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LEARNERS' SCIENTIFIC UNDERSTANDING THROUGH STRUCTURED LEARNING STRATEGIES

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ABSTRACT

This study examined the impact of structured learning strategies on learners' scientific understanding, considering parental educational attainment, number of siblings, and distance from school. The participants were learners from Dr. Catalino Gallego Nava Memorial High School and Remedios E. Vilches–San Lorenzo National High School. Findings showed that learners generally had a high level of scientific understanding, with an overall mean score of 3.9210. They demonstrated strong understanding across biology topics, although slightly lower performance was noted in physiological regulation and genetic engineering, indicating the need for added instructional support. A significant difference was found in scientific understanding based on parental educational attainment ($\chi^2 = 20.039$, $p = .003$), while number of siblings and distance from school showed no significant effect. Teachers used varied materials such as PowerPoint presentations, activity sheets, laboratory experiments, modules, and visual aids, which helped improve concept clarity, critical thinking, retention, and learner autonomy.

Keywords: *Learners, Scientific Understanding, Structured Learning Strategies*

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INTRODUCTION

Scientific understanding is a crucial educational goal that enables learners to comprehend natural phenomena, apply scientific concepts to real-world problems, and make informed decisions. In contemporary science education, understanding is not limited to factual recall but involves meaningful integration of concepts, higher-order thinking, and the ability to explain and predict outcomes using evidence. Recent science education frameworks emphasize scientific understanding as a core learning outcome necessary for scientific literacy and lifelong learning (OECD, 2020; National Academies of Sciences, Engineering, and Medicine [NASEM], 2022).

Despite its importance, many learners continue to struggle with developing a deep scientific understanding. Teacher-centered instructional practices that prioritize memorization and procedural recall often fail to engage learners cognitively or address misconceptions that impede conceptual change. Recent studies highlight that traditional instruction may result in fragmented knowledge structures and limited transfer of learning (OECD, 2023). These challenges have led educators and researchers to explore alternative instructional models that promote meaningful learning, conceptual coherence, and active engagement.

Structured learning strategies refer to instructional approaches that deliberately organize learning experiences into coherent, sequenced, and cognitively supported phases. These strategies include structured inquiry, scaffolded problem solving, guided explanations, use of visual organizers, worked examples, and formative feedback mechanisms that help learners connect new information with prior knowledge. Contemporary learning science

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research emphasizes that structured instructional design supports conceptual understanding by managing cognitive load, fostering schema construction, and promoting metacognitive regulation (Kirschner & Hendrick, 2020; NASEM, 2022). When learning experiences are intentionally structured, learners are better equipped to process complex scientific ideas and construct meaningful conceptual frameworks.

International comparative studies further support the effectiveness of structured learning strategies in science education. Analyses of Programme for International Student Assessment (PISA) data reveal that teacher-directed structured inquiry practices—such as explicit explanation of scientific concepts, connections to real-life contexts, and opportunities for student reflection—are positively associated with higher levels of scientific literacy and achievement (Singer et al., 2022; OECD, 2023). These findings suggest that structured instructional guidance plays a crucial role in enabling learners to apply scientific knowledge meaningfully and coherently.

This study, therefore, sought to investigate the scientific understanding of the Grade 12 STEM learners in General Biology 2 through structured learning strategies. By exploring the effects of structured cognitive support, this research aimed to contribute evidence that could inform classroom practice, teacher professional development, and curriculum design.

MATERIALS AND METHODS

Research Methodology

This chapter presents the research methods, research design, respondents of the study, sampling design, data gathering procedure, research instrument, data analysis and statistical tools that were used in analyzing and interpreting data in the study.

Research Method

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to comprehensively investigate learners' scientific understanding through structured learning strategies. The quantitative component utilized a descriptive design to measure and compare the level of learners' scientific understanding across different groups classified according to parental educational attainment, number of siblings, and distance from school.

Data were collected using a researcher-validated questionnaire and structured assessment tools designed to evaluate learners' comprehension, application, and analysis of biological concepts. Statistical analyses, including descriptive statistics and non-parametric tests such as the Kruskal-Wallis test, were employed to determine the significance of differences among the groups (Creswell & Creswell, 2022; Fraenkel, Wallen, & Hyun, 2020).

Complementing the quantitative data, the qualitative component employed an interpretive approach to explore learners' perceptions, experiences, and strategies when engaging with structured learning materials. Focus group discussions and semi-structured interviews were conducted with a purposive sample of learners to gain in-depth insights into

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how instructional materials, guided activities, and visual aids influence understanding, retention, and critical thinking in science learning. Thematic analysis was applied to identify recurring patterns and themes, providing a nuanced understanding of learners' engagement and conceptual development (Braun & Clarke, 2021; Merriam & Tisdell, 2016).

The use of both quantitative and qualitative approaches enabled data triangulation, strengthening the study's validity and reliability by integrating numerical indicators of understanding with learners' personal experiences. This mixed-methods approach ensures a holistic evaluation of the effectiveness of structured learning strategies in promoting scientific comprehension, while also capturing contextual factors that may influence learner outcomes (Creswell & Plano Clark, 2018). Ethical considerations, including informed consent, confidentiality, and voluntary participation, were strictly observed throughout the study to protect the rights and welfare of participants.

Research Design

This study employed a mixed methods research design, integrating both quantitative and qualitative approaches to provide a comprehensive understanding of learners' scientific understanding through structured learning strategies. The mixed methods approach allows for the combination of numerical measurement and contextual exploration, generating richer and more nuanced insights than either approach alone by capturing both measurable trends and learners' lived experiences (Creswell & Creswell, 2022; Plano Clark & Ivankova, 2020).

The quantitative component of the study utilized a descriptive research design, which is appropriate for examining existing conditions, perceptions, and variations in learners' scientific understanding without manipulating variables. This design is particularly suitable for educational settings where the goal is to describe patterns and relationships among variables within naturally occurring classroom contexts (Fraenkel, Wallen, & Hyun, 2020; Creswell & Creswell, 2022). Data were gathered from intact class groups using validated assessment instruments and structured questionnaires to measure learners' scientific understanding as influenced by structured learning strategies such as organized presentations, guided laboratory activities, activity sheets, and visual aids.

Descriptive statistics and non-parametric tests, including the Kruskal–Wallis H test, were employed to examine differences in scientific understanding when learners were classified according to profile variables such as parents' educational attainment, number of siblings, and distance of school from residence (Field, 2023).

The qualitative component complemented the quantitative findings by exploring learners' perceptions and experiences with structured learning strategies. Semi-structured interviews and focus group discussions enabled learners to describe how specific instructional materials and activities influenced their comprehension, engagement, and critical thinking. Thematic analysis was applied to identify recurring patterns and themes within learners' narratives, providing contextual depth and explanatory insight to the quantitative results (Braun & Clarke, 2021; Merriam & Tisdell, 2022).

By integrating quantitative descriptive data with qualitative interpretations, the study employed data triangulation to enhance validity, credibility, and interpretive depth. These mixed methods design not only describes patterns in learners' scientific understanding but also explains the experiences underlying these patterns, offering a holistic foundation for recommendations in science education practice and policy (Creswell & Plano Clark, 2018; UNESCO, 2023).

Respondents of the Study

This study was confined to the Grade 12-STEM learners taking up the General Biology 2 subject of a public secondary school in the District of San Lorenzo, enrolled during the school year 2024-2025. A census sampling design was used in the study. Sixty-two (62) identified learners in Grade 12 STEM students with General Biology Electives were the participants of the study, twenty-five (25) Grade 12 STEM learners from Dr. Catalino G. Nava Memorial High School, and thirty-seven (37) Grade 12 STEM learners from Remedios E. Vilches-San Lorenzo National High School. The level of scientific understanding of students was determined using a researcher-made questionnaire.

Table 1-A

Distribution of Respondents from the Different Schools in the Municipality of San Lorenzo, Schools Division of Guimaras, during the School Year 2024-2025

School	No. of Learners	%
Dr. Catalino Gallego Nava Memorial High School	25	40.00
Remedios E. Vilches-San Lorenzo National High School	37	60.00
Total	62	100.00

Sampling Design

This study employed a descriptive research design to examine learners' scientific understanding through structured learning strategies. To meet the objectives of the research, a census sampling technique was applied, wherein all individuals within the target population were included as participants. The respondents consisted of Grade 12 STEM strand students enrolled in School Year 2024–2025. Census sampling is a sampling approach in which the entire population of interest is studied, allowing for a comprehensive and accurate representation of learners' scientific understanding within the defined group. According to Palinkas et al. (2019), census sampling is appropriate when the population size is manageable and when the goal is to obtain complete coverage of all eligible participants relevant to the phenomenon under investigation. This method eliminates sampling bias and ensures that variations in learners' characteristics and experiences are fully captured. By including all Grade 12 STEM learners, the study was able to gather rich and inclusive data that reflect the actual learning conditions and experiences of the population, thereby strengthening the reliability and credibility of the findings.

Research Instrument

A researcher-developed questionnaire was employed to gather responses to specific questions. These questions were factual in nature and aimed at collecting information about conditions or practices that participant were assumed to be familiar with.

The researcher-made questionnaire had two parts. Part 1 gathered the respondents' personal information, such as: Name (Optional); Grade and Sect ion; Name of School; Date;

Parents' Educational Attainment, (1) Elementary level, (2) Elementary Graduate, (3) Highschool Level, (4) Highschool Graduate, (5) College level, (6) College Graduate, and (7) Vocational Course; Number of Siblings, (1)1 to 3 siblings, (2)4 to 6 siblings, (3)7 to 9 siblings, and (4) 7 to 9 siblings; and Distance of School from Residence, (1) less than 1 to 3 kilometers, (2) 4 to 6 kilometers, (3) 7 to 9 kilometers, and (4) more than 9 kilometers.

Part II was the questionnaire proper. It has two (2) areas. Area 1 was the level of scientific understanding of learners through structured strategies with twenty (20) items. Area II consisted of an essay-type questionnaire designed to identify the teaching materials used in General Biology 2 and to examine how these materials were applied by teachers to enhance learners' scientific understanding through structured learning strategies. The respondents were asked to check the column intended for their response using the following rating scales:

5 - Strongly Agree

4 - Agree

3 - Undecided

2 - Disagree

1 - Strongly Disagree

Validity of the Research Instrument

The questionnaire was subjected to content validation to confirm its validity. In this context, validity refers to the extent to which a measuring instrument can accurately evaluate or predict the specific concepts, conditions, or phenomena it is designed to assess, ensuring reliable and meaningful results from the responses. The researcher-developed questionnaire was first reviewed by the researcher's adviser, who provided corrections, recommendations, and suggestions to improve clarity, relevance, and overall structure. This preliminary review ensured that the instrument was appropriately aligned with the research objectives before being submitted to the Thesis Committee for formal content validation. To evaluate the validity of the questionnaire items, the Eight-Point Criteria of Good and Scates was employed, serving as a systematic framework for assessing whether each item accurately measured the intended constructs. Integrating expert feedback with established validation standards ensured that the final questionnaire was reliable, thorough, and closely aligned with the research objectives, offering an effective instrument for collecting precise and meaningful data from the respondents.

Reliability of the Research Instrument

After the questionnaire was confirmed to be valid through the final content validation, it was subjected to a trial test to determine its reliability. Reliability of a research instrument refers to the degree to which the instrument consistently measures what it is intended to measure, producing stable and repeatable results over time (LoBiondo-Wood & Haber, 2021). Upon the approval of the thesis adviser and the thesis committee, a researcher-made 20-item test and two (2) items essay-type questionnaire designed to identify the teaching materials used in General Biology 2 and to examine how these materials were applied by teachers to enhance learners' scientific understanding through structured learning strategies was administered to the thirty-nine (39) Grade 12 STEM learners of Desiderio C. Gange National

High School in the municipality of Sibunag, to ensure that the responses could be consistently replicated.

One of the most commonly used measures of reliability is Cronbach's alpha, which evaluates the internal consistency of a set of items in a questionnaire or test. In this study, reliability testing was conducted on two instruments: a 20-item test and a demographic profile questionnaire.

The 20-item test yielded a Cronbach's alpha of 0.903, which falls within the range of excellent reliability ($\alpha \geq 0.9$). This indicates that the test items are highly consistent in measuring the intended construct. On the other hand, the demographic profile questionnaire produced a Cronbach's alpha of 0.863, which is interpreted as good reliability ($0.8 \leq \alpha < 0.9$). While slightly lower than the 20-item test, this value still indicates that the items within the demographic profile are consistent and provide dependable data.

In conclusion, the results of the reliability testing demonstrate that both instruments used in this study are reliable and consistent. The 20-item test exhibits excellent reliability, ensuring that the measurement of the primary construct is stable, while the demographic profile shows good reliability, confirming that demographic data are dependable. These findings support the credibility of the data collected and indicate that the instruments are reliable for use.

Data Gathering Procedures

The data needed were collected in the following manner: Upon the recommendation of the panel, the researcher requested permission to conduct the study from the office of the Graduate School.

Before the conduct of the study, another permit was secured from the Schools Division Superintendent and the School Principals of Remedios E. Vilches-San Lorenzo National High School and Dr. Catalino Gallego Nava Memorial High School, where the study was conducted. After the requests were approved, a letter of consent was sent to parents and the learners, explaining the purpose of the study.

The researcher conducted an orientation for the identified respondents and guided them on how to answer the questionnaire. Identities of the respondents were then kept confidential.

After the orientation, the respondents answered the researcher-made questionnaire checklist to determine the level of learners' scientific understanding through structured strategies.

After gathering the answered questionnaires, the data were tabulated and statistically treated using the Statistical Package for the Social Sciences (SPSS) Software.

Data Analysis

The researchers prepared a substantial number of copies of the validated questionnaire to be administered to the target respondents, who were purposely selected as participants in the study. Once the completed questionnaires were retrieved, the collected data were carefully organized, coded, and entered into the Statistical Package for the Social Sciences (SPSS) software for analysis. The responses were then computed, tabulated, and summarized to facilitate accurate interpretation and presentation of the findings. The data were analyzed using the mean score to determine the level of responses of the participants. The computed mean values were interpreted using the following rating scale:

4.21 - 5.00	Very High
3.41 - 4.20	High
2.61 - 3.40	Moderate
1.81 - 2.60	Low
1.00 - 1.80	Very Low

Statistical Tools

The data gathered were subjected to appropriate statistical treatment. The Social Package for the Social Sciences (SPSS) software was used to analyze the data gathered. For inferential statistics, the level of significance was set at 0.05 level of significance.

Frequency Count. It is a descriptive statistical measure that indicates the number of times a specific value, response, or category occurs in a dataset, helping researchers organize and summarize data patterns before further analysis (e.g., frequency distribution) in quantitative research (descriptive statistics) (OpenStax, *Statistics*,2025). This will be used to find out the distribution of the respondents in a particular group.

Percentage. In research, it refers to expressing a part of a whole as a fraction of 100, enabling researchers to compare proportions and summarize data patterns clearly in

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analysis and reporting (e.g., survey distributions and group comparisons) (Doc McKee, 2025). This is used to get the number of respondents and the percentage of responses in each group.

Mean. It is a descriptive statistic that represents the central value of a dataset by summing all observations and dividing by the total number of values, providing an average that helps describe the overall level of the data (OpenStax,2025). The mean was used to compute the average scores representing learners' scientific understanding based on the pre-test and post-test results.

Kruskal–Wallis Test. Kruskal–Wallis test is a non-parametric statistical test used to determine whether there is a statistically significant difference among three or more independent groups when the data are ordinal or when the assumptions of normality required for one-way ANOVA are not met. According to Field (2020), the Kruskal–Wallis test provides a robust alternative to parametric ANOVA, while Pallant (2020) emphasizes its suitability for non-normally distributed data, ensuring valid and reliable statistical conclusions. It is employed in the study to determine whether there were statistically significant differences in learners' scientific understanding across three or more independent groups exposed to different structured learning strategies.

Post Hoc Tests. In Latin, post hoc means "after this". It is used to explore differences between multiple groups' means after a statistically significant test (Frost, 2023). In the study Learners' Scientific Understanding through Structured Learning Strategies, the post hoc analysis was used to compare learners exposed to different structured learning strategies and to identify which strategies led to significantly higher levels of scientific understanding. The application of post hoc testing ensured accurate interpretation of group differences while controlling for Type I error, thereby strengthening the validity and reliability of the study's findings (Pallant, 2020).

RESULTS AND DISCUSSIONS

Scientific understanding is a cornerstone of science education because it helps learners connect scientific concepts, theories, and real-world applications.

The study found that learners' scientific understanding under structured learning strategies was generally satisfactory, though differences appeared based on parents' educational attainment, number of siblings, and distance from home to school.

Learners with more highly educated parents tended to perform better, while those with more siblings or who lived farther from school showed slightly lower performance, suggesting that family and logistical factors may affect learning outcomes.

The analysis also showed significant differences in learners' scientific understanding across these classifications. This highlights the influence of socio-demographic factors on the effectiveness of structured learning strategies and underscores the need for differentiated instruction that responds to diverse learner contexts.

Teachers used a variety of instructional materials to support scientific understanding, including PowerPoint presentations, textbooks, laboratory activity sheets, and modules. This blend of digital and traditional resources created a diverse learning environment that supported both conceptual understanding and hands-on practice.

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Learners also actively used these materials to strengthen their understanding. They relied on textbooks and modules for reference, joined guided laboratory activities to apply concepts, and used PowerPoint presentations as visual support for learning. This multimodal engagement promoted deeper comprehension and inquiry-based learning, showing that structured learning strategies are more effective when paired with varied teaching materials.

CONCLUSION

This study underscores the importance of carefully planned instructional approaches in enhancing students' understanding, engagement, and practical application of scientific concepts. Structured learning strategies—such as guided inquiry, scaffolded exercises, and the integration of various learning materials—offer learners organized and sequenced experiences that encourage meaningful comprehension rather than rote memorization.

By connecting new concepts to prior knowledge, these strategies help students integrate ideas, recognize relationships, explain natural phenomena, and apply scientific principles in real-world contexts.

The findings indicate that these approaches are effective across diverse learners, with parental education influencing perceptions, while family size and distance from school have little impact.

Students reported using resources such as PowerPoint presentations, activity sheets, laboratory exercises, modules, textbooks, and visual aids to clarify concepts, reinforce understanding, develop critical thinking, support independent learning, and accommodate

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different learning preferences. Experiential activities and experiments further strengthen reasoning, retention, and the ability to transfer knowledge, fostering scientific literacy.

Overall, scientific understanding involves constructing knowledge, evaluating evidence, and applying concepts thoughtfully. Structured strategies combined with varied materials create interactive, learner-centered environments that promote independent, critical-thinking learners capable of applying science meaningfully, transforming education from passive reception to active engagement.

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