

Examining the least learned competencies in Earth and Life Science: Basis for the development of Strategic Intervention Materials

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ABSTRACT

The study aimed to develop a Strategic Intervention Material (SIM) to address the least learned competencies in Grade 11 Earth and Life Science at Basag National High School and Bugsukan Integrated School. Using a descriptive-developmental design, data were gathered from 40 students and 2 science teachers through assessment tests and focus group discussions. The results revealed that students struggled with understanding unifying themes in life science and evolutionary classification. While core instructional materials were adequate, there was a lack of supplementary and digital resources. Learning gaps were linked to resource limitations, insufficient lab equipment, and external challenges. In response, the researchers developed a contextualized, activity-based SIM titled “A Learning Initiative-on: Earth and Life Science” using the 4A’s method, which included various learning components. The SIM was validated by experts and rated “Very Satisfactory” in content, format, organization, and accuracy, making it an effective tool to enhance student understanding in the subject.

Keywords: Strategic Intervention Material (SIM), Earth and Life Science, Learning Gaps

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INTRODUCTION

Equipping students with the tools and knowledge to navigate the modern world depends on high-quality education. Science education—especially Earth and Life Science—understanding biological and geological processes depends on mastery of basic competencies. Fighting ignorance requires a deliberate emphasis on even the most basic competencies, as science is an ever-evolving field. These learning gaps compromise students' scientific literacy and performance, even with the current curriculum and instruction. As Hegwood (2022) underlines, the first step in tackling these challenges is to identify the particular kind of learning gap, which then helps teachers apply efficient interventions, including customized lesson plans and technology-based activities, to improve students’ knowledge and understanding of scientific ideas.

Earth and Life Science was an introductory course in the Senior High School (SHS) Science curriculum that helped students grasp the natural world. Although student performance in this area varied, it consistently revealed difficulties in several spheres, stemming from various factors, including different topics, gaps in instruction, inadequate learning resources, prior knowledge, and child misunderstandings. To address these issues, a suitable strategy is necessary, beginning with a thorough examination of student performance and progressing through the development of customized teaching tools tailored to their academic needs.

Furthermore, the study supported the K to 12 curriculum, which emphasized the development of scientific critical thinking and problem-solving abilities. By addressing the least competent students, teachers' guidance toward a deeper understanding of scientific ideas and equipped them with the tools they needed to succeed in the twenty-first century.

Comparative studies at the international level have identified ongoing issues in science education, particularly in the fields of Earth and Life Sciences. Even with significant investments in STEM education from countries such as the USA, Singapore, and China, disparities in student performance persist, highlighting ongoing issues with teaching methods and the distribution of resources Martin et al., (2020). Studies indicate that students often struggle with complex concepts in Earth and Life Science, such as systems thinking, interdisciplinary connections, and the application of scientific knowledge to real-world problems (OECD, 2022). Everyone needs to have a good understanding of the basic skills required in these critical scientific areas for education to function effectively globally.

Within the Philippine context, the K to 12 curriculum aimed to enhance science education and promote critical thinking skills. Studies have identified persistent challenges in implementing the curriculum, including a lack of adequate resources, insufficient teacher training, and difficulties in assessing student learning (Danao et al., 2021). The diverse learning needs of Filipino students have underscored the need for a more nuanced understanding of the specific areas that pose the most significant challenges for students. Identifying the minimal competencies in Earth and Life Science can offer valuable insights into learning gaps and guide the development of targeted interventions and support programs.

Moving to the local level, the Butuan City Division faces some of these national challenges, which may be exacerbated by region-specific factors such as the availability of localized learning materials and the specific training backgrounds of science teachers within the division. Assessing the common challenges in Earth and Life Science competencies within this division is crucial for developing targeted interventions that align with the local educational context.

An examination of Basag National High School and Bugsukan Integrated School within the East II District, the least learned competencies in Earth and Life Science may reflect the unique interplay of factors specific to these school environments, such as the student's prior academic backgrounds, the specific instructional materials currently in use, and the specific strengths and needs of the teaching staff in these institutions. Analysis at this level may provide information about particular learning gaps that require attention through the creation of developed instructional materials in these educational environments.

Problem statement

The study developed strategic intervention materials in Earth and Life Science for learners of Basag National High School and Bugsukan Integrated School in EBD II. Specifically, this research sought to answer the following questions:

1. What are the least learned competencies in Earth and Life Science Grade 11 Learners based on the assessment test results?

2. What are the available instructional materials in teaching Earth and Life Science in the school based?

3. What factors contributed to these learning gaps as revealed through Focus Group Discussions (FGD) with teachers and students?

5. How valid are the developed Strategic Intervention Materials (SIM) in Grade 11 Earth and Life Science, as evaluated by Science experts using the DepEd LRMS Assessment and Evaluation tool?

METHODOLOGY

This study utilized a descriptive-developmental research design to identify and address the least learned competencies in Grade 11 Earth and Life Science. The descriptive phase focused on assessing students' mastery of specific competencies and understanding learning gaps through both quantitative and qualitative data. The developmental phase involved the creation of Strategic Intervention Materials (SIM) based on the results of assessment tests and focus group discussions (FGDs). The ADDE model—Analysis, Design, Development, and Evaluation—was employed to structure the development process, ensuring that the intervention materials were systematically created and refined based on empirical findings. This combined design facilitated an evidence-based and needs-responsive approach to instructional improvement.

The study was conducted in the East II District of Butuan City Division, particularly at Basag National High School and Bugsukan Integrated School. Basag National High School, located in Barangay Basag, had a student population of 207 and sat 36.4 meters above sea level. Bugsukan Integrated School, situated in Barangay Bugsukan, had 149 students and was elevated at 180.2 meters. These schools were purposively selected due to their relevant student populations and learning contexts, aligning with the study's objectives. Geographical and demographic data were sourced from the Philippine Statistics Authority (2020) and OpenStreetMap contributors (2024).

The research involved a total of 40 Grade 11 students enrolled in Earth and Life Science—20 from each school—constituting a complete census for the subject in the research locale. Two science teachers, one from each school, also participated in the study to provide insights and validation for the identified competencies. The purposive sampling approach ensured that the selected schools and participants reflected the characteristics needed to examine the identified learning gaps in a focused and context-specific manner. Teacher input was instrumental in corroborating student responses and enriching the interpretation of learning deficiencies.

To measure competency mastery, the researchers used a multiple-choice assessment test adapted from Caraga Sukdanan. This instrument aligned with the Department of Education's

Most Essential Learning Competencies (MELCs) for the second quarter, providing accurate and relevant measures of students' understanding. The results from this assessment informed the first phase of the research. To complement this, FGDs with both students and teachers explored instructional challenges and contextual factors contributing to poor performance. These qualitative insights addressed the third research question and helped guide the SIM's design.

The development of the SIM was validated using an evaluation form based on the Department of Education's Learning Resources Management and Development System (LRMDS) Assessment and Evaluation Tool. This instrument evaluated the SIM's content quality, format, presentation, and accuracy. Science experts completed the validation, ensuring the intervention's credibility and alignment with educational standards.

Data collection was conducted with full ethical compliance, following the protocols outlined by the Philippines' Data Privacy Act of 2012 (RA 10173). Permissions were obtained from the Schools Division Superintendent, District Supervisor, and respective school principals. Participation was voluntary, and students were informed of the study's purpose and the confidentiality of their responses. Assessment tests were administered during homeroom or science classes, minimizing disruption to regular schedules. FGDs were held in quiet and comfortable settings to allow for open and focused discussion.

The study employed both descriptive and qualitative analytical tools. Frequency, percentage, and mean were used to analyze students' performance in the assessment test, revealing patterns in the least learned competencies. Thematic analysis was applied to FGD transcripts to extract recurring themes related to instructional challenges and learning barriers. These analyses provided a comprehensive understanding of the issues, informing the development and refinement of the SIM to better support students' learning in Earth and Life Science.

FINDINGS AND DISCUSSION

Least learned competencies in Earth and Life Science Grade 11 Learners based on the second quarter test results

Findings of the study show that that Grade 11 Earth and Life Science students achieved an overall Mean Percentage Score (MPS) of 68.96%, falling into the "Moving Towards Mastery" category across ten competencies. However, a detailed examination highlights significant variations in understanding. Specifically, two competencies, describing the unifying themes and the study of connections of life among living things and how they interact with each other and environment (MPS: 58.48%) and describing the present system classification of organisms based on evolutionary relationships (MPS: 59.38%), were categorized as "Average" and exhibited the lowest performance. These scores suggest that students may be experiencing a high extraneous cognitive load when attempting to grasp the intricate and interconnectedness of life science principles and the fundamental role of evolution in biological classification. This observation is consistent with CLT, which posits that instructional designs should minimize unnecessary cognitive burdens to optimize learning (Sweller, 1988). Recent research further supports this, with studies highlighting how poorly integrated or overly complex information can

lead to high cognitive load, particularly in disciplines that require the synthesis of multiple concepts (e.g., Martella et al., 2024).

The other eight competencies, with MPS ranging from 66.88% to 78.13%, were classified as "Moving Towards Mastery" or "Mastery," showing better performance. This discrepancy emphasizes the urgent requirement of tailored teaching plans and interventions meant especially to target the two least-learned competencies. Teachers can significantly enhance the general understanding of Earth and Life Science among Grade 11 students by redesigning their approaches to these challenging areas, thereby efficiently reducing the cognitive load on them and thereby improving learning outcomes in line with the principles of CLT.

Inventory of instructional materials in teaching Earth and Life Science in the school based

The study assessed the availability of instructional materials for Earth and Life Science in two public secondary schools, namely, Basag National High School and Bugsukan Integrated School—revealing both strengths and gaps in resource provision. At both schools, core instructional materials such as DepEd textbooks, teachers' guides, modules, and the curriculum guide were available at a 1:1 ratio and used daily. This high level of access ensures that each student and teacher can engage with the curriculum consistently, promoting equitable and effective instruction. These findings align with best practices in instructional delivery, as supported by research emphasizing that access to adequate printed resources significantly enhances student performance and teacher preparedness.

In terms of supplementary and technology-based resources, Basag National High School reported sufficient laboratory support with 20 microscopes available at a 1:1 ratio, which supports hands-on science learning. The school also had 50 computers or laptops with individual access, though shared technology like projectors, TVs, and printers were at a 1:20 ratio. Bugsukan Integrated School showed a similar pattern with 20 computers or laptops at a 1:1 ratio, while projectors, TVs, and printers were shared at a 1:23 ratio. Although the core learning resources are strong, shared access to certain technology tools—especially those used for presentations and printing—could pose constraints on instructional flexibility and integration of digital tools, particularly if not managed through effective scheduling and teacher support.

While both schools demonstrated adequate provision of essential printed materials, the varying availability and frequency of use of technology-based resources highlight areas for improvement (David, 2021). Ensuring balanced access to both traditional and modern instructional tools is crucial for supporting a comprehensive and responsive Earth and Life Science education (Alon, 2023).

Factors contributing to the learning gaps

Findings from the Focus Group Discussions (FGDs) with Grade 11 students and their teachers revealed multiple interrelated factors contributing to learning gaps in Earth and Life Science. These factors were classified into four major categories: limited learning resources, deficiencies in digital and online tools, insufficient laboratory equipment, and challenging personal and environmental conditions. Collectively, these elements intensify extraneous cognitive load, as theorized by John Sweller's Cognitive Load Theory (1988), which asserts that effective learning requires minimizing non-essential cognitive effort so learners can focus on processing core instructional content.

Students reported a heavy reliance on static resources such as modules and PowerPoint slides, with minimal hands-on or experiential learning activities. The absence of interactive materials, coupled with the use of English—often a second language for many students—creates additional layers of difficulty. This aligns with findings by Chung and Nation (2006), who emphasized that language proficiency plays a crucial role in content learning, especially in science subjects where conceptual complexity is already high. The lack of diverse and engaging materials forces students to expend mental energy deciphering text-heavy content, thereby reducing their capacity to absorb new knowledge.

Technological limitations emerged as another critical barrier. Students expressed frustration over the lack of personal devices, unreliable internet connectivity, and inadequate access to digital learning platforms. Teachers echoed these concerns, noting that the rural setting of the schools contributes to the digital divide. According to Means et al. (2010), digital access significantly influences students' ability to supplement classroom learning, and the lack thereof can impede academic progress, particularly in resource-dependent subjects like science.

The lack of laboratory equipment was also seen as a hindrance to understanding abstract scientific concepts. Both students and teachers recognized that practical, hands-on activities could deepen conceptual understanding. As Hofstein and Lunetta (2004) point out, laboratory experiences are critical in science education because they help students construct meaningful relationships between theory and practice. Without these experiences, students are left to rely on rote memorization, which is less effective for long-term learning and schema construction—an essential aspect of Sweller's CLT framework.

In addition to resource-related issues, personal and environmental factors significantly contributed to learning difficulties. Students shared that household responsibilities, lack of a quiet study area, and limited academic support at home negatively impacted their ability to focus and retain information. Teachers confirmed these challenges, citing overcrowded living conditions and students' need to contribute to the household income. These findings are supported by Bronfenbrenner's Ecological Systems Theory (1979), which highlights how environmental contexts, such as family and home life, profoundly influence educational outcomes.

Validity of the developed Strategic Intervention Materials (SIM) in Grade 11 Earth and Life Science

The developed Strategic Intervention Materials (SIM) for Grade 11 Earth and Life Science underwent a rigorous evaluation by science experts using the Department of Education's Learning Resources Management and Development System (LRMDS) Assessment and Evaluation Tool. The results strongly validate the SIM's quality and instructional efficacy, with consistently "Very Satisfactory" ratings across all domains—content quality, format, presentation and organization, and accuracy and up-to-datedness. This robust evaluation indicates that the SIM meets and exceeds the required LRMDS standards, making it a credible and pedagogically sound resource for addressing learning gaps in Earth and Life Science.

From a content perspective, the SIM was deemed developmentally appropriate, aligned with learning objectives, and effective in fostering higher-order thinking skills such as critical thinking, inquiry, and problem-solving. The inclusion of values education and unbiased content

further supports its holistic design. The average weighted mean of 3.52 across content indicators confirms its alignment with educational goals and its capacity to stimulate learner engagement. This is supported by Ambayon (2020) and Nurhasnah et al. (2020), who underscore that well-structured modules should reinforce learning through developmentally appropriate, interactive content to enhance retention and comprehension.

Format-wise, the SIM scored a 3.50 weighted mean, indicating a high level of user-friendliness in terms of print clarity, readable font, clear illustrations, cultural relevance, and durable layout. Experts found the materials visually appealing and accessible to learners, contributing positively to their usability and attractiveness. This aligns with Schnotz and Lowe (2020), who emphasized that visual and physical elements significantly affect learner engagement and processing, especially in self-directed instructional formats.

Regarding presentation and organization, the SIM earned an overall mean of 3.60, indicating that it was engaging, logically sequenced, and appropriate for the learners' reading and comprehension level. The highest rating of 4.00 in "engagement and understandability" reflects its strong appeal to students. This supports Mayer's (2021) Cognitive Theory of Multimedia Learning, which highlights that coherent structure and appropriate language reduce cognitive overload and help learners construct meaningful knowledge from instructional content.

The strongest validation was observed in the domain of accuracy and up-to-datedness, where the SIM achieved a perfect 4.00 weighted mean across all six indicators, including conceptual, factual, grammatical, and computational accuracy. This comprehensive accuracy affirms the SIM's reliability and ensures that learners are exposed to correct and current scientific information. The significance of such accuracy is underscored by the National Academies of Sciences, Engineering, and Medicine (2022), who emphasized the critical role of content validity in shaping scientifically literate students and preventing the formation of misconceptions. Chi et al. (2020) further reinforce that students' conceptual understanding is highly dependent on the precision and clarity of instructional materials.

Viewed through the lens of John Sweller's Cognitive Load Theory (1988), the SIM's validated quality in content, format, organization, and accuracy collectively contributes to reducing extraneous cognitive load. By presenting clear, accurate, and well-structured information, the SIM allows students to focus their cognitive resources on intrinsic learning tasks, thereby promoting germane load necessary for schema development. This intentional instructional design enhances not only comprehension but also long-term retention of complex Earth and Life Science concepts.

CONCLUSION

The targeted instructional materials are essential to enhance Grade 11 students' understanding of unifying themes in life science and the evolutionary basis of organism classification, addressing identified gaps in their comprehension. The core instructional materials are generally adequate in both Basag National High School and Bugsukan Integrated School, there is a notable limitation in the availability of supplementary and technology-based resources. Furthermore, the learning gaps in Earth and Life Science are influenced by a combination of factors, including insufficient learning resources, limited access to technology, inadequate laboratory equipment, and personal and environmental challenges faced by students. The development of contextualized and activity-based Strategic Intervention Materials (SIM) is a

relevant and suitable approach to address specific learning needs in Earth and Life Science. Expert validation confirms the developed SIM as a high-quality instructional tool, demonstrating its strong content, format, presentation, organization, and accuracy.

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