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Development and Validation of Improvised Indigenous Devices in Teaching Physics

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Abstract
Aim: The study aimed to develop and validate Improvised Indigenous Devices (IIDs) for selected topics in Physics, specifically targeting the least-learned competencies in Grade 7 Physics for indigenous students. It sought to improve the understanding of core Physics concepts while integrating cultural elements relevant to the indigenous learners in Bislig City Division.
Methodology: This developmental research used the Engineering Design Process (EDP), Analysis, Design, Development, Implementation and Evaluation (ADDIE) instructional model, and Grassroots Innovation Scheme (GRIND) to create the IIDs. Validation of the devices' validity, usability, acceptability was conducted through Likert Scale surveys from both teachers and learners.
Results: The validation indicated strong support from teachers and learners for the devices' educational validity or accuracy, usability, and cultural relevance.
Conclusion: The improvised indigenous devices (IIDs) successfully blended core physics concepts with local cultural elements, giving students hands-on, culturally resonant models for topics from waves to capacitor charging. Both teachers and learners rated the devices highly for validity or accuracy, usability and acceptability, These results highlight the IIDs' strong potential as scalable, effective tools for enriching physics education
Keywords: *Improvised Indigenous Device, Physics, Culturally-responsive education*

INTRODUCTION

Physics has commonly been perceived as one of the most challenging subject areas within science education (Gaurina et al., 2025). Many learners struggle to understand its abstract concepts, which are essential for the development of reasoning, problem-solving skills, and critical thinking (Faridi, et al., 2021). This struggle is reflected in low academic performance in Physics globally, with studies showing a significant challenge in grasping fundamental principles, especially among indigenous students. As reported by Assem et al. (2023), the learning gap in Physics has become a pressing issue worldwide, further exacerbated in the Philippines (Diate & Mordeno, 2021). This issue is particularly prevalent among indigenous Filipino students, as research shows that they often face unique barriers that impede their learning in science (Govender & Mudzamiri, 2021).

One of the major factors contributing to these challenges is the lack of access to adequate and culturally relevant teaching materials. For indigenous learners, educational content that aligns with their cultural experiences and identities is critical for engagement and success. Abad (2020) emphasized the importance of culturally appropriate teaching materials for indigenous students, arguing that these materials can help bridge the gap in performance, especially in subjects like Physics. However, a shortage of such resources often leads to poor academic performance, particularly in subjects that require hands-on learning experiences, such as Physics (Antwi et al., 2021).

Research highlights the importance of instructional materials that are both culturally relevant and effective in enhancing students' learning outcomes (Niyitanga et al., 2021). Improvised Indigenous Devices (IIDs) have emerged as a promising solution to address this gap. These devices are crafted from locally available materials, infused with indigenous knowledge and practices, making them culturally relevant and pedagogically sound for indigenous learners. Studies by Mashoko (2022) and Bulla et al. (2024) demonstrate that such improvised tools can improve engagement, understanding, and interest in Physics education by connecting abstract concepts to students' lived experiences.

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The Philippines, with its rich cultural diversity, offers a unique opportunity to develop educational tools that are culturally resonant. IIDs offer an innovative approach to teaching Physics by integrating indigenous cultural elements—such as symbols, narratives, and local materials—into the learning process. This approach not only enhances students' understanding of Physics but also strengthens their cultural identity. Studies show that culturally responsive teaching (CRT) can significantly improve students' academic success, motivation, and personal growth (Highfield et al., 2024). According to Lowe et al. (2021), integrating indigenous practices in education boosts students' sense of identity and cultural connection, which in turn fosters greater motivation and academic performance.

The need for culturally relevant teaching tools is underscored by the success of Culturally Responsive Teaching (CRT) approaches in other educational contexts (Gorecki & Doyle-Jones, 2021). This study posits that Improvised Indigenous Devices (IIDs) can serve not only as educational tools but also as instruments for cultural preservation, allowing indigenous students to engage with scientific content while preserving and promoting their cultural heritage. This approach aligns with McCarty and Brayboy's (2021) assertion that CRT has an important role in promoting social justice in education, particularly in fields like Physics, which are traditionally perceived as difficult for underrepresented students.

This study explores the development and validation of IIDs as tools for teaching Physics to Grade 7 indigenous learners in the Bislig City Division, specifically targeting the least learned competencies. By integrating indigenous perspectives in science education, this research contributes to the growing body of knowledge on culturally responsive teaching practices, offering a model for other regions with similar educational and cultural challenges. The ultimate goal is to bridge the gap between indigenous students' cultural experiences and the academic content of Physics, providing an educational approach that is both academically effective and culturally empowering.

Statement of the Problem

The study aimed to validate the Improvised Indigenous Devices (IID) in selected topics in Physics. Specifically, it sought to answer the following:

1. What are the developed IID on the selected topics on teaching Physics based on the least learned competencies?
2. What is the level of validity of the IID as perceived by the two groups of respondents as to:
   2.1 Accuracy;
   2.2 Usability; and
   2.3 Acceptability?

METHODS

Research Design

This study employed a developmental research design, focusing on the creation and validation of Improvised Indigenous Devices (IIDs) for teaching Physics. This design is particularly suitable for developing educational tools and refining them through testing and validation to ensure they meet the desired educational outcomes.

Population and Sampling

The study's respondents were divided into two main groups: Physics teachers and Grade 7 indigenous learners. The teachers were selected from the Bislig City Division, consisting of permanent public school Physics teachers with experience in teaching Physics. Indigenous learners from San Isidro National High School and Mone National High School, both Indigenous Peoples Education (IPED) schools in Bislig City, were also included as respondents, with a focus on students from the Manobo and Mandaya tribes. These learners were chosen based on their enrollment and participation in the Grade 7 Physics curriculum.

Instruments

The primary instruments used in this study were survey questionnaires designed to assess the usability, acceptability, and validity or accuracy of the Improvised Indigenous Devices (IIDs). The survey was administered to both teachers and learners to gather feedback on the device's performance, cultural relevance, and effectiveness in

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improving academic outcomes. The survey included Likert-scale items that allowed respondents to rate the device's effectiveness based on their experiences.

Data Collection

Data collection was carried out in several phases. Initially, teacher validation occurred, where the usability, acceptability, and validity or accuracy of the Improvised Indigenous Devices (IIDs) were assessed by the Physics teachers from Bislig City Division. After teacher validation, the IID was implemented in the classroom setting at San Isidro National High School and Mone National High School, where Grade 7 indigenous learners used the device as part of their Physics lessons. Following the classroom implementation, learner validation was conducted, where both teachers and students provided feedback on the device's validity, usability, and acceptability. This phased approach ensured that feedback was gathered from all key stakeholders involved in the study.

Data Analysis

Data analysis in this study focused on the quantitative evaluation of the Improvised Indigenous Devices (IIDs) based on their validity, usability, and acceptability. Survey data collected from both teachers and learners were analyzed using descriptive statistics. Specifically, measures such as the mean, standard deviation, and frequency distribution were used to summarize the responses obtained through a five-point Likert scale. This scale assessed the extent of agreement or disagreement with various indicators related to the quality and appropriateness of the IIDs. The analysis aimed to determine the overall reception of the developed devices, particularly how well they aligned with educational standards and cultural contexts. By quantifying stakeholders' perceptions, the study was able to assess the strengths and areas for improvement of the IIDs in a systematic manner. This approach ensured an objective basis for evaluating the devices' educational relevance and user satisfaction, which is essential in developmental research involving culturally rooted instructional materials.

Ethical Considerations

Informed consent was obtained from all participants, including teachers and students, ensuring they were fully aware of the study's purpose and procedures. Confidentiality was maintained throughout the research process, and the data was anonymized to protect participants' identities. Additionally, the study adhered to ethical guidelines by ensuring that the participation of indigenous learners was voluntary, with an emphasis on cultural sensitivity and respect for the indigenous community's traditions and values.

RESULTS and DISCUSSION

Developed IID in Selected Topics in Physics

The Improvised Indigenous Devices (IIDs) were developed to help students grasp complex Physics concepts while integrating cultural knowledge. IID 1: The Transverse vs. Longitudinal "Wave Device" demonstrates the difference between transverse and longitudinal waves using bamboo, abaca rope, and coconut shells, inspired by the Manobo and Mandaya tribes' cultural heritage. This device offers a culturally enriched way to understand wave behavior by combining scientific principles with indigenous storytelling. IID 2: The Characteristics of Sound Device helps students understand the relationship between wavelength, velocity, and amplitude in sound waves. Using a seesaw mechanism made of bamboo and coconut shells, the device visually represents how amplitude and velocity are related and inversely linked to wavelength, with cultural connections through a traditional riddle about balance. IID 3: The Brightness of Light Model Device illustrates how light intensity decreases with distance by using bamboo and indigenous materials to demonstrate the scattering of light from a distant source and its concentration when close. The device connects this scientific principle to the Manobo and Mandaya tribes' cultural belief that light originates from the heavens. IID 4: The Frequency vs. Wavelength Device uses a seesaw model to show the inverse relationship between frequency and wavelength in light waves, incorporating cultural folklore to explain the interaction of these scientific concepts in an indigenous context. IID 5: The Heat Transfer Device teaches students about the conditions for heat transfer and the direction of energy flow. The device uses materials representing hot and cold temperatures, linked to the numerology and balance symbols of the Manobo and Mandaya tribes, to make the concept of heat transfer more relatable. IID 6: The Charging Device demonstrates charging by friction using coconut husks with positive and negative charges, showing how opposite charges attract and like charges repel. The device blends indigenous spiritual beliefs, associating positive charges with masculinity and activity, and negative

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charges with femininity and passivity. IID 7: The Charging and Discharging Device illustrates the process of charging and discharging through a capacitor, using a stone to represent negative charge. The design integrates cultural numerology to symbolize the accumulation, movement, and release of energy, offering an immersive learning experience that connects scientific and cultural principles.

Validation of the IID in terms of vaidity/ accuracy, usability and acceptability

The developed IIDs were subjected to validation, which is the process of assessing the accuracy, effectiveness, and appropriateness of the device.

Table 1. Mean of Teacher and Learner Validation on the Accuracy/Validity of Improvised Indigenous Devices

Validation Indicators	Weighted Mean						
	IID 1 Wave Device	IID 2 Sound Device	IID 3 Brightness Device	IID 4 Frequency vs. Wavelength Device	IID 5 Heat Transfer Device	IID 6 Charging Device	IID 7 Charging and Discharging Device
The Improvised Indigenous Device (IID) effectively addresses the identified problem or need.	**4.90**	**4.85**	**4.89**	**4.89**	**4.90**	**4.87**	**4.89**
The design and functionality of the IID align with the defined objectives and specifications.	**4.92**	**4.89**	**4.91**	**4.85**	**4.86**	**4.83**	**4.89**
The scientific and engineering principles employed in the IID's development are sound.	**4.83**	**4.89**	**4.90**	**4.85**	**4.89**	**4.86**	**4.84**
The IID incorporates accurate and reliable measurements or data collection mechanisms.	**4.83**	**4.88**	**4.91**	**4.93**	**4.91**	**4.96**	**4.94**
The results or outcomes obtained from	**4.87**	**4.89**	**4.88**	**4.92**	**4.89**	**4.92**	**4.90**

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using the IID are consistent and dependable							
The objectives and learning outcomes of the IID are clearly defined and aligned with the ADDIE model.	**4.89**	**4.80**	**4.85**	**4.86**	**4.86**	**4.84**	**4.81**
The IID's content and materials are accurate, reliable, and scientifically sound	**4.92**	**4.90**	**4.96**	**4.93**	**4.95**	**4.90**	**4.86**
Average Weighing Mean	**4.88**	**4.87**	**4.90**	**4.89**	**4.90**	**4.88**	**4.88**
Description	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**

The validation results obtained from both teachers and learners demonstrate that all seven Improvised Indigenous Devices (IIDs) achieved exceptionally high levels of validity and accuracy across every indicator, with average weighted means ranging narrowly from 4.87 to 4.90 (Strongly Agree). Notably, the Wave (IID 1), Brightness (IID 3), and Heat Transfer (IID 5) devices attained the highest overall means (4.90), reflecting particularly strong performance in content accuracy and measurement reliability. Each device was uniformly affirmed as effectively addressing its instructional objective (mean 4.85–4.90) and as being grounded in sound scientific and engineering principles (mean 4.83–4.90). The alignment of design and functionality with predetermined objectives and specifications was also rated very highly (mean 4.83–4.92). The only modest variance appeared in the linkage of learning outcomes to the ADDIE model, where IID 2 recorded the lowest mean (4.80)—which nevertheless remains within the "Strongly Agree" range. Collectively, these consistently elevated scores confirm that the IIDs provide accurate measurements, yield dependable results, and offer pedagogically valid tools for the effective teaching of key physics concepts.

Table 2. Mean of Teacher and Learner Validation on the Usability of Improvised Indigenous Devices

Validation Indicators	**Weighted Mean**						
	IID 1 Wave Device	**IID 2 Sound Device**	**IID 3 Brightness Device**	**IID 4 Frequency vs. Wavelength Device**	**IID 5 Heat Transfer Device**	**IID 6 Charging Device**	**IID 7 Charging and Discharging Device**
The IID is user-friendly and intuitive, requiring minimal training or instruction	**4.93**	**4.88**	**4.79**	**4.85**	**4.90**	**4.92**	**4.78**

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The device's controls, interfaces, and displays are clear and easily understandable	**4.87**	**4.87**	**4.84**	**4.90**	**4.91**	**4.90**	**4.77**
The IID provides accurate and timely feedback or information to the user	**4.88**	**4.81**	**4.89**	**4.90**	**4.91**	**4.95**	**4.87**
The IID can be operated efficiently and effectively by the intended users	**4.92**	**4.86**	**4.87**	**4.93**	**4.95**	**4.99**	**4.94**
The IID is adaptable and can be customized to meet specific user requirements	**4.90**	**4.85**	**4.86**	**4.88**	**4.93**	**4.95**	**4.94**
The IID is easy to use and operate	**4.95**	**4.89**	**4.87**	**4.89**	**4.95**	**4.92**	**4.80**
The IID provides clear instructions and guidance for its proper utilization	**4.89**	**4.89**	**4.92**	**4.93**	**4.95**	**4.92**	**4.80**
The IID offers an engaging and interactive learning experience	**4.83**	**4.82**	**4.88**	**4.94**	**4.92**	**4.89**	**4.75**
Average Weighing Mean	**4.90**	**4.86**	**4.97**	**4.90**	**4.93**	**4.93**	**4.83**
Description	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**

Both teachers and learners concurred that all seven improvised indigenous devices (IIDs) for Physics 7 are highly usable, as every usability indicator received a descriptive rating of "Strongly Agree" with weighted means well above 4.5 (on a 5-point scale) and overall device means ranging from 4.83 to 4.97. Among the indicators, the respondents most emphatically endorsed the ease and efficiency of operation: the Charging Device posted the study's single-highest mean (4.99) for the statement "The IID can be operated efficiently and effectively by the intended users," while similar scores (≥ 4.95) were recorded for "easy to use and operate," "adaptable and customizable," and "accurate and timely feedback" across several devices. User-friendliness and intuitive design, clarity of controls and displays, and the provision of clear instructional guidance also garnered uniformly strong agreement (typically 4.87–4.95). Even the comparatively lowest-rated item—the Charging and Discharging Device's engaging-and-interactive indicator at 4.75—still fell well within the "Strongly Agree" band, underscoring that both

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faculty and students view the IIDs as intuitive, reliable, and pedagogically engaging tools that can be deployed with minimal training yet offer flexible, accurate, and interactive support for conceptual learning in Grade 7 physics.

Table 3. Mean of Teacher and Learner Validation on the Acceptability of Improvised Indigenous Devices

Validation Indicators	Weighted Mean						
	IID 1 Wave Device	IID 2 Sound Device	IID 3 Brightness Device	IID 4 Frequency vs. Wavelength Device	IID 5 Heat Transfer Device	IID 6 Charging Device	IID 7 Charging and Discharging Device
The IID meets the expectations and needs of the users.	4.92	4.84	4.93	4.92	4.93	4.97	4.92
The IID is perceived as a valuable tool in the field of engineering or physics	4.89	4.91	4.90	4.92	4.92	4.97	4.93
The IID is compatible with existing systems or technologies used in the field.	4.89	4.88	4.90	4.95	4.93	4.91	4.88
The IID is considered a practical and cost-effective solution.	4.91	4.88	4.92	4.84	4.91	4.93	4.91
The IID is likely to be adopted and embraced by the Engineering or Physics community.	4.95	4.91	4.92	4.89	4.92	4.90	4.87
As a Teacher/Learner, I would recommend the IID for educational purposes.	4.94	4.89	4.88	4.89	4.93	4.83	4.84
The IID aligns well with the principles of the ADDIE model and the Engineering Development Process (EDP).	4.91	4.87	4.92	4.93	4.90	4.86	4.85
Average	4.92	4.88	4.91	4.91	4.92	4.91	4.89

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Weighing Mean							
Description	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**	**Strongly Agree**

Both teachers and students rated every improvised indigenous device (IID) for Physics 7 as highly acceptable, with overall means tightly clustered between 4.88 and 4.92—squarely within the "Strongly Agree" range on the 5-point scale—showing no meaningful drop-off across the seven devices. The strongest endorsement centered on utility: the Charging Device registered the study's top score (4.97) for "meets the expectations and needs of the users," and matched that high for being "perceived as a valuable tool," while all other devices remained at 4.84 or above on both indicators. Respondents likewise affirmed that the IIDs are "practical and cost-effective" and "compatible with existing technologies" (4.84–4.95), signaling confidence in day-to-day classroom or laboratory integration. Future uptake also looks promising: ratings for "likely to be adopted by the engineering or physics community" and for personal recommendation ("As a Teacher/Learner, I would recommend…") stayed robust (≥ 4.83), underscoring enthusiastic word-of-mouth potential. Finally, alignment with best-practice frameworks—ADDIE and the Engineering Design Process—drew firm agreement (≥ 4.85), suggesting the devices not only fit instructional needs but also adhere to systematic design standards. Taken together, these convergent ratings show that both stakeholder groups regard the IIDs as valuable, cost-sensible, and readily adoptable teaching tools that satisfy curricular, technological, and professional expectations.

Conclusions

The development and implementation of Improvised Indigenous Devices (IIDs) contributed to the improvement of Physics education by integrating scientific principles with indigenous cultural elements. Validation results from both teachers and students indicated that the devices were valid or accurate, usable, acceptable, and aligned with the educational needs of the target learners. The study highlights the importance of utilizing culturally relevant instructional tools to support the learning of Physics concepts among indigenous students, reinforcing the role of localized educational materials in promoting contextualized and meaningful instruction.

Recommendations

It is recommended that Improvised Indigenous Devices (IIDs) be integrated into the Physics curriculum in areas with indigenous populations to enhance learning by connecting scientific concepts with cultural heritage. Teachers should receive additional training on effectively using IIDs to maximize their impact. Future research should explore the long-term effects of IIDs on student performance and expand their use to other subjects.

REFERENCES

Abad, P. (2020). Improving academic performance among indigenous learners: The role of culturally appropriate materials. *Journal of Education and Development*, *18*(2), 45-57. https://www.researchgate.net/publication/361827985_Designing_a_Contextualized_and_Culture-Based_Reading_Material_for_Indigenous_Learners

Antwi, V., Sakyi-Hagan, N. A., Addo-Wuver, F., & Asare, B. (2021). Effect of practical work on physics learning effectiveness: A case of a senior high school in Ghana. *East African Journal of Education and Social Sciences*, *2*(3), 43 – 55. https://doi.org/10.46606/eajess2021v02i03.0102

Assem, H., Faridi, A., & Kowalski, M. (2023). Global performance trends in physics education: Insights from recent studies. *International Journal of Science Education*, *29*(5), 73-88. https://doi.org/10.24018/ejedu.2023.4.1.551

Bulla, M. A., Oliviera, T., Franco, M. K. K. D., & Yokaichiya, F. (2024). Cronpes: time measurement device suitable for teaching experimental physics in Brazil. *Physics Education*, *59*(6), 065002. https://doi.org/10.1088/1361-6552/ad6d23

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Diate, K., & Mordeno, I. C. V. (2021). Filipino Physics teachers' teaching challenges and perception of essential skills for a supportive learning environment. *Asia Research Network Journal of Education*, *1*(2), 61–76. https://so05.tci-thaijo.org/index.php/arnje/article/view/251765

Faridi, H., Tuli, N., Mantri, A., Singh, G., & Gargrish, S. (2021). A framework utilizing augmented reality to improve critical thinking ability and learning gain of the students in Physics. *Computer Applications in Engineering Education*, *29*(1), 258-273 https://doi.org/10.1002/cae.22342

Gaurina, M., Alajbeg, A., & Weber, I. (2025). The power of play: Investigating the effects of gamification on motivation and engagement in physics classroom. *Education Sciences, 15*(1), 104. https://doi.org/10.3390/educsci15010104

Gorecki, L., & Doyle-Jones, C. (2021). Centering voices: Weaving Indigenous perspectives in teacher education. *The Canadian Journal of Action Research*, *21*(3), 115-141. https://doi.org/10.33524/CJAR.V21I3.536

Govender, N., & Mudzamiri, E. (2021). Incorporating indigenous artefacts in developing an integrated indigenous-pedagogical model in high school physics curriculum: Views of elders, teachers and learners. *Cultural Studies of Science Education, 17*(3), 827-850. https://doi.org/10.1007/s11422-021-10076-2

Highfield, C., Webber, M., & Woods, R. (2024). Teacher and Middle Leader Perceptions of Culturally Responsive Middle Leadership Practices and Their Ability to Meet the Needs of Māori Students in New Zealand Secondary Schools. *New Zealand Journal of Educational Studies*, *59*(1) 1-16. https://doi.org/10.1007/s40841-024-00366-y

Lowe, K., Tennent, C., Moodie, N., Guenther, J., & Burgess, C. (2021). School-based Indigenous cultural programs and their impact on Australian Indigenous students: a systematic review. *Asia-Pacific Journal of Teacher Education*, *49*(1), 78-98. https://doi.org/10.1080/1359866X.2020.1843137

Mashoko, D. (2022). Indigenous artefacts and physics curriculum: teaching science as a cultural way of knowing. *Cultural Studies of Science Education*, *17*(3), 863-874. https://doi.org/10.1007/s11422-021-10085-1

McCarty, T. L., & Brayboy, B. M. J. (2021). Culturally responsive, sustaining, and revitalizing pedagogies: Perspectives from Native American education. *In The Educational Forum 85*(4), 429-443. https://doi.org/10.1080/00131725.2021.1957642

Niyitanga, T., Bihoyiki, T., & Nkundabakura, P. (2021). Factors affecting use of practical work in teaching and learning physics: assessment of six secondary schools in Kigali city, Rwanda. *African Journal of Educational Studies in Mathematics and Sciences*, *17*(1), 61-77. https://doi.org/10.4314/ajesms.v17i1.4