



**LEAST MASTERED COMPETENCES IN BIOLOGY 1: BASES FOR
TEACHER-INITIATED LABORATORY MANUAL AS
A LEARNING SUPPLEMENT**

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ABSTRACT

This study aimed to identify the least mastered competencies in Biology 1 and develop a teacher-initiated laboratory manual as a learning supplement. The study utilized a developmental research design focusing on the systematic identification of competency gaps and the development of an instructional material. Item analysis was conducted on the First and Second Quarter Biology 1 examinations administered to two hundred sixty-eight 268 Grade 11 students at Iloilo National High School. Competencies with mastery levels below the 75 percent benchmark were classified as least mastered. Findings revealed fourteen competencies with low mastery levels. These results suggest that students encounter challenges in higher-order scientific reasoning. Based on these findings, a teacher-initiated laboratory manual consisting of fourteen inquiry-based laboratory activities was developed to address the identified competencies. The manual aims to enhance conceptual understanding and strengthen students' mastery of Biology 1 through structured laboratory experiences.

Keywords: *Biology 1, least mastered competencies, teacher-initiated laboratory manual*

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INTRODUCTION

Science education in the Philippines continues to face systemic problems despite reforms under the K–12 program. Filipino students persistently underperformed on international assessments such as PISA and TIMSS (De La Cruz, 2022; Sison, 2022). The Department of Education (DepEd) has acknowledged shortcomings, particularly in laboratory-based instruction, which remains underdeveloped because of inadequate resources, insufficient teacher training, and a curriculum misaligned with students’ needs.

In the 2018 PISA, the Philippines ranked among the lowest, with students scoring below average in science, mathematics, and reading (OECD, 2019). This outcome highlights entrenched issues in curriculum rollout, instructional design, and resource distribution. Many public schools lack basic laboratory equipment, making experiential science learning difficult; DepEd reported that only 40% of secondary schools have functional science laboratories (DepEd, 2020). A notable share of science teachers are assigned subjects outside their specialization, and the Philippine Institute for Development Studies found that just 60% of science teachers had formal training in their assigned subjects (PIDS, 2021). Although the K–12 curriculum introduced in 2012 sought to strengthen science education, implementation has been inconsistent—teachers struggle to cover competencies, particularly laboratory-based ones, due to time constraints and a shortage of contextually relevant materials (SEI-DOST, 2020).

In Western Visayas, STEM-track students reported limited laboratory exposure. A UP Visayas regional study found that 70% of students relied mainly on theoretical instruction

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because of material shortages (UPV Research Office, 2022). Master teachers and education specialists in the region had limited access to updated instructional design frameworks, constraining their capacity to mentor junior teachers and to innovate classroom practices (CHED Region VI, 2021). Teachers also found it difficult to contextualize science topics to local realities—for example, environmental science lessons often failed to reference regional ecosystems, reducing relevance and student engagement (DepEd Region VI, 2020). Internal assessments at Iloilo National High School showed ongoing gaps in students’ mastery of laboratory competencies.

During the pandemic, the school depended heavily on printed modules that lacked laboratory integration, resulting in conceptual gaps and lowered engagement (School Report, 2021). Teachers at INHS voiced the need for structured, teacher-created manuals to bridge theory and practice and stressed the importance of pre-implementation design to ensure alignment with curriculum standards and student needs. While several studies addressed instructional material development, few focused specifically on teacher-initiated laboratory manuals targeting least-mastered competencies; most existing manuals were generic, lacked contextual relevance, and were not validated by master teachers.

Based on these premises, the researcher conducted the study to empower teachers, address persistent science competency gaps, and produce a validated, contextualized manual to improve laboratory instruction and support quality education at Iloilo National High School.

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MATERIALS AND METHODS

Research Methodology

This chapter presents the methodology employed in the conduct of the study, which focuses on identifying the least mastered competencies in Biology 1 and developing a teacher-initiated laboratory learning manual as a supplementary instructional material. The study adopts a mixed-methods approach, integrating quantitative data analysis and qualitative material development procedures. This approach is appropriate because the study involves numerical analysis of student performance data to diagnose learning gaps, followed by qualitative instructional design processes in crafting laboratory activities aligned with the identified needs.

The research design utilizes a descriptive mixed-methods developmental design. The quantitative component involves item analysis of the 1st and 2nd Quarter Examinations administered to Grade 11 students. This phase identifies competencies with mastery levels below the established benchmark. The qualitative component involves the systematic development of the laboratory manual, where instructional content, activity structure, and thematic organization are crafted based on the quantitative findings. The integration of both strands ensures that the instructional material is grounded in empirical classroom data while incorporating pedagogical principles in its design.

The participants of the study consist of Grade 11 students enrolled in Biology 1, whose examination results serve as the primary quantitative data source. Their performance provides the empirical basis for identifying the least mastered competencies. No additional respondents

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are involved in the development phase, as the laboratory manual is constructed by the researcher using curriculum standards, theoretical foundations, and identified performance gaps.

The primary research instruments include the 1st and 2nd Quarter Examination results and the Table of Specifications used to map test items to specific learning competencies. These documents serve as the basis for quantitative analysis. For the qualitative component, the researcher utilizes curriculum guides, instructional frameworks, and relevant literature in science education to structure the laboratory manual.

The data gathering procedure begins with the collection of student examination scores. Each test item is mapped to its corresponding competency using the Table of Specifications. The frequency of correct responses per item is computed and converted into percentage scores. Competencies obtaining mastery levels below 75 percent are identified as least mastered. These identified gaps then serve as the foundation for the development of the laboratory manual. In the qualitative phase, laboratory activities are drafted, organized into thematic instructional domains, and structured according to standardized components such as objectives, procedures, observation tables, guide questions, and rubrics.

The data analysis procedure integrates both quantitative and qualitative techniques. Quantitatively, descriptive statistics such as frequency counts and percentage distributions are used to determine mastery levels of competencies. Competencies are ranked from lowest to highest percentage to prioritize instructional focus. No inferential statistics are employed, as the purpose of the study is diagnostic rather than comparative. Qualitatively, the identified

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competencies are categorized into broader biological domains to guide thematic organization of the manual. The development process follows principles of curriculum alignment, constructivist learning theory, and inquiry-based instruction to ensure coherence and instructional relevance.

Through this mixed-methods design, the study establishes a direct connection between empirical student performance data and the systematic development of a competency-based laboratory learning manual. The quantitative findings inform the instructional focus, while the qualitative design process translates these findings into structured, inquiry-driven laboratory activities aimed at strengthening conceptual mastery in Biology 1.

Research Method

This study adopts a mixed-methods developmental research methodology focused on the systematic development of a teacher-initiated Biology 1 laboratory manual grounded on identified least mastered competencies. The approach integrates quantitative analysis of student performance data with qualitative instructional design procedures.

The quantitative component provides objective evidence of learning gaps through statistical treatment of examination results, while the qualitative component guides the structured development of laboratory activities aligned with curriculum standards and pedagogical principles. This integration ensures that a strong study design aligns research questions, technique, and data gathering methods, ensuring valid, trustworthy, and meaningful outcomes (Creswell and Creswell, 2023).

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The study followed a developmental research sequence beginning with the identification of the least mastered competencies in Biology 1 through item analysis of quarterly examination results. Each test item is mapped to its corresponding learning competency using the Table of Specifications to ensure curriculum alignment. Competencies falling below the established mastery benchmark are prioritized for instructional intervention.

Guided by curriculum development principles and constructivist learning theory, the researcher then designed laboratory activities directly aligned with these identified competencies. The laboratory manual was organized into thematic instructional domains and structured with standardized components such as learning objectives, materials, procedures, observation tables, guide questions, and performance-based rubrics. The final output represented a systematically developed instructional material informed by quantitative evidence and qualitative pedagogical design, prepared for potential classroom implementation.

Research Design

In this study, the researcher employed a mixed-methods developmental research design, integrating quantitative and qualitative approaches to ensure a comprehensive and systematic development of a teacher-initiated Science 10 laboratory manual. Mixed-methods research is particularly appropriate in educational material development, where both measurable evidence and contextual insights are necessary to produce instructionally sound outputs (Creswell & Plano Clark, 2021). This design allows the study to combine statistical diagnosis of learning gaps with pedagogically informed material construction.

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The quantitative component of the study focused on identifying the least mastered competencies in Biology 1 through item analysis of quarterly examination results. Numerical data derived from frequency counts and percentage distributions provide objective evidence of specific areas where students demonstrate low mastery. These results serve as the empirical foundation for prioritizing instructional content in the development of the laboratory manual. By relying on statistical analysis, the study ensures that instructional decisions are data-driven rather than based on assumptions.

The qualitative component centered on the systematic design and organization of the laboratory manual. Guided by curriculum standards, constructivist learning principles, and inquiry-based instructional frameworks, the researcher develops laboratory activities that directly address the identified competencies. The qualitative process involves structuring each activity with clearly defined objectives, materials, procedures, observation tables, guide questions, and performance-based rubrics. This stage emphasizes pedagogical coherence, contextual appropriateness, and thematic organization of content across biological domains.

The integration of quantitative findings and qualitative instructional design strengthens the overall rigor of the study. Quantitative data determine what competencies require intervention, while qualitative development determines how those competencies will be addressed through structured laboratory experiences. This complementary relationship enhances internal consistency and ensures that the manual is both empirically grounded and educationally responsive. Such integration aligns with the Department of Education's emphasis on evidence-based and context-sensitive instructional innovation (DepEd, 2023).

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Overall, the mixed-methods design enables the researcher to bridge statistical diagnosis with instructional development, resulting in a laboratory manual that is systematically constructed, competency-aligned, and responsive to actual classroom needs.

Participants of the Study

The participants of this study consist of two hundred sixty eight (268) Grade 11 students enrolled in Biology 1 during the conduct of the research, utilizing a total enumeration approach. Total enumeration was employed to ensure that the entire population of senior high school biology students was included in the analysis, thereby eliminating sampling bias and providing a comprehensive representation of student performance.

Through total enumeration, all available examination results from the 1st and 2nd Quarter assessments were collected and analyzed. This approach strengthens the reliability and accuracy of the findings because the computed mastery levels reflect the actual performance of the whole student population rather than a selected subset. It also enhances the internal validity of the study, as conclusions are drawn from complete population data within the defined research setting.

The academic performance data of all Grade 11 students served as the quantitative basis for identifying least mastered competencies in Biology 1. These identified learning gaps then guided the systematic development of the teacher-initiated laboratory learning manual. By grounding instructional material development in total population data, the study ensured that the resulting laboratory activities were directly responsive to the demonstrated needs of the learners.

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Research Instrument

The data analysis in this study utilized a mastery-level classification scale to interpret student performance across identified Biology 1 competencies. Mastery levels are determined based on percentage scores derived from the number of correct responses relative to the total number of students. The scale categorizes performance into defined proficiency levels to allow systematic interpretation of learning outcomes.

The classification followed a structured benchmark: 90–100 percent indicates Very High Mastery, 80–89 percent indicates High Mastery, 75–79 percent indicates Approaching Mastery, 50–74 percent indicates Low Mastery, and below 50 percent indicates Very Low Mastery. Competencies falling below the 75 percent threshold are classified as least mastered and prioritized for instructional intervention.

This structured interpretation scale ensures consistency and objectivity in analyzing examination results. Higher percentage values reflect stronger conceptual understanding and skill acquisition, while lower percentages indicate areas requiring targeted instructional support. The use of defined mastery benchmarks facilitates clear comparison across competencies and provides a data-driven foundation for the development of the teacher-initiated laboratory learning manual.

Data Gathering Procedures

The data-gathering procedure of the study focused on the development of a laboratory learning manual for Biology 1 based on the identified least mastered competencies of Grade

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11 learners. The procedure consists of two major phases: Preparation and Planning and Learning Manual Development.

Phase 1: Preparation and Planning

The study began with the identification of the least mastered competencies in Biology 1 among Grade 11 students. To accomplish this, the researcher collected and reviewed the quarterly examination results of Grade 11 Biology learners from school-based assessments. These results served as the primary data source in determining areas where students demonstrated difficulty in mastering the required competencies. Each examination item was carefully matched with its corresponding learning competency using the Table of Specifications (TOS) to ensure that the analysis was aligned with the competencies prescribed by the Department of Education in the K–12 Science Curriculum Guide.

After the examination results were gathered, the scores were organized and tabulated according to competency. Frequency counts and percentage distributions were computed to determine the level of mastery of each competency. Through this process, patterns of learner performance were identified, allowing the researcher to determine which competencies consistently fell below the expected mastery level. Competencies that did not meet the mastery benchmark were classified as least mastered competencies and were prioritized in the development of the laboratory learning manual.

Prior to conducting the data collection and analysis, the researcher coordinated with Biology teachers for access to relevant academic records. This step ensured that the collection

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and use of student performance data adhered to institutional policies and ethical considerations.

Phase 2: Learning Manual Development

Following the identification of the least mastered competencies in Biology 1, the researcher proceeded with the development of the teacher-initiated laboratory learning manual. The structure of the manual was designed using Taba's Curriculum Development Model and guided by constructivist learning principles, which emphasize active learner engagement and experiential learning. The laboratory manual was structured to provide teachers with organized and competency-based laboratory activities that support the development of conceptual understanding through hands-on investigation.

For each identified competency, the researcher developed inquiry-based laboratory activities that encourage students to observe, experiment, analyze data, and draw conclusions based on scientific evidence. Each activity included clearly defined learning objectives, a list of required materials, laboratory safety guidelines, step-by-step experimental procedures, and guide questions that promote analytical thinking. In addition, assessment rubrics were incorporated to help teachers evaluate learners' performance during laboratory activities.

The completed laboratory activities were compiled and formatted into a structured laboratory manual designed for classroom use. The manual includes clear instructions, organized sections, visual aids, and competency alignment to ensure that the laboratory activities directly address the identified learning gaps in Biology 1. By grounding the development of the manual on systematically analyzed student performance data, the

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instructional material is intended to directly respond to the actual academic needs of Grade 11 learners and provide teachers with a structured resource for facilitating laboratory-based learning experiences.

after a series of interviews.

Data Analyses

This study employed a systematic data analysis procedure to accurately identify the least mastered competencies in Biology 1 and to establish a valid basis for the development of the teacher-initiated laboratory learning manual. The analysis focused on the results of the 1st and 2nd Quarter Examinations administered to 268 students. The primary objective was to determine competency mastery levels through item analysis and descriptive statistical techniques.

The first step in the analysis involved the consolidation of raw test scores from both quarterly examinations. Each test item was mapped to its corresponding learning competency based on the Table of Specifications to ensure alignment with curriculum standards. After mapping, the frequency of correct responses per item was computed. These frequencies were then converted into percentage scores to determine the mastery level of each competency. The percentage of correct responses served as the primary indicator of student performance.

RESULTS AND DISCUSSIONS

This study was conducted to identify the least mastered competencies in Biology 1 and to develop a teacher-initiated laboratory learning manual as a learning supplement based on

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the identified instructional gaps. The study utilized item analysis of the 1st and 2nd Quarter Examinations administered to 268 Grade 11 students. Descriptive statistical tools, specifically frequency counts and percentage distributions, were employed to determine mastery levels of each competency. Competencies with mastery levels below 75 percent were classified as least mastered.

The findings revealed fourteen competencies that fell below the mastery threshold. The lowest mastery levels were observed in topics related to aerobic respiration, differentiation of aerobic and anaerobic respiration, light-dependent and light-independent reactions of photosynthesis, mitochondrial structure and ATP production, and cell cycle regulation.

Moderate but still insufficient mastery levels were observed in competencies related to mitosis and meiosis, membrane transport mechanisms, and cellular structure differentiation. These results indicate that students encounter significant difficulty in topics involving energy transformation, regulatory mechanisms, and structure–function relationships—areas that require higher-order thinking and systems integration.

Based on these findings, a teacher-initiated laboratory learning manual was developed. The manual was organized into five instructional domains: Cellular Structure and Organization, Membrane Dynamics and Homeostasis, Cell Division and Regulation, Photosynthesis and Energy Capture, and Cellular Respiration and Energy Release. Each laboratory activity was directly aligned with identified least mastered competencies and followed a standardized structure including learning objectives, procedures, observation tables, guide questions,

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conclusion sections, and performance-based rubrics. The instructional design was grounded in Constructivist Learning Theory and Taba’s Model of Curriculum Development, ensuring alignment between diagnosed learning needs and targeted instructional intervention.

The findings of the study reveal that students experience significant difficulty in mastering Biology 1 competencies that involve complex biological processes such as cellular respiration, photosynthesis, and cell cycle regulation. These topics require students to understand interconnected biochemical pathways and microscopic mechanisms that cannot be directly observed. As a result, learners often struggle to develop a clear conceptual understanding when instruction relies primarily on theoretical explanations rather than experiential or visual learning approaches.

Another important insight is that competencies related to energy transformation and regulatory biological systems appear to be more challenging for students compared to structural topics. Concepts that require learners to analyze sequences of biological events, interpret interactions among cellular components, and explain functional relationships demand higher levels of cognitive processing. Without opportunities to actively engage in experimentation, modeling, or guided inquiry, students tend to memorize information rather than develop deeper scientific understanding.

The use of item analysis and percentage-based mastery evaluation also provides meaningful insights into student learning patterns. By applying a 75 percent mastery benchmark, the analysis clearly identifies specific competencies where students demonstrate insufficient understanding. This diagnostic approach highlights the value of data-driven

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instructional planning, allowing educators to pinpoint the exact areas that require targeted interventions and improved teaching strategies.

Furthermore, the findings highlight the importance of integrating laboratory-based learning experiences in Biology instruction. Hands-on activities, guided experimentation, and inquiry-based tasks provide opportunities for students to observe biological processes, test scientific ideas, and interpret experimental data. These learning experiences help bridge the gap between abstract theoretical concepts and real biological phenomena, enabling students to construct more meaningful and lasting understanding of essential biological

CONCLUSION

In light of the findings and the identified significance of this study to various stakeholders, the following recommendations are proposed:

Biology 1 teachers are encouraged to adopt the Teacher-Initiated Laboratory Learning Manual to address identified learning gaps. Its structured, inquiry-based activities—featuring clear procedures and performance rubrics—may enhance instructional delivery. By integrating the manual into lesson planning, educators may better facilitate concepts like energy transformation and regulatory mechanisms. In resource-constrained settings, maximizing the manual's suggested local materials ensures sustainability, while regular item analysis may help refine future laboratory instruction.

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Master teachers should use this study as a model for developing contextualized materials and spearheading data-driven, teacher-led innovations. As instructional leaders, they may mentor colleagues in inquiry-based strategies and competency-aligned design. Furthermore, the validated manual may serve as a benchmark for action research and peer coaching aimed at elevating science teaching quality.

School heads should support the manual's implementation by providing necessary resources and logistical aid. These findings may guide administrative decisions regarding equipment procurement and teacher training. By institutionalizing data-driven planning and upgrading laboratory facilities, school heads may significantly improve students' mastery levels in Biology 1.

Education program specialists should utilize this study as a framework for curriculum review and policy development. The manual demonstrates how localized innovations may bridge persistent learning gaps. Consequently, specialists may promote the scaling of similar evidence-based interventions across divisions and incorporate these findings into professional development modules.

Learners are encouraged to engage fully in hands-on activities and critical reflections to maximize conceptual understanding. Through consistent participation in inquiry-based tasks, learners may strengthen their scientific reasoning skills and improve their readiness for higher-level science subjects.

Future researchers should consider experimental or quasi-experimental studies to measure the manual's effectiveness through pre-test and post-test designs. Longitudinal

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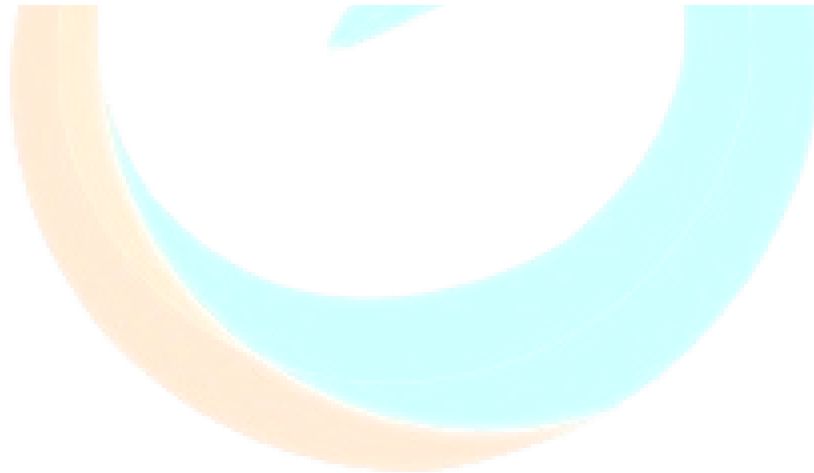
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research may assess sustained impacts on academic retention, while replicating the
framework in other disciplines may explore its scalability. Additionally, integrating digital
simulations into this model may further enrich biological instructional innovation.



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