientific literacy.

The uniformity of low performance across these categories underscores the systemic nature of the problem. The results suggest that the educational disruptions caused by the COVID-19 pandemic, coupled with the limitations of modular and blended learning modalities, have significantly hindered the development of core scientific competencies. The absence of hands-on laboratory experiences, reduced teacher-student interaction, and the lack of opportunities for inquiry-based learning likely contributed to these outcomes. These findings reflect the broader national and global concerns about learning loss and educational inequality in the wake of prolonged school closures.

Among the six scientific process skills assessed, measuring, inferring, and predicting emerged as the most underdeveloped. These skills require higher-order cognitive engagement and often depend on real-life application, feedback, and guided exploration—conditions that were largely missing in the new normal instructional context. Meanwhile, skills like classifying, observing, and communicating showed slightly higher but still insufficient mastery levels, suggesting uneven cognitive development that demands instructional recalibration.

Statistical analyses confirmed that the students' scientific literacy levels did not significantly differ by sex, grade level, track, or socioeconomic status, indicating that traditional predictors of academic performance had limited influence in the context of disrupted and improvised learning environments. Instead, the quality and accessibility of instructional delivery appeared to be the most decisive factors affecting student outcomes.

These conclusions highlight a pressing need for pedagogical innovation. In particular, the development and implementation of contextualized task cards in Earth and Life Science present a viable solution to help bridge the learning gaps identified in this study. By anchoring instruction in real-life, local contexts and promoting active learning, these tools have the potential to re-engage students, strengthen their foundational skills, and restore confidence in scientific inquiry.

In light of these findings, stakeholders in science education—including teachers, curriculum developers, school administrators, and education policymakers—must prioritize the recovery of lost competencies and design adaptive strategies that respond to the enduring impacts of the pandemic. Ensuring that students are not only knowledgeable in science content but also proficient in applying scientific processes is crucial to rebuilding a scientifically literate and resilient generation of learners.

Based on the findings and conclusions of this study, it is recommended that schools and educators prioritize the integration of contextualized, skills-based instructional materials—such as task cards tailored to real-life scenarios—to improve students' scientific literacy, particularly in the areas of measuring, inferring, and predicting. The Department of Education, through its curriculum and learning resource development units, should support the creation and dissemination of such tools, ensuring they are accessible across tracks and socioeconomic backgrounds. Teachers are encouraged to adopt inquiry-based and experiential teaching approaches that promote active engagement and critical thinking, while school administrators should invest in targeted teacher training to enhance science instruction in blended and in-person modalities. Future researchers may expand on this study by evaluating the effectiveness of these interventions across diverse educational contexts to further inform policy and classroom practice.

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