

Development and Evaluation of Larong Pinoy-STEM (Lapistem) Instructional Material in Bioenergetics

Christine Mae T. Pulot^{1*}, Monera A. Salic-Hairulla², Douglas A. Salazar³, Rhea F. Confesor⁴, Joy B. Bagaloyos⁵, Jocelyn A. Pattuinan⁶, Liza A. Adamat⁷

^{1,2,3,4,5}Department of Science and Mathematics Education, College of Education, Mindanao State University – Iligan Institute of Technology, Bonifacio Ave., Tibanga, Iligan City, 9200, Philippines

⁶Philippine Science High School - Central Mindanao Campus, Lanao del Norte, Philippines

⁷Department of Biological Sciences, College of Science and Mathematics, MSU-Iligan Institute of Technology, Iligan City, 9200 Philippines

*Corresponding Author

DOI: <https://doi.org/10.47772/IJRISS.2026.100300130>

Received: 19 March 2026; Accepted: 24 March 2026; Published: 29 March 2026

ABSTRACT

This study developed and evaluated Larong Pinoy-Integrated STEM (LaPiSTEM) instructional material designed to enhance the teaching of bioenergetics among Grade 11 learners. Anchored on constructivist learning theory, context-based science learning, and the ADDIE model, the material integrates traditional Filipino games—such as Agawan Base, Patintero, Slipper Game, and Tumbang Preso—with STEM-based activities to promote active, experiential, and culturally responsive learning. A developmental research design was employed, involving curriculum mapping, expert validation, and evaluation by science educators using the Department of Education evaluation rating tool. Results revealed that the instructional material achieved an overall rating of “Very Satisfactory” ($M = 3.73$), demonstrating high quality in terms of content accuracy, format, presentation, organization, and up-to-datedness. The findings indicate that LaPiSTEM effectively supports learners’ achievement, engagement, and appreciation of bioenergetics while fostering higher-order thinking skills and cultural awareness. Minor improvements were suggested in areas such as grammatical accuracy, visual clarity, and instructional detail. Despite not yet being implemented in an actual classroom setting, the material shows strong potential to enhance effective science instruction. Overall, the study confirms that LaPiSTEM is a valid, reliable, and culturally relevant instructional resource suitable for classroom implementation in science education.

Keywords: Bioenergetics, culturally responsive teaching, STEM education, game-based learning, Grade 11 science, instructional material development, validation

INTRODUCTION

In the 2022 Programme for International Student Assessment (PISA), Philippine students scored significantly below the OECD average in mathematics, reading, and science, with only a small proportion reaching baseline proficiency levels (OECD, 2023). One major challenge in science education is the teaching of complex and abstract topics such as bioenergetics, including photosynthesis and cellular respiration. Students often struggle to understand energy transformation processes and metabolic interactions, contributing to low achievement and engagement (Jančaříková & Jančařík, 2022). Conventional lecture-based teaching methods have shown limited effectiveness in addressing these challenges, highlighting the need for innovative and targeted instructional strategies (Descartin et al., 2023; Orine et al., 2024; Kharomah et al., 2024).

The importance of active, inquiry-based, and learner-centered STEM instruction to improve students’ conceptual understanding, motivation, and engagement (Castro et al., 2023). While digital learning tools and game-based

platforms can enhance engagement and academic performance, poorly designed digital instruction may increase cognitive load and lead to negative health effects, such as digital eye strain and sleep disruption (Şambel Aykutlu et al., 2024). Moreover, excessive reliance on digital media has contributed to learners' disconnection from traditional Filipino cultural practices, including indigenous games (Tongco, 2019).

The integration of traditional Filipino games and Indigenous Knowledge Systems and Practices (IKSPs), enhances student engagement, motivation, and academic performance while preserving cultural heritage (Camiring-Picpican et al., 2023). Empirical evidence demonstrates that Larong Pinoy-based activities effectively support STEM learning by improving conceptual understanding and participation (Besa et al., 2025). These approaches align with national policies promoting culture-based education and global priorities such as Sustainable Development Goal 4 on quality education and SDG 10 (Reduced Inequalities) by ensuring cultural responsiveness; nationally (Official Gazette, 2023). It supports the Philippine Education Development Medium-Term Outcomes (EDMO 2), which emphasizes improving learning outcomes and equipping learners with 21st-century skills through responsive, contextualized, and culture-based instructional practices. Consequently, this study aimed to develop and validate LaPiSTEM learning activities in bioenergetics as instructional material to provide a valid resource that can support effective teaching of bioenergetics.

METHODOLOGY

Research Design

This study utilized a developmental research design to create and validate learning materials on bioenergetics for Grade 11 learners. The process included curriculum alignment, expert-led content validation, and evaluation by educational practitioners to ensure instructional suitability. The scope was limited to the refinement and evaluation of the product prior to actual classroom delivery, emphasizing the establishment of a high-quality, validated instructional tool. The study did not include classroom implementation or experimental testing; instead, it focused on the validation and evaluation of the instructional material before its application in actual teaching.

Research Locale

The validation phase involved highly qualified science educators with over ten (10) years of pedagogical experience and doctoral degrees (PhD) in science. In addition, a group of science experts, including the thesis adviser and panel members, participated in the review process. These evaluators were deliberately selected for their extensive subject-matter expertise and strong contextual understanding of the science curriculum, ensuring that the feedback was both authoritative and aligned with the needs of the material's intended end-users.

Participants of the Study

The validation phase involved five (5) highly qualified science educators with over ten (10) years of pedagogical experience and doctoral degrees (PhD) in science. In addition, a panel of experts—composed of the thesis adviser and five (5) panel members—participated in the evaluation process. In total, the study engaged eleven (11) participants therefore included both expert validators and science teacher-evaluators. The expert panel, consisting of the thesis adviser and subject-matter specialists, conducted the initial validation of the instructional materials. Subsequently, the science educators served as evaluators, assessing the activity sheets in terms of quality, usability, and instructional suitability. All participants were selected through purposive sampling, with criteria based on their professional expertise, years of teaching experience, and strong familiarity with curriculum standards.

Research Instrument

The study's primary output is a Larong Pinoy-STEM instructional material designed to bolster learners' achievement, engagement and appreciation level of bioenergetic. This instructional tool integrates core pedagogical components, including an introduction, behavioral objectives, and K-12 curriculum standards (content, performance, and competencies). The learning activities are systematically organized through the ADDIE Model (Analyze, Design, Develop, Implement, and Evaluate) and supplemented by formative

assessment, performance-based assessments, and reflective questions. Validation was conducted using an instrument adapted from the Department of Education (DepEd) Evaluation Rating Sheet for Print Resources. This four-point Likert scale (1–4) assessed the material across four critical domains: content quality, formatting, organizational clarity, and the accuracy of scientific information.

Validation of the Instructional Material

The developed instructional material underwent rigorous face and content validation by a panel of subject-matter experts to ensure alignment with curriculum standards and overall instructional quality. The validation focused on content accuracy, instructional clarity, and the integration of LaPiSTEM learning activities. Feedback and recommendations provided by the validators were systematically reviewed and incorporated into the material's revision, ensuring the final activity sheets met the established criteria for effective instructional design.

Data Gathering Procedure

The data gathering procedure followed a systematic three-phase sequence. In the Development Phase, the instructional material was conceptualized through curriculum mapping and the drafting of an initial prototype. This was followed by the Validation Phase, where a panel of experts subjected the material to rigorous face and content validation; their feedback was then used to revise and refine the activity sheets. In the final Evaluation Phase, the revised version was assessed by panel experts using a standardized evaluation rating sheet. All completed evaluation forms were subsequently collected and compiled for formal analysis.

Data Analysis

To ensure a reliable interpretation of findings, descriptive statistical tools were utilized to calculate mean scores and standard deviation for each evaluation component. These scores were mapped against a Likert-based descriptive scale to classify the material's quality. Furthermore, qualitative content analysis was applied to the validators' written remarks to synthesize recommendations for the final version of the learning activities.

Ethical Considerations

The study strictly adhered to established ethical standards in research. Evaluator participation was entirely voluntary, with participants providing informed consent and retaining the right to withdraw without repercussion. To safeguard privacy, all responses were treated with the utmost confidentiality and anonymity, with data utilized exclusively for the stated research objectives. Furthermore, the study maintained high levels of academic integrity by ensuring proper citation and acknowledgment of all sources during the development of the instructional materials.

RESULTS AND DISCUSSION

The development of the instructional material followed a systematic progression through curriculum mapping, content drafting and expert validation. During the curriculum mapping phase, learning objectives and activities were meticulously aligned with prescribed science competencies to ensure the material effectively supports intended learning outcomes and meets national standards.

Following the initial drafting, the material underwent expert validation to verify content accuracy, instructional design, and clarity. This expert feedback was instrumental in refining the prototype prior to broader assessment. Finally, panel of experts appraised the material using a standardized evaluation rating sheet, focusing on its practical suitability, usability, and overall instructional quality for the classroom environment.

Curriculum Mapping of the Developed LaPiSTEM Learning Activities in Bioenergetics

Table 1. Curriculum Mapping of the Developed Learning Activities in Bioenergetics

Content Standard	Performance Standard	Learning Competencies/Objectives	LaPiSTEM Activities	Code
The learners demonstrate an understanding of:	The learners shall be able to:	The learners: 1. explain how cells carry out functions required for life	Agawan Base Edition (Cell Structure and Function)	-S11/12LT-Iibd-4

<p>1. the cell as the basic unit of life</p> <p>2. how photosynthetic organisms capture light energy to form sugar molecules</p> <p>3. how organisms obtain and utilize energy.</p>	<p>Engage in Traditional Filipino games integrated with STEM-based activities on bioenergetics.</p> <p>Develop a prototype for each learning competency in bioenergetics.</p>			
		<p>2. explain how photosynthetic organisms use light energy to combine carbon dioxide and water to form energy-rich</p>	<p>Patintero Edition (Photosynthesis)</p>	<p>S11/12LT-Iibd-5</p>
		<p>3. trace the energy flow from the environment to the cells.</p>	<p>Slipper Game Edition (Energy Transfer in Ecosystems)</p>	<p>S11/12LT-Iibd-6</p>
		<p>4. describe how organisms obtain and utilize energy</p> <p>5. recognize that organisms require energy to carry out functions required for life</p>	<p>D. Tumbang Preso Edition (Cellular Respiration)</p>	<p>S11/12LT-Iibd-7</p> <p>S11/12LT-Iibd-8</p>

Table 1 provides curriculum mapping and integrates Traditional Filipino Games (Laro ng Lahi) with STEM-based activities to enhance the understanding of bioenergetics among students. This approach aligns with culturally responsive pedagogy and experiential learning, aiming to improve conceptual retention and systems thinking in biology (Pulot & et.al,2025) (Espino, 2024)(Avila,2021)

To ensure pedagogical consistency, curriculum mapping was employed to synchronize the activity sheets with national learning competencies and standards. This step is critical for aligning instructional tasks with desired learning outcomes, a practice that Richey and Klein (2014) suggest is essential for impactful science teaching. By anchoring the material in curriculum goals, the study facilitates more coherent learning pathways that strengthen students' scientific literacy and conceptual understanding (Faizin et al., 2024; Lestari et al., 2024).

To map the competencies, the researchers first identified specific Grade 11 Earth and Life Science standards regarding the "Bioenergetics." These were then broken down into manageable subtasks, creating a structured sequence of activities to guide students through the learning process.

The curriculum specifically addresses several key learning competencies in bioenergetics:

- 1.) explaining how cells carry out functions required for life (Agawan Base Edition - Cell Structure and Function) This activity, "Agawan Base Edition (Cell Structure and Function)," is designed to help learners explain how cells carry out functions required for life (Errabo, Fujinami, & Isozaki, 2024).
- .2.) Explaining how photosynthetic organisms use light energy to combine carbon dioxide and water to form energy-rich compounds (Patintero Edition - Photosynthesis) The "Patintero Edition (Photosynthesis)" activity directly addresses the learning objective of explaining how photosynthetic organisms utilize light energy to convert carbon dioxide and water into energy-rich compounds (Pulot & et.al, 2025) (Errabo, Fujinami, & Isozaki, 2024).
- 3.)tracing the energy flow from the environment to the cells (Slipper Game Edition - Energy Transfer in Ecosystems) The "Slipper Game Edition (Energy Transfer in Ecosystems)" aims to help students trace the flow of energy from the environment to cells (Errabo, Fujinami, & Isozaki, 2024).
- .4.) describing how organisms obtain and utilize energy, and recognizing that organisms require energy to carry out functions required for life (Tumbang Preso Edition - Cellular Respiration). The "Tumbang Preso Edition (Cellular Respiration)" focuses on describing how

organisms obtain and utilize energy, and recognizing the necessity of energy for life functions (Errabo, Fujinami, & Isozaki, 2024).

The incorporation of these traditional games into STEM education provides a robust framework for teaching bioenergetics, enhancing student engagement and comprehension (Pulot et al., 2025). Studies have shown that game-based learning strategies can improve conceptual understanding and address alternative conceptions students often hold regarding energy in life (Dewi & et al, 2024). The use of culturally relevant pedagogical tools, such as Filipino traditional games, helps connect abstract scientific concepts to students' lived experiences, making learning more meaningful and accessible (Avila, 2021).

Development of LaPiSTEM Learning Activities as Instructional Material

The overall structure and instructional material of the LaPiSTEM learning activities were carefully planned. Learning objectives were clearly defined based on the targeted bioenergetics competencies, including explaining cell functions, describing photosynthesis, tracing energy flow, and understanding how organisms obtain and utilize energy. Appropriate traditional Filipino games such as Agawan Base, Patintero, Slipper Game, and Tumbang Preso were selected and mapped to specific scientific concepts. Each game was designed to simulate biological processes, allowing learners to experience abstract concepts through physical and collaborative activities. Assessment strategies, including formative and summative assessments, were also planned, incorporating reflective questions and STEM task cards to evaluate learners' understanding and engagement.

LaPiSTEM Learning Activities Material Outline

LaPiSTEM (Larong Pinoy-Integrated STEM) is an innovative instructional approach that integrates traditional Filipino games with Science, Technology, Engineering, and Mathematics (STEM) concepts, with a particular focus on bioenergetics. Specifically designed for Grade 11 Biology learners and aligned with the Most Essential Learning Competencies (MELCs), LaPiSTEM provides a meaningful, engaging, and contextually relevant learning experience. By incorporating culturally familiar games into the teaching process, it promotes active and experiential learning, allowing students to construct knowledge through direct participation rather than passive reception. At the same time, it strengthens cultural appreciation by embedding indigenous play into academic content, while fostering collaboration, teamwork, and social interaction among learners.

The LaPiSTEM instructional framework is guided by the principles of Constructivist Learning Theory, Context-Based Science Learning, and the ADDIE Model, offering a structured yet flexible approach to teaching bioenergetics. Guided by constructivism, learning is viewed as an active, student-centered process, where learners build understanding through experience, reflection, and social interaction. Students are encouraged to connect new bioenergetics concepts to prior knowledge, identify misconceptions, and engage in collaborative problem-solving, making abstract scientific ideas more meaningful. The ADDIE Model ensures a systematic instructional process, encompassing analysis of learners' prior knowledge and learning needs, the design and development of LaPiSTEM activities and instructional materials such as STEM Task Cards and visual aids, the implementation of game-based learning experiences, and the evaluation of learner outcomes to inform continuous improvement.

LaPiSTEM emphasizes hands-on learning, where learners actively participate in Larong Pinoy game adaptations that model energy processes, reinforcing understanding through physical engagement. It also fosters conceptual understanding through simulation, allowing learners to visualize complex bioenergetics processes while STEM Task Cards provide cognitive scaffolding to ensure deep comprehension. Moreover, the framework highlights the integration of science and culture, embedding traditional Filipino games into instruction to create learning experiences that are contextually relevant, engaging, and culturally meaningful. Together, these elements make LaPiSTEM a theory-driven, culturally responsive, and experiential instructional approach that promotes active learning, collaboration, and mastery of bioenergetics concepts. The following are six (6) major parts of LaPiSTEM learning activities:

Introductory

It presents the introductory pages of the LaPiSTEM instructional material, providing an overview of its structure and purpose. The cover page highlights the theme of integrating Larong Pinoy with bioenergetics concepts, using

colorful and engaging visuals to attract learners' interest. The table of contents outlines the organization of topics and activities, giving a clear roadmap of the learning material. The preface explains the goals of the material and emphasizes the importance of interactive and culturally relevant teaching strategies. The "How to Use" section guides both teachers and learners on how to navigate the activities, while the "Time Allotment" presents the suggested schedule for implementation. Lastly, the Teacher's Guide provides instructional support, including teaching approaches, facilitation strategies, and expected learning outcomes, ensuring effective delivery of the LaPiSTEM activities.

Concept Building Activities

Basic concept-building activities serve as the foundation for deeper engagement with bioenergetics, utilizing interactive and culturally relevant tasks to orient learners toward key scientific concepts. These tasks, such as "Do You Know" quizzes and "4 Pics 1 Word" challenges, are strategically designed to activate prior knowledge and stimulate curiosity regarding energy processes in living systems (Lazarides et al., 2021). Beyond introducing core ideas in a relatable format, these activities facilitate collaborative learning, where students work in small groups to share observations and build knowledge collectively (Chiu, 2021). Through instructional scaffolding, complex bioenergetics topics—including cellular respiration, ATP, and photosynthesis—are broken into manageable parts, supported by visual aids and real-life examples that connect abstract theories to familiar contexts (Husamah et al., 2022). This stage also functions as a formative assessment, enabling the instructor to identify specific areas for reinforcement before students progress to more advanced, game-based LaPiSTEM activities (Gikandi et al., 2021). By the end of this phase, learners are not only cognitively prepared but also motivationally engaged, ensuring they are ready for the experiential and collaborative learning required in subsequent lessons (Zheng et al., 2023).

Core Game-Based Learning

The Game-Based Learning of LaPiSTEM emphasizes active, experiential, and collaborative learning by adapting traditional Filipino games (Larong Pinoy) into the context of bioenergetics. This phase builds on the foundational knowledge developed in the concept building phase, allowing learners to apply concepts in meaningful and engaging ways. Four major Larong Pinoy games are carefully selected and adapted to promote both physical activity and cognitive engagement, ensuring that learners not only enjoy the gameplay but also deepen their understanding of scientific concepts. The following are the Larong Pinoy STEM learning activities.

Agawan Base Edition (Cell Structure and Function)

The game "Agawan Base" can effectively model cellular compartmentalization and functional specialization. In this analogy, different players or teams represent various organelles, each with a specific role, contributing to the overall function and homeostasis of the cell, much like organelles work together to maintain cellular processes. The territorial aspect of the game can symbolize the distinct boundaries and functions of cellular structures, such as the cell membrane regulating transport or the nucleus housing genetic material, thereby making abstract cellular concepts more tangible and interactive for students (Errabo, Fujinami, & Isozaki, 2024).

Patintero Edition (Photosynthesis)

Photosynthesis is the biological process by which many organisms convert light energy into chemical energy, stored in organic compounds that can be metabolized later through cellular respiration. This process involves both light-dependent and light-independent reactions. "Patintero" can simulate these reactions by having players represent 'photons' navigating 'chloroplast' zones to deliver 'energy carriers' (analogous to ATP and NADPH) that enable 'carbon fixation' in an end zone, mirroring the Z-scheme and Calvin cycle mechanics (Korrensalo & et. al, 2024) (Karamudin & et.al,2024) (Pedrera, Barrutia & Diez, 2024). The dynamic nature of the game helps students visualize the energy transformations and the roles of different components in the photosynthetic pathway (Koberstein & Meisert, 2023)

Slipper Game Edition (Energy Transfer in Ecosystems)

Energy flow in ecosystems is a fundamental concept where energy is captured by producers and transferred through trophic levels. The Second Law of Thermodynamics dictates that a significant portion of usable energy

is lost as heat at each trophic transfer, typically resulting in only about 10% efficiency between levels. The "Slipper Game" can embody this trophic energy flow by having players pass slippers (representing 'energy quanta') across different 'trophic levels,' with a progressive loss at each transfer, demonstrating the ecological efficiency rule and thermodynamic constraints (Boss'ér, & Wennersten, 2024). This helps students understand how energy moves through an ecosystem and why food chains are generally limited in length.

Tumbang Preso Edition (Cellular Respiration)

Cellular respiration is the process by which organisms convert biochemical energy from nutrients into ATP, the universal energy currency. This process involves glycolysis, the Krebs cycle, and oxidative phosphorylation. The game can stage these as sequential challenges, for instance, 'glucose breakdown' by knocking down cans, yielding 'ATP tokens,' and an 'oxygen player' enabling final ATP synthesis, emphasizing the dependence on oxygen for efficient energy production and the central role of mitochondria (Dewi et.al,2024) (Shemwell & et al.,2023) (Uke & et al.,2024). This experiential learning helps clarify the complex and often misunderstood pathways of cellular respiration and bioenergetics (Hofeld, 2021) (Souza & et al.,2024)

STEM Integration

The STEM Task Cards are integrated across all LaPiSTEM activities, serving as a cognitive anchor that bridges gameplay with academic rigor through a transdisciplinary STEM approach. Each card incorporates Science, Technology, Engineering, and Mathematics to promote a holistic interdisciplinary understanding, where Science tasks reinforce conceptual knowledge of bioenergetics—including cellular processes and energy flow—while Technology tasks foster digital literacy through the creation of infographics and digital diagrams. Engineering challenges invite learners to construct physical or virtual models, such as 3D cell structures or ecosystem prototypes, and Mathematics exercises utilize numerical reasoning to solve problems related to ATP yields and energy transfer efficiency. Each LaPiSTEM activity culminates in a tangible STEM product—such as a functional cell model or energy flow diagram—allowing students to apply theoretical concepts to practical, evidence-based scenarios. This design not only enhances critical thinking and problem-solving skills but also supports differentiated learning by offering challenges at varying levels of complexity, ensuring all learners remain cognitively engaged within a supportive, gamified environment (Baldwin, 2019)(Hıdırođlu, & Karakaş, 2022)

Assessment Strategies

The LaPiSTEM instructional approach employs a comprehensive, multi-level assessment strategy to evaluate learners' knowledge, skills, and engagement throughout the learning process (Baser, 2019). Formative assessment is conducted continuously during gameplay, focusing on game performance and STEM task completion, which allows instructors to monitor understanding in real-time, provide immediate feedback, and adjust instruction to address misconceptions (Xiao, 2019; Smith & Lee, 2021). Summative assessment occurs at the conclusion of lessons, utilizing reflective questions and conceptual exercises to evaluate students' terminal understanding of biological processes like photosynthesis and cellular respiration (Baser, 2019). Complementing these is a performance-based assessment that emphasizes the active demonstration of learning through role-playing and model construction, ensuring students can effectively bridge theoretical knowledge with practical, hands-on application (Humanities and Social Sciences Communications, 2023). This integrated combination fosters a balanced evaluation across the cognitive, psychomotor, and affective domains (Chen et al., 2023).

Reflective Learning

A key feature of the LaPiSTEM framework is the reflective learning component, which is systematically embedded in every activity to enhance metacognition and deeper comprehension (Zheng et al., 2023). Each game incorporates structured reflective questions that prompt learners to connect their immediate gameplay experiences to abstract scientific concepts, encouraging them to analyze the underlying causes of specific actions or outcomes (Tobar-Munoz et al., 2022). These prompts further stimulate critical thinking and problem-solving as learners evaluate the effectiveness of their strategies and relate observed phenomena to real-life biological

processes (Hwang et al., 2023). By engaging in this intentional reflection, students are able to internalize knowledge and forge meaningful connections between active learning, interdisciplinary STEM tasks, and complex bioenergetics principles (Argaw et al., 2021). Ultimately, this reflective practice fosters long-term retention and the successful application of science concepts within authentic, real-world contexts (Vandercruysse et al., 2020).





Figure 1. LaPiSTEM Material Sample

Figure 1 presents the prototype sample of the developed LaPiSTEM learning activities prior to the revision suggested by the evaluators. The prototype activity sheet served as the initial model for the instructional material, designed to facilitate students' understanding of bioenergetic concepts through structured learning activities. It included essential lesson components, such as learning objectives, activity instructions, and elicit tests, to promote student engagement. Following a review by the thesis adviser and panel members, this preliminary version underwent refinement to improve its organization, clarity, and alignment with prescribed learning competencies. Consequently, the prototype functioned as a foundational version that guided the subsequent development and enhancement of the final instructional material.

Table 2 Revision on LaPiSTEM Instructional Material from Evaluators

Before	Comments and Suggestion	After
	Please specify the time allotment	

<p>Safety Guideline not yet included</p>	<p>The inclusion of safety guidelines, particularly for outdoor physical games, to ensure learner protection and promote responsible participation</p>	
<p>Classroom rules not yet included</p>	<p>Add classroom rules</p>	
	<p>Too wordy and repetitive phrasing</p>	

	<p>Please make the instructions clear.</p>	
	<p>STEM stations, noting that they “lack detailed steps.”</p>	
<p>Performance task rubrics not yet included</p>	<p>Add rubrics for performance tasks</p>	

<p>Teacher Tips for classroom management</p>	<p>Add teacher tips for classroom management</p>	
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Table 2 shows the comments and suggestions on the LaPiSTEM learning activities as instructional material. The evaluator commended the instructional material for being “highly creative, pedagogically sound, and culturally relevant,” noting its strong potential as an effective learning resource. However, the evaluator identified several areas for improvement. They suggested that some explanations need clearer wording and recommended that “some scientific explanations could be simplified for readability.” Concerns were also raised about the STEM stations, noting that they “lack detailed steps” and that the “time allotment section should include specific minutes per activity for classroom usability.” The evaluator observed redundancy in wording, citing repeated and noted several typographical and formatting issues, including misspellings, grammatical errors, inconsistent capitalization of headings, misaligned or overlapping labels, overly bright color combinations, inconsistent page numbering, sections out of order in the table of contents, and text touching margins. Additionally, they highlighted missing instructional components: “Where is the rubrics for performance tasks?,” “Add teacher tips for classroom management during games,” and “Since this is a game, please include in your instruction’s safety reminders for physical games.” The overall comment emphasized that “with proofreading, formatting consistency, and minor layout refinements, this can become a professional-quality instructional module suitable for classroom implementation or publication.”

Another provided complementary recommendations to further enhance the material’s quality. They suggested “the inclusion of safety guidelines, particularly for outdoor physical games, to ensure learner protection and promote responsible participation,” noted the “need for improved proofreading to address existing grammatical and typographical errors,” and recommended that “images and diagrams be made clearer and accompanied by more precise labels to improve comprehension and visual support for learners.” They also advised that the material include “assessment rubrics or evaluation tools ... to provide a structured basis for measuring student outputs and performance,” and emphasized the importance of “incorporating teacher notes, particularly on classroom management strategies, to guide educators in effectively implementing physical games within the learning environment.”

Both evaluators emphasized that “with careful proofreading, improved formatting consistency, inclusion of clear visuals, structured assessments, and attention to safety and classroom management guidance,” the instructional material has strong potential to become a professional-quality resource suitable for classroom implementation or publication.

Evaluation by Panel of Experts

Table 3 Evaluator’s Rating on Content Factor

Content	Mean	SD	Description
1. Content is suitable to the student's level of development.	4.00	0	Very Satisfactory

2. Material contributes to the achievement of specific objectives of the subject area and grade/year level for w it is intended.	4.00	0	Very Satisfactory
3. Material provides for the development of higher cognitive skills such as critical thinking, creativity, learning by doing inquiry, problem solving, etc.	3.40	0.49	Very Satisfactory
4. Material is free of ideological, cultural, religious, racial, gender biases and prejudices.	3.20	0.40	Satisfactory
5. Material enhances the development of desirable values and traits (See Appendix).	3.80	0.40	Very Satisfactory
6. Material has the potential to arouse interest of the target reader.	3.80	0.40	Very Satisfactory
7. Adequate warning/cautionary notes are provided in to and activities where safety and health are of concern.	3.60	0.49	Very Satisfactory
Total	3.69	0.22	Very Satisfactory

Legend: 1.00-1.74 (not satisfactory); 1.75-2.49 (poor); 2.50-3.24 (satisfactory); 3.25-4.00 (very satisfactory)

Table 3 reveals that the instructional material achieved an overall mean of 3.69 (SD = 0.22), interpreted as “Very Satisfactory,” indicating a consistently high level of content quality across all evaluated dimensions. The relatively low standard deviation suggests strong agreement among expert evaluators, reinforcing the reliability of the assessment and implying that the material demonstrates a stable and coherent design rather than isolated strengths..

The perfect ratings for content suitability to learners’ developmental level and alignment with intended learning objectives (M = 4.00) suggest that the material is firmly grounded in curriculum expectations and cognitive readiness. This implies that the design of the material was guided by a clear understanding of learner characteristics and competency standards. Such alignment is critical because it reduces cognitive mismatch and enhances meaningful learning, indicating that learners are more likely to successfully engage with and internalize the presented concepts. This also reflects a strong adherence to principles of constructive alignment, where learning objectives, content, and activities are cohesively structured. This supports established curriculum design practices emphasizing developmentally appropriate instruction to enhance engagement and ensure equitable learning opportunities among diverse learners (Kuraedah et al., 2023; Izzuddin et al., 2021; Kuchynka et al., 2022; Badshah et al., 2021). Related evidence also shows that developmentally appropriate and unbiased materials promote inclusive engagement and improved learning outcomes across different student groups (Izzuddin et al., 2021; Badshah et al., 2021; Vu & Pham, 2022).

Similarly, the mean of 4.00 for the material’s contribution to the achievement of specific objectives confirms that the content is well-aligned with intended learning outcomes and standards-based curricula, reinforcing its effectiveness in supporting academic performance and reducing potential learning gaps (Kuchynka et al., 2022;; Blažević & Blažević, 2023). This is consistent with literature highlighting that well-designed instructional materials help achieve curriculum goals by ensuring alignment between content and expected competencies (Blažević & Blažević, 2023; Malelu-Gitau, 2023).

However, the relatively lower mean for higher-order thinking skills (M = 3.40, SD = 0.49), despite still being within the “Very Satisfactory” range, reveals an important pattern. This suggests that while the material includes elements of inquiry and problem-solving, these are not uniformly or deeply embedded across all components. A plausible explanation is that some activities may still emphasize procedural or recall-based learning rather than sustained analytical or evaluative thinking. This implies that the material, although effective at foundational understanding, may not yet fully maximize its potential to develop advanced cognitive processes. Strengthening this aspect would require more intentional integration of open-ended tasks, real-world problem scenarios, and

reflective questioning. This variation highlights the need for more consistent integration of activities that foster analysis, synthesis, and evaluation (Izzuddin et al., 2021; Vu & Pham, 2022). Studies further emphasize that deliberate inclusion of inquiry-based tasks, case analyses, and reflective prompts can strengthen higher-order thinking development (Izzuddin et al., 2021; Vu & Pham, 2022).

The strong ratings in values formation ($M = 3.80$) and learner interest ($M = 3.80$) indicate that the material is not only cognitively appropriate but also effectively engaging. This suggests that the material successfully integrates elements that promote motivation, ethical awareness, and positive learning dispositions. Such outcomes imply that learners are likely to develop not only conceptual understanding but also desirable attitudes toward science learning. However, the slight variability indicates that these affective components may not be consistently reinforced across all activities, suggesting an opportunity for more explicit and systematic integration. This finding aligns with studies documenting the persistence of gender bias and socio-cultural stereotyping in educational materials (Izzuddin et al., 2021; Badshah et al., 2021; Blažević & Blažević, 2023; Vu & Pham, 2022). However, some research also highlights improvements in representation in certain contexts, suggesting a nuanced landscape that requires continuous review and updating of materials (Izzuddin et al., 2021; Badshah et al., 2021; Blažević & Blažević, 2023; Malelu-Gitau, 2023; Vu & Pham, 2022).

The development of desirable values and traits received a mean of 3.80 ($SD = 0.40$), indicating that the material effectively promotes positive attitudes such as respect, inclusivity, and ethical awareness, although not uniformly across all components. This aligns with the expectation that instructional materials should contribute to values formation and social development (Badshah et al., 2021; Vu & Pham, 2022). Conceptual and empirical studies further highlight that explicit integration of values education enhances learners' ability to internalize prosocial behaviors and ethical standards (Bickmore, 2019; Vu & Pham, 2022).

Similarly, the arousal of reader interest garnered a mean of 3.80 ($SD = 0.40$), suggesting that the material is generally engaging and capable of sustaining learners' motivation. Engaging and relevant content has been consistently identified as a key factor influencing student interest and persistence in learning (Izzuddin et al., 2021; Blažević & Blažević, 2023; Vu & Pham, 2022). However, variations in engagement indicate that incorporating more contextualized examples, interactive elements, and culturally relevant content could further enhance learner interest (Blažević & Blažević, 2023; Vu & Pham, 2022).

Additionally, the inclusion of adequate safety and health warnings achieved a mean of 3.60 ($SD = 0.49$), demonstrating satisfactory attention to learner safety, particularly in activities involving potential risks. This aligns with recommendations that instructional materials should include clear safety guidelines and precautionary measures to ensure responsible and safe learning environments (Vu & Pham, 2022).

The aggregate mean of 3.69 ($SD = 0.22$) indicates a "Very Satisfactory" level of content quality. The relatively low standard deviation suggests consistent high ratings across evaluation criteria, reflecting a cohesive and well-structured instructional material. However, slight variations in ratings—particularly in higher-order thinking development and bias-free content—highlight specific areas for improvement. These findings are consistent with existing literature emphasizing that while instructional materials may effectively support developmental appropriateness and curriculum alignment, continuous evaluation and refinement are necessary to address subtle biases and strengthen the promotion of higher-order cognitive skills (Primativa, 2021; Izzuddin et al., 2021; Badshah et al., 2021; Vu & Pham, 2022).

Table 4 Evaluator's Rating on Format Factor

Format	Mean	SD	Description
A. Prints			
1. Size of letters is appropriate to the intended user.	4.00	0	Very Satisfactory
2. Spaces between letters and words facilitate reading.	4.00	0	Very Satisfactory

3.Font is easy to read.	4.00	0	Very Satisfactory
B. Illustration			
1.Simple and easily recognizable.	3.40	0.55	Very Satisfactory
2.Clarify and supplement the text.	3.80	0.45	Satisfactory
3.Properly labelled or captioned (if applicable)	3.00	0	Very Satisfactory
4.Realistic / appropriate colors.	3.80	0.45	Very Satisfactory
5.Attractive and appealing.	3.80	0.45	Very Satisfactory
6.Culturally relevant.	3.80	0.45	Very Satisfactory
C. Design and Layout			
1. Attractive and pleasing to look at.	3.80	0.45	Very Satisfactory
2.Simple (i.e., does not distract the attention of the reader).	3.20	0.40	Satisfactory
3. Adequate illustration in relation to text.	3.80	0.40	Very Satisfactory
4.Harmonious blending of elements (e.g., illustrations and text).	3.80	0.45	Very Satisfactory
D. Paper and Binding			
1. Paper used contributes to easy reading.	4.00	0	Very Satisfactory
2. Durable binding to withstand frequent use.	4.00	0	Very Satisfactory
E. Size and Weight of Resource			
1. Easy to handle.	4.00	0	Very Satisfactory
2. Relatively light.	4.00	0	Very Satisfactory
Total	3.78	0.23	Very Satisfactory

Legend: 1.00-1.74 (not satisfactory); 1.75-2.49 (poor); 2.50-3.24 (satisfactory); 3.25-4.00 (very satisfactory)

Table 4 shows the format evaluation yielded an overall mean of 3.78 (SD = 0.23), indicating a “Very Satisfactory” level of design quality. The near-perfect ratings in print readability, durability, and usability suggest that the material is highly accessible and user-friendly. This implies that the design effectively minimizes extraneous cognitive load, allowing learners to focus more on content processing rather than navigating the material itself.

The perfect scores in typography and spacing (M = 4.00) indicate that the material adheres to fundamental readability principles. This suggests that the designers prioritized clarity and accessibility, which are essential for accommodating diverse learners. The absence of variability further implies strong consensus that the material poses no barriers to visual comprehension. The appropriate font size and spacing significantly enhance reading ease, aligning with research emphasizing that clear typography improves comprehension and accessibility across

diverse learners (McDarby et al., 2020). The uniformity of responses further indicates strong consensus regarding the effectiveness of the material’s print design.

In the illustration subdomain, results show generally effective but slightly varied performance. Illustrations were found to be helpful in clarifying and supplementing text ($M = 3.80$, $SD = 0.45$), supporting established principles that visuals should reinforce learning rather than serve decorative purposes (Noël et al., 2022; Raja & Fitzpatrick, 2022). However, the relatively lower ratings in illustration clarity ($M = 3.40$, $SD = 0.55$) and layout simplicity ($M = 3.20$, $SD = 0.40$) reveal a deeper design-related issue. These findings suggest that while visuals are present and generally helpful, they may not always be optimally designed for immediate comprehension. A possible explanation is that some illustrations may contain unnecessary complexity or lack sufficient emphasis on key concepts. Similarly, the slightly lower score in layout simplicity implies that certain design elements may compete for attention, potentially increasing cognitive load rather than reducing it. The use of appropriate colors, attractiveness, and cultural relevance (all $M = 3.80$) reflects effective visual design that supports engagement and inclusivity, consistent with literature on the role of aesthetics and culturally responsive visuals in improving learner motivation and understanding (Cabouat et al., 2025).

The design and layout domain also demonstrated strong performance, particularly in visual appeal, balance between text and illustrations, and harmonious integration of elements ($M = 3.80$). These findings align with design principles emphasizing coherence and visual hierarchy to enhance readability and reduce cognitive load (Noël et al., 2022; Marsh et al., 2020). However, the slightly lower rating for simplicity ($M = 3.20$, $SD = 0.40$) suggests that some layout elements may be somewhat distracting, indicating an opportunity to streamline design components for improved focus and clarity.

For paper and binding, perfect scores ($M = 4.00$) indicate excellent material quality and durability, ensuring that the resource can withstand frequent use while maintaining readability. This supports findings that physical durability and paper quality are essential for long-term usability of instructional materials (Glick et al., 2010). Similarly, the size and weight of the resource received perfect ratings ($M = 4.00$), indicating optimal portability and ease of handling, which are key factors influencing usability and learner convenience (Raja & Fitzpatrick, 2022).

The findings suggest that the instructional material is strong in foundational aspects such as print readability, durability, and usability, while minor improvements are needed in illustration clarity and layout simplicity. The slight variability observed in visual-related components reflects broader literature indicating that design and visual interpretation are often context-dependent and require continuous refinement to ensure universal accessibility and cultural relevance (Noël et al., 2022; Cabouat et al., 2025). Thus, while the material is already highly effective, ongoing enhancements in visual clarity, captioning consistency, and layout simplification will further strengthen its overall quality and instructional impact.

Table 5 Evaluator’s Rating on Presentation and Organization Factor

Presentation and Organization	Mean	SD	Description
1.Presentation is engaging, interesting, and understandable.	4.00	0	Very Satisfactory
2.There is a logical and smooth flow of ideas.	3.80	0.45	Very Satisfactory
3. Vocabulary level is adapted to target reader's likely experience and level of understanding.	3.80	0.45	Very Satisfactory
4.Length of sentences is suited to the comprehension level of the target reader	3.40	0.55	VerySatisfactory
5.Sentences and paragraph structures are varied and interesting to the target reader.	3.20	0.45	Satisfactory

6. Material has the potential to arouse interest of the target reader.	3.80	0.40	Very Satisfactory
Total	3.67	0.19	Very Satisfactory

Legend: 1.00-1.74 (not satisfactory); 1.75-2.49 (poor); 2.50-3.24 (satisfactory); 3.25-4.00 (very satisfactory)

Table 5 shows the Presentation and Organization evaluation indicates that the instructional resource demonstrates a high level of effectiveness in communicating content, achieving an overall “Very Satisfactory” rating ($M = 3.67$, $SD = 0.19$) with minimal variability. This suggests that the material consistently meets quality standards in terms of engagement, clarity, structure, and readability, all of which are essential for effective instructional delivery.

In terms of engagement and coherence, the material performed exceptionally well. The perfect mean score for engagement and understandability ($M = 4.00$, $SD = 0$) reflects unanimous agreement that the presentation is clear, interesting, and accessible to learners. This supports research emphasizing that engaging and comprehensible materials enhance learner attention, motivation, and initial understanding (Rustamaji et al., 2024; Fatkhullova et al., 2020; AlShaikh et al., 2024). Additionally, the logical and smooth flow of ideas ($M = 3.80$, $SD = 0.45$) indicates strong coherence in content organization, which is critical for facilitating comprehension and knowledge transfer (Morony, 2023; Andriichuk et al., 2022; Pepin, 2021). Together, these findings suggest that the material effectively integrates engagement with structured progression, supporting sustained learning.

Regarding lexical suitability and readability, the material demonstrates a strong alignment with the target audience. The vocabulary level ($M = 3.80$, $SD = 0.45$) indicates that language is generally appropriate to learners’ level of understanding, consistent with principles of readability and accessibility in educational materials (Rustamaji et al., 2024; Ahmadzadeh et al., 2023). However, the slightly lower rating for sentence length ($M = 3.40$, $SD = 0.55$) suggests some variability in sentence complexity, indicating that certain portions may be more challenging for readers. Literature consistently notes that overly long or complex sentences can increase cognitive load and hinder comprehension, particularly for less proficient readers (Ahmadzadeh et al., 2023, Rustamaji et al., 2024).

In terms of structural variety and engagement, the results show a balance between effectiveness and areas for refinement. The material’s ability to arouse reader interest ($M = 3.80$, $SD = 0.40$) reflects strong motivational appeal, which is a key factor in promoting deeper cognitive processing and sustained engagement (Rustamaji et al., 2024; Andriichuk et al., 2022; Auliya & Amrullah, 2024). Meanwhile, sentence and paragraph variety ($M = 3.20$, $SD = 0.45$) received a satisfactory rating, suggesting that while the text includes some variation, further improvement could enhance readability and maintain reader interest. Research indicates that varied structures can enrich text quality and engagement, but must be carefully managed to preserve coherence and logical flow (Rustamaji et al., 2024; Andriichuk et al., 2022; Auliya & Amrullah, 2024).

The findings reflect a well-organized and engaging instructional material that effectively balances clarity, coherence, and audience-appropriate language. The relatively low standard deviation indicates consistency across evaluation criteria, reinforcing the reliability of the results. However, minor improvements in sentence length and structural variety could further enhance readability and accessibility, particularly for diverse learner groups. These results align with existing literature, which emphasizes that high-quality instructional materials integrate engaging presentation, logical organization, and readable language to optimize learning outcomes (Rustamaji et al., 2024; Morony, 2023; Andriichuk et al., 2022; Auliya & Amrullah, 2024).

Table 6 Evaluator’s Rating on Accuracy and Up-to-datedness of Information Factor

Accuracy and Up-to-dateness of Information	Mean	SD	Description
1. Conceptual errors.	4.00	0	Very Satisfactory

2. Factual errors.	4.00	0	Very Satisfactory
3. Grammatical errors.	3.00	0	Satisfactory
4. Computational errors.	4.00	0	Very Satisfactory
5. Obsolete information.	4.00	0	Very Satisfactory
6. Typographical and other minor errors (e.g., inappropriate or unclear illustrations, missing labels, wrong captions, etc.)	3.60	0.55	Very Satisfactory
Total	3.77	0.22	Very Satisfactory

Legend: 1.00-1.74 (not satisfactory); 1.75-2.49 (poor); 2.50-3.24 (satisfactory); 3.25-4.00 (very satisfactory)

Table 6 shows evaluation of accuracy and up-to-datedness indicates that the instructional material demonstrates a high level of content reliability, achieving an overall “Very Satisfactory” rating ($M = 3.77$, $SD = 0.22$) with relatively low variability. This suggests consistent quality across all indicators of accuracy, reinforcing the credibility and trustworthiness of the material.

In terms of conceptual and factual accuracy, both items received perfect mean scores ($M = 4.00$, $SD = 0$), indicating that no conceptual or factual errors were identified. This reflects strong adherence to evidence-based content development and ensures that learners are exposed to correct and reliable information. Such accuracy is essential in preventing misconceptions and supporting meaningful learning, as emphasized in studies highlighting the importance of precise and validated instructional content (Rustamaji et al., 2024; Andriichuk et al., 2022; Auliya & Amrullah, 2024). These results suggest that the material has undergone thorough validation and aligns with current knowledge in the field.

Similarly, computational accuracy achieved a perfect rating ($M = 4.00$, $SD = 0$), indicating that all numerical data, calculations, and procedures are correct. This is particularly important in materials involving quantitative analysis or problem-solving, as computational errors can significantly affect learning outcomes. The absence of such errors reflects careful development and review processes, consistent with standards for high-quality educational materials (Andriichuk et al., 2022; Rustamaji et al., 2024).

The material also performed excellently in terms of up-to-datedness, with no obsolete information detected ($M = 4.00$, $SD = 0$). This suggests that the content is current and relevant, which is crucial in ensuring that learners engage with accurate and contemporary knowledge. Literature emphasizes that regular updating of instructional materials is necessary to maintain relevance, particularly in rapidly evolving fields (Morony, 2023; Andriichuk et al., 2022).

However, minor areas for improvement were observed in grammatical and typographical accuracy. The rating for grammatical correctness ($M = 3.00$, $SD = 0$) indicates satisfactory performance, suggesting the presence of minor grammatical issues that do not significantly affect understanding but may influence readability and perceived professionalism. Similarly, typographical and minor errors ($M = 3.60$, $SD = 0.55$) were rated as very satisfactory, though the variability suggests occasional inconsistencies in formatting, labeling, or text presentation. Existing literature notes that even minor linguistic and typographical errors can distract learners and slightly reduce the overall quality of instructional materials, highlighting the importance of careful proofreading and editing (Rustamaji et al., 2024; Andriichuk et al., 2022; Auliya & Amrullah, 2024).

The findings indicate that the instructional material is highly accurate, current, and reliable, with strong performance in conceptual, factual, and computational dimensions. The low standard deviation reflects consistency in evaluator judgments, further supporting the material’s quality. While minor grammatical and typographical issues are present, these do not undermine the overall integrity of the content but rather point to opportunities for refinement through additional editing and quality assurance processes. Consistent with the literature, maintaining high accuracy alongside continuous updates and editorial improvements will further

enhance the effectiveness and credibility of the instructional material (Andriichuk et al., 2022; Rustamaji et al., 2024; Morony, 2023; Auliya & Amrullah, 2024).

Table 7 Summary of Evaluator’s Rating on Printed Materials

Factor	Mean	SD	Description
Content	3.69	0.22	Very Satisfactory
Format	3.78	0.23	Very Satisfactory
Presentation and Organization	3.67	0.19	Very Satisfactory
Accuracy and Up-to-datedness of Information	3.77	0.22	Very Satisfactory
Total	3.73	0.02	Very Satisfactory

Legend: 1.00-1.74 (not satisfactory); 1.75-2.49 (poor); 2.50-3.24 (satisfactory); 3.25-4.00 (very satisfactory)

Table 7 presents the summary of evaluators’ ratings of printed instructional materials across four key factors: Content, Format, Presentation and Organization, and Accuracy and Up-to-datedness of Information, along with an overall Total score. All factor means fall within the “Very Satisfactory” range (Content = 3.69, Format = 3.78, Presentation and Organization = 3.67, Accuracy and Up-to-datedness = 3.77), with small to moderate standard deviations, indicating consistently high quality across criteria. The overall mean of 3.73 with a very low standard deviation (SD = 0.02) suggests near-unanimous agreement among evaluators, reflecting a highly reliable and well-developed instructional resource. The following synthesis integrates these findings and situates them within current literature on instructional material design and evaluation.

The content factor (M = 3.69, SD = 0.22) indicates a Very Satisfactory level, suggesting that the material presents accurate, relevant, and up-to-date information aligned with current knowledge. High-quality instructional content requires conceptual clarity and factual correctness to support effective learning and informed decision-making. The observed ratings are consistent with established standards emphasizing content validity and reliability as essential to credible educational materials (Mashoufi et al., 2023; Soman & Whyte, 2020). The relatively low variability further reflects strong agreement among evaluators regarding the material’s content quality. However, literature also highlights that even minor inaccuracies can affect credibility, underscoring the importance of continuous content review and updating (Mashoufi et al., 2023; Soman & Whyte, 2020).

The format factor achieved a mean of 3.78 (SD = 0.23), indicating Very Satisfactory performance in terms of readability and physical design. This suggests that the material effectively utilizes appropriate typography, spacing, layout, and physical features to support ease of reading and handling. Research in information design and data presentation consistently shows that clear typographic choices and well-structured layouts enhance comprehension and user experience (Mashoufi et al., 2023; Alogaiel & Alrwais, 2023). The strong rating confirms that the material meets these design standards. Nonetheless, literature notes that even minor issues in spacing or visual density can affect accessibility, particularly for readers with diverse needs, indicating potential areas for further refinement (Mashoufi et al., 2023).

The presentation and organization factor (M = 3.67, SD = 0.19) reflects a Very Satisfactory level of clarity, engagement, and structural coherence. This indicates that the material effectively organizes ideas, maintains logical flow, and uses language appropriate for the target audience. These qualities are essential for promoting comprehension, retention, and learner engagement. The findings align with literature emphasizing the importance of coherent sequencing, engaging presentation, and readable text structures in instructional materials (Rustamaji et al., 2024; Morony, 2023; Andriichuk et al., 2022; Auliya & Amrullah, 2024). However, the slightly lower rating for sentence and paragraph variety (M = 3.20) suggests that while the structure is generally effective, enhancing variation and transitions could further improve readability and maintain reader interest. Studies note

that structural diversity must be balanced with coherence to avoid disrupting comprehension (Rustamaji et al., 2024; Andriichuk et al., 2022; Auliya & Amrullah, 2024).

The accuracy and up-to-datedness factor ($M = 3.77$, $SD = 0.22$) indicates that the material demonstrates a high level of correctness and relevance. The strong performance in conceptual, factual, computational accuracy, and absence of obsolete information suggests that the material is both reliable and current. Minor gaps in grammatical accuracy and typographical precision indicate areas for improvement but do not significantly affect overall quality. These findings are consistent with literature emphasizing the importance of rigorous validation and continuous updating to maintain accuracy in educational resources (Arça et al., 2024; Kianian et al., 2023). Additionally, studies highlight that the concept of “currency” is context-dependent, reinforcing the need for periodic review to ensure continued relevance (Cubides et al., 2023).

The total mean of 3.73 ($SD = 0.02$) reflects a high level of quality across all evaluated dimensions, with minimal variability indicating strong evaluator consensus. The material demonstrates particular strengths in content accuracy, format and readability, and overall presentation, with only minor areas for refinement in language precision and structural variation. These results align with existing literature, which emphasizes that high-quality printed instructional materials are characterized by the integration of accurate content, effective design, coherent organization, and continuous quality assurance processes (Soman & Whyte, 2020; Arça et al., 2024; Kianian et al., 2023). Overall, the findings confirm that the evaluated material is well-developed, reliable, and suitable for instructional use, while still benefiting from ongoing review and enhancement.

CONCLUSION

This study developed and validated LaPiSTEM learning activities as instructional material for Grade 11 Earth and Life Science, specifically focusing on Bioenergetics. Through a rigorous process of curriculum mapping, expert validation, and administrative review, the material was designed to meet high instructional standards. The evaluation results were highly positive giving the content, format, and organization a "very satisfactory" rating. The findings confirm that the activity sheet is accurate, age-appropriate, and effective at fostering higher-order thinking skills—such as critical thinking and problem-solving—through structured, Filipino cultural games and STEM activities.

ACKNOWLEDGEMENT.

To God, for the wisdom, strength, and guidance throughout this academic journey. To my family and friends, whose unwavering love, patience, and encouragement made this work possible. To my PhD colleagues, for the shared struggles, insights, and motivation along the way. Sincere appreciation is also given to the Department of Science and Technology (DOST)-CBPSME for the scholarship assistance that supported this research. Special thanks to my institution Mindanao State University-Iligan Institute of Technology.

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