



Effectiveness of Traditional Filipino Games on Senior High School Students' Conceptual Understanding of Physics

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ABSTRACT

This study developed, validated, and implemented culturally contextualized physics learning activities integrating traditional Filipino games (Laro-ng-Lahi) as instructional tools to enhance students' conceptual understanding in physics. Using a three-phase process—development, validation, and implementation—the researchers designed five game-based activities aligned with the Department of Education's Most Essential Learning Competencies (MELCs). They evaluated them using the Learning Resources Management and Development System (LRMDS) standards. A panel of subject matter experts rated the materials highly in terms of content quality, format, organization, and accuracy, while student feedback highlighted their clarity, engagement, and relevance. Employing an embedded mixed-methods, one-group pretest–posttest design, the study found statistically significant gains in conceptual understanding, with student performance improving from “Low Mastery” to “Near Full Mastery.” These results suggest that Laro-ng-Lahi-based physics games offer a viable, culturally responsive approach to physics instruction. Future research may explore their application across other science topics and educational levels, particularly in junior high school settings.

RESUMO

Este estudo desenvolveu, validou e implementou atividades de aprendizagem de física contextualizadas culturalmente, integrando jogos tradicionais filipinos (Laro-ng-Lahi) como ferramentas instrucionais para aprimorar a compreensão conceitual dos alunos em física. Utilizando um processo de três fases — desenvolvimento, validação e implementação —, os pesquisadores projetaram cinco atividades baseadas em jogos alinhadas às Competências de Aprendizagem Mais Essenciais (MELCs) do Departamento de Educação. Eles as avaliaram utilizando os padrões do Sistema de Gestão e Desenvolvimento de Recursos de Aprendizagem (LRMDS). Um painel de especialistas no assunto avaliou os materiais com alta pontuação em termos de qualidade do conteúdo, formato, organização e precisão, enquanto o feedback dos alunos destacou sua clareza, engajamento e relevância. Empregando um delineamento pré-teste-pós-teste de um grupo, com métodos mistos incorporados, o estudo encontrou ganhos estatisticamente significativos na compreensão conceitual, com o desempenho dos alunos melhorando de “Baixo Domínio” para “Quase Domínio Total”. Esses resultados sugerem que os jogos de física baseados em Laro-ng-Lahi oferecem uma abordagem viável e culturalmente responsiva ao ensino de física. Pesquisas futuras podem explorar sua aplicação em outros tópicos científicos e níveis educacionais, especialmente em ambientes de ensino fundamental.

RESUME

Este estudio desarrolló, validó e implementó actividades de aprendizaje contextualizadas culturalmente en física, integrando juegos tradicionales filipinos (*Laro-ng-Lahi*) como herramientas instruccionales para mejorar la comprensión conceptual de los estudiantes en física. A través de un proceso de tres fases—desarrollo, validación e implementación—los investigadores diseñaron cinco actividades basadas en juegos, alineadas con las Competencias Esenciales Más Importantes (MELCs) del Departamento de Educación y evaluadas según los estándares del Sistema de Gestión y Desarrollo de Recursos de Aprendizaje (LRMDS). Un panel de expertos en la materia calificó altamente los materiales en cuanto a calidad de contenido, formato, organización y precisión, mientras que la retroalimentación de los estudiantes destacó su claridad, atractivo y relevancia. Empleando un diseño cuasi-experimental con métodos mixtos integrados y un solo grupo con preprueba y postprueba, el estudio encontró mejoras estadísticamente significativas en la comprensión conceptual, con un rendimiento que pasó de “Bajo Dominio” a “Casi Dominio Completo.” Estos resultados sugieren que los juegos de física basados en *Laro-ng-Lahi* ofrecen un enfoque viable y culturalmente receptivo para la enseñanza de la física. Futuras investigaciones podrían explorar su aplicación en otros temas de ciencias y niveles educativos, particularmente en la educación secundaria básica.

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Introduction

Physics is widely regarded as one of the most essential scientific disciplines, equipping students with the skills to analyze natural phenomena, understand technological developments, and apply logical reasoning in real-world contexts (Hewitt, 2014; Arslan & Eraslan, 2003). As a foundational science subject in the curriculum, it is integral to the promotion of scientific literacy, national development, and global competitiveness. Despite its importance, many students find physics difficult to learn due to its abstract nature, mathematical representations, and perceived lack of relevance to everyday experiences (Ornek et al., 2008; Tural, 2013; Saleh, 2012).

These learning difficulties are not unique to any single country. However, in the Philippines, they are especially pronounced. In international assessments such as the Programme for International Student Assessment (PISA), Filipino students have consistently ranked low in science performance (DepEd, 2019). National-level diagnostic exams reflect similar patterns, pointing to persistent challenges in comprehension, retention, and application of core physics concepts. Scholars and educators have identified several contributing factors to this issue: traditional lecture-based teaching methods, insufficient instructional resources, limited attention to diverse learning styles, and minimal cultural relevance in content delivery (Angell et al., 2004; Orleans, 2007).

Amid these concerns, there is a growing call for transformative teaching approaches that connect science content with students' cultural backgrounds and daily realities. Game-based learning, which capitalizes on learners' natural affinity for play, has emerged as a promising strategy. Studies suggest that incorporating games into science instruction can promote active engagement, reduce anxiety, and improve conceptual understanding by offering hands-on, experiential learning opportunities (Lasala, 2024; Boyraz & Serin, 2016; Selcuk, 2010). This is particularly effective in physics, where kinaesthetic and visual engagement can bridge the gap between abstract principles and lived experiences.

In the Philippine context, *Laro-ng-Lahi*—a collection of traditional Filipino games passed down through generations—offers a culturally rooted medium through which physics concepts can be taught meaningfully. These games are inherently rich in physical dynamics, rules, and problem-solving elements that align naturally with physics principles. Examples such as *tumbang preso* (target motion), *patintero* (path planning and motion), and *syato* (rotational motion and projectile dynamics) demonstrate the potential of embedding scientific ideas into culturally familiar formats. Moreover, these games reinforce collaboration, critical thinking, and learner engagement—key goals of the 21st-century Philippine K–12 curriculum (RA 10533).

Integrating *Laro-ng-Lahi* into physics education is not only pedagogically sound but also aligned with national goals to promote culturally responsive teaching and preserve Filipino identity. Research consistently shows that contextualizing science instruction using

local games and indigenous knowledge enhances both student motivation and conceptual understanding (Tupas & Palmares, 2018; Del Carmen et al., 2015; Tangonan-Capinding & Salazar, 2023; Lasala, 2023a; Loberes et al., 2025; Gestiada et al., 2025). This approach is consistent with culturally responsive pedagogy, which emphasizes the use of learners' cultural references to foster effective teaching (Villena et al., 2021; Lasala, 2023b). Moreover, the integration of traditional Filipino games supports inclusive and differentiated instruction, particularly benefiting learners who struggle with conventional, abstract, or textbook-centered approaches in STEM subjects (Medina, 2018; Villena et al., 2021).

To ensure instructional relevance, the physics topics chosen for integration were not arbitrary; instead, they were informed by national and institutional data that identified them as the least mastered competencies in Senior High School physics. Specifically, concepts such as force and motion, energy transformation, Newton's laws of motion, and work-energy relationships have been consistently identified as challenging areas for students, often resulting in proficiency levels that fall below the desired standards. The Department of Education's Bureau of Education Assessment (DepEd-BEA) has emphasized the persistent low performance in physics, particularly in mechanics-related items, across multiple assessment cycles (DepEd, 2019).

Furthermore, research consistently identifies mechanics and energy concepts as particularly challenging in physics education. For example, Wells et al. (2020) documented enduring misconceptions in force and Newton's laws. Rivaldo et al. (2020) reported correct response rates as low as 11%–38% across key work–energy subtopics. Singh & Rosengrant (2016) further found that students struggle to interpret energy and momentum qualitatively, and Brundage, Meltzer & Singh (2024) reveal ongoing confusion even at advanced levels. This multi-level evidence strengthens the rationale for exploring culturally grounded approaches, like *Laro-ng-Lahi*, to address these persistent conceptual difficulties.

Additionally, other scholarly literature supports this trend. Physics, in general, has historically been identified as one of the most challenging science subjects to learn and teach due to its high level of abstraction and mathematical nature (Selçuk, 2010; Wambugu & Changeiywo, 2008; Folashade & Akinbobola, 2009). Tural (2013) affirms that abstract concepts in physics often overwhelm students, contributing to persistent low performance. Many students perceive physics as difficult (Saleh, 2012; Tural, 2013), boring, or irrelevant to real-life contexts (Efthimiou et al., 2006; Lye, Fry & Hart, 2002, as cited in Tural, 2013). These perceptions point to the urgent need for instructional strategies that make physics learning more concrete, engaging, and meaningful.

In response to these pedagogical and cultural imperatives, the present study aims to explore the integration of *Laro-ng-Lahi* in teaching senior high school physics. Specifically, it seeks to: (1) develop contextualized physics learning activities anchored on selected Filipino traditional games; (2) validate the content and design of these activities through expert and

student review; and (3) evaluate the effectiveness of these activities in enhancing students' conceptual understanding of identified least mastered physics competencies. The study contributes to the growing body of work on culturally relevant science education and offers evidence-based insights to inform both instructional practice and curriculum policy in Philippine STEM education.

Methodology

This study employed an embedded mixed-methods design, integrating qualitative data within a predominantly quantitative quasi-experimental framework to enrich the interpretation of results. The primary aim was to evaluate the effectiveness of traditional Filipino games (*Laro-ng-Lahi*) as game-based learning tools in enhancing students' conceptual understanding of selected physics topics.

The core design was quantitative, using a one-group pretest-posttest quasi-experimental approach to measure changes in student understanding before and after the intervention. This design is commonly used to assess the impact of an instructional treatment in a real-world educational setting (Creswell & Plano Clark, 2018). To supplement the quantitative findings and provide contextual insights into students' learning experiences, qualitative data in the form of journal reflections were collected.

Selected quotes from these reflections were analyzed thematically to gain a better understanding of student perceptions of the learning process and the influence of *Laro-ng-Lahi*-based activities on their engagement and conceptual grasp. The embedded nature of the qualitative data served to triangulate findings and enhance the interpretation of the observed learning gains (Ivankova, Creswell, & Stick, 2006; Leech & Onwuegbuzie, 2009). The design is represented as:

O1 X O2

Where: X- Game-based Learning Intervention (Physics Game- based on *Laro-ng-Lahi*); O1- Pretest; O2- Posttest

This study consisted of three major phases: development, validation, and implementation, similar development-validation-implementation approach was employed in the study by Lasala Jr. et al. (2025a), where interactive e-learning modules in Earth Science were designed, validated by experts, and tested with students to examine their impact on conceptual understanding. Like the present research, the study combined expert evaluation, pilot testing, and empirical analysis to ensure instructional rigor and contextual relevance.

In the development phase, a total of 30 Grade 11 STEM students from a large secondary school in Sorsogon participated in the small-scale pilot testing. Traditional Filipino games were

identified through document analysis and literature review, then aligned with Grade 11 physics content based on the DepEd Most Essential Learning Competencies (MELCs). Games such as *Tumbang Preso*, *Patintero*, and *Syato* were transformed into instructional activities that emphasize physics principles like projectile motion, force, and energy transfer.

Similar to previous work validating game-based instructional materials in biology (Lasala, 2022), this study employed the LRMDs framework to ensure the Physics Games met standards set by the Department of Education. The initial versions of the physics learning activities were validated by a panel of five subject matter experts (SMEs) in physics education, selected based on their professional expertise and experience. The panel consisted of one Division Science Supervisor, two nationally recognized Master Teacher II in senior high school, two University Professors specializing in physics education and instructional design. All validators were affiliated with different academic institutions in the province of Sorsogon, ensuring a diversity of pedagogical perspectives.

Validation employed the DepEd Rating Sheet for Print Materials, as prescribed in *DepEd Order No. 441, s. 2019*. This tool assesses four key domains: Content (Factor A), Format (Factor B), Presentation and Organization (Factor C), and Up-to-date Information (Factor D). It uses a 5-point Likert scale ranging from 1 (*Needs Major Revision*) to 5 (*Excellent*) and includes sample indicators such as “*The content is aligned with MELCs*” and “*Presentation encourages learner engagement.*” The collected data were analyzed using descriptive statistics, including mean and standard deviation. Items with mean scores below 3.5 were revised accordingly. The improved materials were then pilot-implemented and subsequently re-evaluated by the same panel to confirm improvements and establish content validity.

While the validators were qualified subject matter experts in physics education, a notable limitation of this study is the non-involvement of official DepEd curriculum specialists, such as national or regional curriculum developers. As a result, while the content was evaluated for academic and pedagogical soundness, it may not fully capture policy-level curriculum considerations. Future research and instructional material development efforts are encouraged to involve recognized curriculum planners to ensure alignment not only with the MELCs but also with ongoing national reforms and long-term curricular priorities.

The validated games were implemented with 50 Grade 12 STEM students in a public senior high school in Sorsogon over a period of four weeks, following the prescribed DepEd MELCs time allocations. A conceptual understanding test was administered before (pretest) and after (posttest) the intervention. The 40-item multiple-choice test was validated by physics experts and covered core topics, including motion, force, energy, and momentum. The test’s reliability was established through Kuder–Richardson Formula 20, yielding an internal consistency coefficient of 0.82.

Additionally, qualitative data were collected through student journal logs. After each activity, students responded to reflection prompts such as: “*How did this game help you understand the topic?*” and “*What part of the activity helped you connect physics to real-life situations?*” These responses were analyzed using thematic analysis, following Braun and Clarke’s (2006) six-phase model. Codes were first generated inductively, then organized into emergent themes, which were used to triangulate quantitative findings.

Meanwhile, Ethical clearance for the study was secured through formal letters of request, which were duly approved by the school principals and department heads of the participating institutions. All respondents were informed of the study’s purpose and procedures and were assured of confidentiality, anonymity, and the voluntary nature of their participation. Students were explicitly informed that they had the right to withdraw from the study at any point without any academic or personal consequences.

To analyze the data, the researchers employed descriptive statistics, specifically the computation of means and standard deviations, to summarize the expert validation ratings and student performance scores in both the pretest and posttest. To determine whether the observed differences in students’ conceptual understanding before and after the intervention were statistically significant, a paired-sample *t*-test was conducted. Furthermore, the magnitude of the intervention’s effect was assessed using Cohen’s *d*, allowing for the interpretation of the practical significance of the results.

This integrated methodological approach ensured both statistical and interpretive rigor, supported by triangulated evidence from quantitative tests and qualitative reflections. The study adhered to national ethical and educational standards, thereby enhancing the validity and reliability of its findings on the use of traditional Filipino games as a culturally grounded pedagogical intervention in physics education.

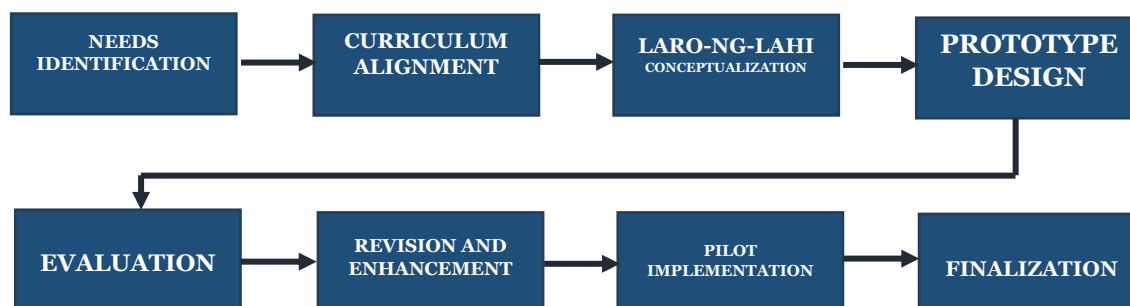
Results and Discussion

Development of Laro-ng-Lahi: Physics Games

To address persistent difficulties in physics learning, this study developed five culturally contextualized game-based activities using traditional Filipino games (Laro-ng-Lahi) as instructional tools. These activities were aligned with the Grade 11 General Physics 1 curriculum and the Most Essential Learning Competencies (MELCs), targeting scalar and vector quantities (Rubber Band Challenge), acceleration (Sip-Acceleration), projectile motion (Siyato Launcher), Newton’s laws (Newton’s Slipper Motion), and collisions (Hollisions). The activities aimed to foster deeper conceptual understanding through constructivist, experiential, and kinaesthetic learning. The image below illustrates the structured process used to guide the development phase of the study.

Figure 1

Developmental stages of the Laro-ng-Lahi-based game activities guided by a localized instructional design process. Each phase contributed to the technical quality, pedagogical relevance, and cultural responsiveness of the modules.



As mentioned earlier, the process followed a structured development sequence, beginning with needs identification. Relevant data from national and local assessments, as well as literature, were analyzed to determine the most challenging physics topics for Grade 11 learners (Kurt, 2017). Among those consistently identified as least mastered were scalar and vector quantities, acceleration, projectile motion, Newton's laws of motion, and collisions—concepts that tend to be abstract and complex for students to visualize and apply meaningfully.

This initial analysis informed the curriculum alignment phase, where each identified topic was mapped directly to the Most Essential Learning Competencies (MELCs) prescribed in the Grade 11 General Physics 1 curriculum. Ensuring this alignment was critical for both instructional relevance and compliance with national standards. The alignment process also considered the cognitive demands of each competency and how these might be supported through culturally embedded, experiential learning. Moreover, this reflects the notion of *constructive alignment* in pedagogy (Biggs, 2003), wherein outcomes, activities, and assessments are coherently linked.

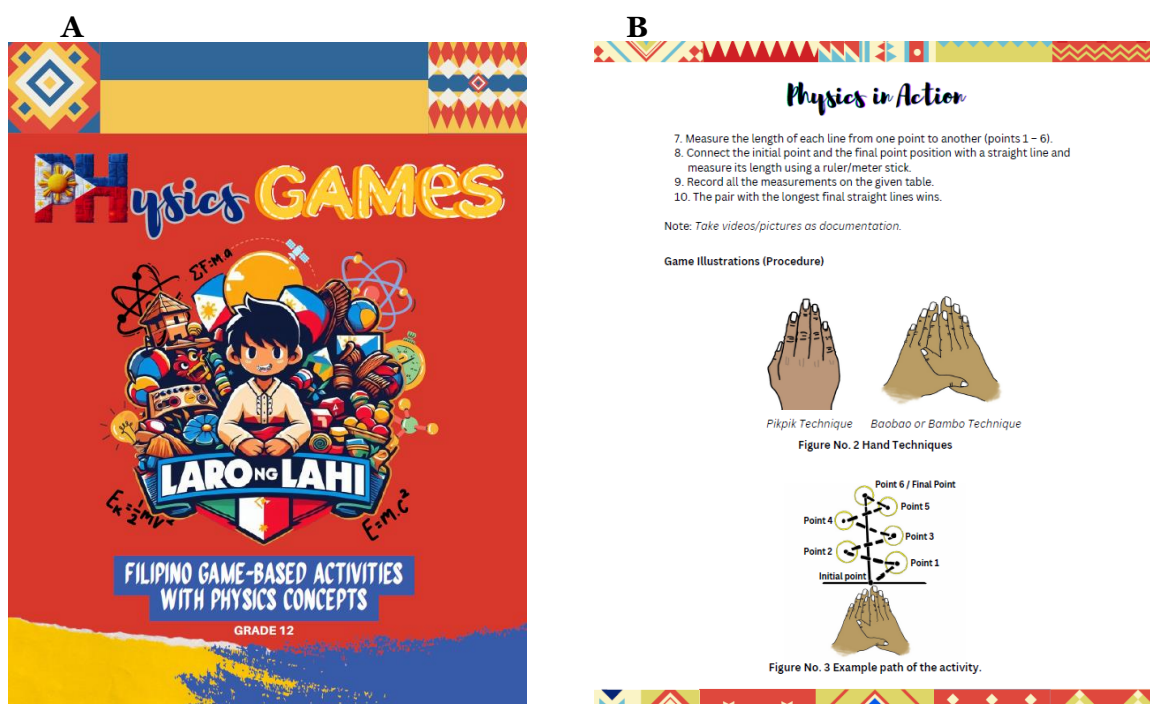
With the competencies established, the next stage focused on game conceptualization. Traditional Filipino games were selected and creatively adapted to represent the relevant physics concepts. For instance, *Rubber Band Challenge* was used to demonstrate scalar and vector quantities, *Sip-Acceleration* illustrated acceleration, *Siyato Launcher* modeled projectile motion, *Newton's Slipper Motion* embodied Newton's laws, and *Hollisions* captured the dynamics of collisions. These games were intentionally chosen for their physical nature, cultural familiarity, and potential to support kinaesthetic and constructivist learning. Drawing on these kinaesthetic-rich games may support a more profound understanding through active exploration (Carmen et al., 2015).

In the prototype design phase, each module was crafted with clear visuals, accessible language, and culturally resonant imagery—features that align with well-established principles in multimodal instructional design. Research indicates that integrating visuals such as diagrams and culturally relevant artwork enhances both comprehension and student identity affirmation in scientific learning (Zähringer et al., 2024; Patel & Mathis, 2024). For example, Zähringer et al. (2024) found that aesthetically pleasing and affectively engaging visuals in physics instruction significantly increased both aesthetic appreciation and conceptual understanding among learners. Similarly, Patel and Mathis’s (2024) PERC study highlights that culturally grounded approaches in physics—like using students’ cultural backgrounds as teaching anchors—can foster deeper engagement and inclusivity.

By embedding design elements such as Barong Tagalog motifs, national colors, and traditional toys (shown in figure 2), the modules not only improved readability and engagement but also reinforced Filipino cultural identity, a key component of culturally responsive pedagogy (Patel & Mathis, 2024). This visual and cultural alignment was structured in accordance with DepEd’s Regional Memo No. 91, s. 2020, ensuring standardized formatting—including cover pages, prefaces, tables of contents, conceptual backgrounds, “Physics in Action” sections, assessment sheets, and student journals—offering a coherent, learner-friendly user experience in line with Kozma et al.’s (2015) recommendations.

Figure 2

Sample prototype page showing culturally symbolic design (a) and instructional layout (b).



The materials then proceeded to expert validation, wherein a panel of five subject matter experts—composed of a physics supervisor, a master teacher, two experienced high school physics teachers, and a university physics professor—evaluated the activities using the DepEd Rating Sheet for Print Materials (DepEd Order No. 441, s. 2019). This instrument assessed content, format, presentation, and up-to-date information. Scores were analyzed using mean and standard deviation, and items with a mean below 3.5 were flagged for revision.

Following validation, the revision and enhancement phase was undertaken. Feedback from experts was incorporated to refine the clarity of game instructions, align content more tightly with the MELCs, and strengthen the visual and pedagogical coherence of the modules. Particular attention was given to simplifying technical language, strengthening conceptual prompts, and enhancing visual scaffolds to promote deeper understanding through inquiry and application. This is central to the iterative design philosophy, especially in instructional development (Kurt, 2017)

The revised modules were then subjected to pilot implementation with selected Grade 11 students. During implementation, learners engaged with the activities both physically and cognitively, playing games, collecting data, analyzing outcomes, and reflecting on their experiences, as shown in figure 3. Anecdotal records and student journal logs revealed that the cultural familiarity and physical interaction inherent in the games fostered higher engagement and improved conceptual clarity. As mentioned by several researchers, Pilot studies are vital in educational design to detect misalignments and support the method–theory fit (Muresherwa & Jita, 2022; REL Appalachia, 2025). Meanwhile, student logs and reflections revealed enhanced engagement and conceptual clarity, consistent with the literature on embodied learning (Alsalhi et al., 2022). These were vital in ensuring that the activities were not only aligned with cognitive goals but also responsive to students’ affective and metacognitive needs.

The feedback obtained during this stage offered valuable insights into how students internalized concepts, navigated difficulties, and experienced physics in culturally meaningful ways. Moreover, the embodied nature of the activities—grounded in familiar physical games—appeared to reduce intimidation often associated with abstract physics topics, thereby promoting learner confidence and participation. This aligns with findings from embodied cognition theory, which argues that physical engagement with learning materials can enhance conceptual processing and retention (Wilson & Golonka, 2013).

Figure 3

Grade 11 students played and performed the “PHYSICS IN ACTION” activities during pilot implementation of the study.



Finally, in the finalization stage, insights from the pilot implementation and journal reflections were synthesized with expert feedback to make final adjustments to the modules. This included refining assessment sheets, clarifying game instructions, and enhancing visual elements. The resulting instructional materials were not only technically compliant with DepEd standards but also pedagogically sound and culturally rooted. This development process highlights the importance of integrating national identity, experiential engagement, and cognitive scaffolding to create learning resources that support conceptual change and inclusive science education in the Philippine context.

Experts' Validation of the Laro-ng-Lahi: Physics Games

To ensure the instructional quality, cultural responsiveness, and curricular alignment of the developed game-based activities, the study employed the DepEd Learning Resources Management and Development System (LRMDS) tool for printed materials (DepEd Order No. 441, s. 2019). This validation framework focuses on four core criteria: Content, Format, Presentation, Organization, and Up-to-datedness of Information. Five expert validators, comprising science teachers, a physics supervisor, a master teacher, and a university professor-

assessed the materials using a 5-point Likert scale across these domains. The results are summarized in the Table below.

Table 1
Expert's Validation Results of the Physics Games

Criteria	Point to Pass (DepEd, 2009)	Mean Scores of Expert Validators					Average Score M1-M5
		M1	M2	M3	M4	M5	
Content	at least 21 of 28	27	27	28	28	28	28
Format	at least 54 of 72	71	70	70	71	71	71
Organization and Presentation	at least 15 of 20	19	20	20	20	19	20
Up-to-dateness of Information	at least 24 of 24	24	24	24	24	24	24

Note: *M*- Module

Table 1 presents the consolidated scores of five expert validators using the Department of Education's LRMDs Evaluation Rating Sheet for Print Materials (DepEd, 2009). This tool assesses print-based learning resources across four primary criteria—Content, Format, Organization, Presentation, and Up-to-dateness of Information. As shown in the table, the developed *Laro-ng-Lahi*-based physics games exceeded the minimum required benchmarks for each criterion. All validators rated the materials highly, demonstrating a strong level of content validity, technical quality, and instructional soundness. A copy of the LRMDs evaluation tool used in this study is included in Appendix A for reference.

In terms of content, the developed instructional materials achieved a perfect average score of 28 out of 28, surpassing the minimum passing requirement of 21. This indicates that the physics games effectively integrated core scientific concepts with contextual accuracy, clarity, and relevance to the targeted curriculum.

Such a result affirms that the content is not only aligned with the DepEd MELCs but also enriched with pedagogical soundness, ensuring conceptual accuracy and suitability for senior high school learners. It reflects the validators' consensus that the learning activities contain comprehensive, appropriate, and scientifically rigorous explanations—a key indicator of content validity in instructional materials. Moreover, experts affirmed that the activities embodied scientifically sound explanations and contextual relevance. This supports Morales' (2014) assertion that cultural integration in physics instruction enhances learner motivation and meaning-making. As one expert noted, the contextualization of physics through indigenous games deepens engagement and grounds abstract content in local experiences.

For the format, an average score of 71 out of a possible 72 signifies that the layout, material durability, typography, and visual presentation adhered to DepEd's standards for printed learning resources. This strong rating confirms that the physical and structural

elements of the modules are conducive to classroom implementation. It also suggests that the design choices—such as the use of engaging illustrations, logical layout, and accessible formatting—effectively support student attention, motivation, and usability. As instructional design literature emphasizes (Mayer, 2009; Khalil & Elkhider, 2016), visual clarity and structural coherence are essential in reducing extraneous cognitive load and enhancing learner engagement.

The organization and presentation category also attained a near-perfect average score of 20 out of 20, well above the required 15 points. This validates the instructional coherence, logical sequencing, and appropriateness of the language used. Experts confirmed that the flow of ideas, transitions between sections, and internal consistency of the modules supported comprehension, reinforcing the importance of well-structured content in improving academic performance and learner autonomy (Musaevna, 2020).

Lastly, the up-to-datedness of information earned the maximum score of 24, indicating that all included content was current, relevant, and free from outdated concepts. This is critical in science education, where instructional materials must reflect the latest frameworks and real-world relevance. While some minor typographical or formatting concerns were raised, these were swiftly addressed, further underscoring the researchers' commitment to quality and continuous improvement.

Collectively, the result reflects a strong consensus among expert raters that the developed *Laro-ng-Lahi*-based physics activities are technically robust, instructionally sound, and pedagogically effective. The results justify the materials' readiness for implementation and further empirical testing and their potential for wider adoption in culturally responsive science education.

Student's Evaluation of Physics Games

To complement expert validation, the study also solicited feedback from the target users—Grade 12 STEM students—who participated in the pilot implementation of the developed game-based activities. Their evaluation focused on three adapted criteria: Content, Format, and Presentation and Organization. This step was essential to assess the materials' clarity, accessibility, and user engagement from the learner's perspective.

As shown in Table 2, all three criteria received a rating of Very Satisfactory. Criteria A (Content) and Criteria C (Presentation and Organization) both achieved a weighted mean of 3.7, while Criteria B (Format) garnered a mean of 3.6. These results suggest that the instructional materials were perceived as effective in terms of instructional clarity, aesthetic appeal, and organization. While expert validators used four criteria in their validation, the student version focused on three to ensure age-appropriate comprehension. The fourth factor—Up-to-date Information—was excluded as it requires a level of content expertise not

expected from student respondents. However, the remaining indicators remained aligned with those in the expert evaluation form.

Table 2
Students' Evaluation Result of the Physics Games

Criteria	Mean Scores of Students' Evaluation					Overall
	M1	M2	M3	M4	M5	
Content	3.7 (VS)	3.7 (VS)	3.7 (VS)	3.8 (VS)	3.7 (VS)	3.7 (VS)
Format	3.8 (VS)	3.5 (VS)	3.6 (VS)	3.7 (VS)	3.6 (VS)	3.6 (VS)
Organization and Presentation	3.8 (VS)	3.5 (VS)	3.8 (VS)	3.8 (VS)	3.8 (VS)	3.7 (VS)

Note: M- Module; VS- Very Satisfactory

In support of the quantitative findings, qualitative data from student interviews and journal logs revealed a generally positive reception of the game-based approach. Many students expressed that the traditional games heightened their engagement, deepened their understanding of physics concepts, and instilled a sense of nationalism. For instance, one student remarked: *"It was a fun and active way to learn velocity and acceleration. It is engaging and can test our competitiveness and increase our knowledge about it while relating it to our daily lives."*

Nonetheless, some students noted implementation challenges, particularly in performing the games in limited physical spaces. One student recommended: *"The activities should be done in a proper/appropriate game area to conduct the games effectively."* These reflections provided practical insights for improving the module's delivery.

All comments, suggestions, and recommendations were used to enhance the final version of the Physics Games. The revised materials integrated these improvements to ensure the activities were not only pedagogically sound but also contextually appropriate for Filipino learners.

Effects of the Laro-ng-Lahi GBAs on Students' Conceptual Understanding

To assess the effect of the developed traditional game-based learning activities on students' understanding of physics concepts, a pretest-posttest evaluation was conducted among 50 Grade 12 STEM students. The goal was to determine whether the integration of culturally contextualized games could significantly improve conceptual mastery. The results of this comparison are summarized in Table 3.

Table 3*Paired t-test results for pre-test and post-test assessment scores*

Topics	Pre-Test					Posttest				
	No. Of items	No. Of Points	Weighted Mean	PL (%)	Interpretation	Weighted Mean	PL (%)	Interpretation	Effect Size	Interpretation
Vector and Scalar Quantity	5	15	10.31	69	NM	13.88	93.0	FM	2	L
Acceleration	10	30	2.6	9	NoM	25.59	85.0	NFM	3	L
Projectile Motion	10	20	12.18	41	LM	22.84	76.0	M	2	L
Newton's Law of Motion	10	20	7.31	24	NoM	26.43	88.0	NFM	3	L
Collisions	5	15	4.41	29	LM	11.97	80.0	M	2	
Overall Mean	40	120	36.8	31	LM	100.71	84.0	NFM	3	L
Sd			3.98				6.8			
p-value	0.012									

*Note: *** significant at 0.05 level**PL= Performance Level; NoM= No Mastery; LM= Low Mastery**NM= Near Mastery; M= Mastery; NFM= Near Full Mastery**FM= Full Mastery*

The results presented in Table 3 reveal compelling evidence for the potential of culturally contextualized, game-based learning in enhancing conceptual understanding of physics among Senior High School students. Prior to the intervention, learners exhibited markedly low mastery across all five targeted topics—scalar and vector quantities, acceleration, projectile motion, Newton's laws of motion, and collisions—with an overall pre-test performance level of 36.8%, categorized as Low Mastery (LM) under Department of Education benchmarks. Most notably, students demonstrated No Mastery (NoM) in acceleration and Newton's laws, with pretest scores of 9% and 24%, respectively.

These results echo long-standing national trends documented by DepEd, (2019), which identified mechanics as persistently underperformed domains in Philippine physics education. Similar difficulties have been observed internationally, as in Saleh (2012), who found that Newtonian mechanics remains one of the least understood areas among secondary students due to its abstract and counterintuitive nature.

Following the implementation of the Laro-ng-Lahi Physics Games, students' post-test scores improved significantly, with the overall mean rising to 100.71%, interpreted as Near Full Mastery (NFM). All five topics showed substantial gains, with acceleration increasing from 9% to 85%, and Newton's laws from 24% to 88%. These improvements reflect not only numerical growth but a qualitative shift in learners' conceptual grasp of physics principles. The corresponding p-value of 0.012 confirms that the observed differences are statistically significant at the 0.05 level. Moreover, the effect sizes, ranging from 2 to 3 across all topics, fall within the "large" category based on Cohen's (1988) guidelines. This suggests that the intervention may influence student learning, far beyond what would be expected from conventional instruction alone.

The pedagogical significance of these results lies in the interplay of cultural relevance, embodied cognition, and multimodal engagement. The Laro-ng-Lahi activities provided learners with experiential access to physics concepts through physical play and culturally familiar contexts. This is particularly important in physics education, where traditional lecture-based delivery often fails to translate abstract principles into meaningful learning experiences for students. As Alsalmi et al. (2022) argue, educational games that incorporate visual, kinesthetic, and collaborative elements can significantly enhance learners' conceptual clarity and engagement.

The integration of Filipino traditional games—such as *Siyato*, *Sipà*, and *Tumbang Preso*—enabled students to visualize projectile motion, acceleration, and Newtonian mechanics not as abstract formulas, but as tangible, observable, and relatable phenomena. The present findings resonate with prior research (e.g., Lasala Jr. et al., 2025b), which demonstrated that interactive, well-validated learning tools grounded in learning science can significantly enhance conceptual mastery. While BESMART focused on digital delivery, and this study on embodied cultural play, both point to the value of design-informed, student-centered learning innovations in science education.

These findings are also consistent with the broader framework of culturally responsive pedagogy (Gay, 2010; Ladson-Billings, 1995), which underscores the value of grounding instruction in the cultural experiences and cognitive styles of learners. Morales (2014) demonstrated, for instance, that embedding indigenous knowledge systems into science instruction improves student motivation and deepens their understanding. The results of the current study affirm this assertion: students were not only more engaged but also more accurate in applying physics concepts after interacting with the games, suggesting that cultural familiarity facilitated cognitive assimilation.

Furthermore, the intervention advanced the principles of constructivist learning by positioning students as active participants in the meaning-making process. Learning through

Laro-ng-Lahi required learners to hypothesize, test, observe, and reflect—a learning cycle aligned with Vygotsky’s (1978) sociocultural theory and supported by research in game-based inquiry (Tham & Tham, 2012; Karamustafaoğlu & Coşgun, 2021). The games also promoted collaborative problem-solving, reinforcing the role of peer dialogue and shared meaning-making in conceptual development.

In addition to instructional value, the games served as diagnostic tools. Embedded assessments and student journal reflections captured both cognitive and affective dimensions of learning, enabling real-time feedback and metacognitive monitoring. This dual function aligns with recent calls for assessment as learning, where the process of engagement itself becomes a site for both learning and evaluation (Bybee et al., 2006).

Despite the promising outcomes, certain limitations must be acknowledged. The study utilized a quasi-experimental one-group pretest-posttest design without a control group, which limits causal inferences. Additionally, the implementation was conducted in a localized setting within the Bicol Region, and while the results offer strong internal validity, their external generalizability remains constrained. Lastly, although subject matter experts validated the instructional materials, the absence of curriculum developers from the evaluation process represents a potential oversight in aligning materials with broader systemic goals.

Nevertheless, the implications are far-reaching. The study demonstrates that contextualized, game-based strategies rooted in local culture can produce not only statistically significant outcomes but also meaningful educational experiences. This approach directly addresses the challenges of abstract content, low engagement, and achievement disparities in science education. In doing so, it contributes to the discourse on inclusive and decolonized pedagogies, offering a viable and scalable model for transformative STEM instruction in multicultural contexts, such as the Philippines.

Conclusion

This study developed, validated, and implemented a culturally contextualized set of Physics instructional materials integrating *Laro-ng-Lahi*, or traditional Filipino games, as tools for enhancing students’ conceptual understanding. The activities were aligned with Grade 11 physics competencies and structured around DepEd’s MELCs and LRMDs standards, ensuring both technical rigor and pedagogical relevance. Each game was thoughtfully redesigned to model core physics principles—such as motion, force, and energy—through embodied, kinaesthetic engagement, bridging scientific abstraction with everyday cultural experiences.

The validation phase confirmed the instructional quality of the Physics Games. Expert raters evaluated the materials as highly satisfactory across four criteria: content accuracy,

format and design, presentation and organization, and currency of information. Student respondents echoed these findings, emphasizing the games' clarity, relevance, and capacity to foster engagement and reflection. The implementation phase yielded statistically significant learning gains, as evidenced by a marked improvement in pretest and post-test scores. These results confirm the effectiveness of Laro-ng-Lahi-based activities in promoting conceptual change and meaningful learning in physics.

Despite the promising outcomes, the study is limited by its small sample size and localized context, which focus on a single Grade 12 STEM class in one public senior high school. Therefore, generalizations should be made with caution beyond similar contexts. Nonetheless, the findings provide robust support for the use of traditional games as a culturally responsive and learner-centered pedagogical strategy in science education.

Future research is encouraged to replicate and expand upon this work by adapting *Laro-ng-Lahi* to other grade levels, science topics, or learner populations, particularly in junior high school settings. Furthermore, integrating principles from constructivist and sociocultural learning theories in future instructional designs can deepen the impact of game-based learning interventions. As education systems seek innovative ways to localize curriculum and personalize learning, the Laro-ng-Lahi Physics Games present a compelling model that unites cultural heritage, curriculum standards, and conceptual rigor.

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