INTEGRATION OF INDIGENOUS KNOWLEDGE SYSTEMS IN IMPROVING GRADE 9 INDIGENOUS PEOPLE STUDENTS' PERFORMANCE IN PHYSICS

Elgemar I. Mindoro*, Jemma Rose P. Baylon, Joycel I. Candelario, Vheean H. Moreno, Efren Mae E. Warain, Benjamin B. Cerezo II
Bachelor of Secondary Education major in Science
College of Teacher Education
Occidental Mindoro State University
**mindoroelgemar916@gmail.com*

ABSTRACT

Physics instruction for Indigenous People (IP) students often follows Western format which lacks cultural relevance for them, resulting in low engagement and poor performance. While the integration of Indigenous Knowledge Systems (IKS) has shown benefits in other scientific disciplines, there is still limited empirical evidence of its effectiveness in Physics. This study addresses the gap by examining the effectiveness of integrating IKS in improving the performance of the Grade 9 IP students in work, power, and energy. A quasi-experimental pre-test and post-test design were utilized to the 30 IP students from Cabugao National High School which were evenly assigned to control (Conventional Teaching Method) and experimental (IKS-integrated) groups. A validated 15-item researcher-made test measured the change in their performance. Mann-Whitney Test was used to analyze for group comparisons and the Wilcoxon Signed-Ranks Test for the differences within the groups. Pre-test results revealed no significant difference between the two groups, ensuring baseline equivalence. Post-test results, on the other hand, revealed that both groups improved significantly, however, the experimental group attained higher mean scores than the control group, attaining a significant post-test difference. Both methods were effective but the IKS-integrated approach showed higher improvement gains and reduced performance variability, indicating an equitable learning experience, aligning with research showing that indigenized and culturally contextualized lessons significantly improved the performance of the IP students compared to conventional teaching methods. The study concludes that integrating IKS into Physics lessons, particularly work, power, and energy significantly improved the performance of the IP students.

Keywords: *indigenous knowledge systems, physics education, indigenous people (ip) students, work, power, and energy, quasi-experimental design*

SDG: *SDG 4 – Quality Education*

INTRODUCTION

Incorporating Indigenous Knowledge Systems (IKS) in science education particularly in Physics still remains a significant challenge, as many educators still face a lack of engagement that hinders effective learning and good performance in students, specifically the indigenous students. Since Physics is most of the time taught in abstract, mathematical, and Western frameworks, Indigenous People (IP) students may find that these teaching approaches are disconnected from their lived experiences and results in low academic engagement and poor academic performance (Buenaflor et al., 2023). This educational disconnect calls for a more culturally responsive approach that bridges the cultural knowledge of the IP students with formal scientific concepts.

The integration of Indigenous Knowledge Systems and Practices (IKSPs) on integrated Science identified that IKSPs were found to be effective in teaching the different Science subjects including Integrated Biology, Integrated Science, and Chemistry (Donato-Kinomis, 2016; Tawanda & Mudau, 2024) while Physics still lacks empirical data that demonstrates how IKS can improve the performance among IP students.

Paquin (2023) suggests that student performance improves when curriculum content aligns with the cultural experiences of students. In Indonesia, Dewi et al. (2022) elaborated that the integration of IKS inside the classroom reflects the local values and promotes intercultural competence. Moreover, involving the students' actively in scientific practices and maintaining their academic interest is important (Habig and Gupta, 2021).

Locally, Moro and Billote's (2023) research on the integration of indigenous Ivatan games into Physics learning modules investigated its impact on the student's comprehension, motivation, and scientific sublime. Their study revealed that students engaged in culturally integrated activities experienced joy and nostalgia with relatable learning experiences. However, the integration was not too effective in promoting the scientific sublime, a term denoting the capacity of the students to appreciate the beauty and interconnectedness of scientific principles, which is essential for improving the engagement and comprehension in Physics.

Cabugao National High School (CNHS), located in Bulalacao, Oriental Mindoro, a school where most of the students belong to indigenous communities, including the Hanunuo Mangyan, a well-known indigenous group in the region. The school has made meaningful efforts in integrating IKS into their curriculum aiming to acknowledge the cultures and traditional practices of the community as important learning sources. In recent years, CNHS has integrated IKS in Science subjects, where traditional ecological and local environmental practices are aligned with scientific concepts. Various scientific disciplines like Astronomy and Earth and Life Sciences were evidently effective when it was being integrated by IKS however Physics still lacks empirical data to show the effectiveness of integrating IKS in improving the performance of the IP students. Physics, unlike other scientific disciplines, most of the time involves abstract and mathematical representations of phenomena, such as forces, motion, and energy transfer, topics that can be challenging for students to conceptualize. For indigenous students, this difficulty is worsened by the lack of culturally relevant analogies and examples (Badruldin and Alias, 2022).

This study examined the effectiveness of integrating IKS in improving the Grade 9 indigenous people (IP) students' performance in Physics. Specifically, this study aimed to determine the level of performance of the IP students in Physics as measured by the pre-test, establish homogeneity between the pre-test results of the IP students in the control group and the experimental group, determine the level of performance of the IP students in Physics as measured by the post-test, identify the significant difference between the level of performance of the IP students in Physics in the pre-test and in the post-test of the control group, identify the significant difference between the level of performance of the IP students in Physics in the pre-test and in the post-test of the experimental group, and examine the significant difference between the level of performance of the IP students in Physics in the post-test of the control group and experimental group.

METHOD

Research Design

This study utilized a quasi-experimental design with pre-tests and post-tests to examine the effects of integrating indigenous knowledge systems into Physics instruction to improve the performance of the IP students. To ascertain the effectiveness of integrating IKS in improving the Physics performance of the Grade 9 IP students was the primary objective of this methodology.

Study Site

This research was conducted at Cabugao National High School located in Cabugao, Bulalacao, Oriental Mindoro during the school year 2024 – 2025. The school is at the southern-most part of Cabugao and mostly caters to indigenous people students.

Sample

The respondents of this study were the Grade 9 IP students of Cabugao National High School during the fourth quarter of the School Year 2024-2025. The researchers utilized two instructional set ups: one employs conventional teaching methods and the other integrates IKS. The total population of students is 45 Grade 9 students with 23 students from section Loyalty, and 22 students from section Charity. From these sections, the researchers purposely selected 30 IP students as the sample of the study - the 15 IP students from section Loyalty composed the experimental group and the 15 IP students from the section Charity formed the control group.

Research Instrument

The researchers employed a self-made 15-item pre-test and post-test as valuable instruments of data gathering for the fourth quarter. To ensure validity of the tests, they underwent expert evaluation for content and face validity to align the items with the learning competencies and ensure clarity and appropriateness. To assess the knowledge of the IP students in Physics prior to instruction, a pre-test was administered to them. Additionally, to measure performance of the IP students in Physics after instruction, they took a post-test. To evaluate the performance of the IP students in Physics, the researchers used the mean scores obtained from the pre-test and the post-test results. A self-made scale was employed for this purpose, using verbal interpretations based on DepEd DO No. 8, Series of 2015 for grades and grading where mean score of 0 – 7.49 was interpreted as did not meet expectations, 7.50 – 9.49 as fairly satisfactory, 9.50 – 11.49 as satisfactory, 11.50 – 13.49 as very satisfactory, and 13.50 – 15 as outstanding.

Data Collection

Following administrative clearance from the National Commission on Indigenous Peoples (NCIP) and the school principal, Grade 9 Indigenous Participant (IP) students from Cabugao National High School were allocated into a control group (conventional instruction) and an experimental group (Indigenous Knowledge Systems [IKS]-integrated instruction). The intervention spanned five consecutive days (10 hours total; 5 hours per group). Day 1 involved student orientation and the distribution of parental informed consent forms. On Day 2, a 15-item pre-test evaluated baseline knowledge on mechanical energy. Subsequently, parallel 1-hour physics sessions were conducted daily (Control: 08:30–09:30; Experimental: 10:00–11:00). While both groups completed identical seatwork and baseline activities, instructional delivery differed: the control group utilized standard digital simulations (e.g., roller coasters) and conventional chalk-and-talk methods, whereas the experimental group interacted with localized cultural elements (e.g., a 3D Karosa Model, Darapugan, bow-and-arrow analogies, and traditional lighting technologies) to contextualize kinetic, potential, and conserved energy. On Day 5, a 15-item post-test was administered to measure performance gains across both instructional modalities.

Ethical Considerations

This study adhered to strict ethical protocols, particularly regarding the protection of minors and Indigenous Peoples (IP) communities. Institutional clearance was obtained from the National Commission on Indigenous Peoples (NCIP) and the school administration prior to data collection. Because participants were minors, parental or guardian written informed consent was secured alongside participant assent following a comprehensive orientation on research procedures, risks, and benefits. Participant autonomy and privacy were strictly maintained; participation was entirely voluntary, with guaranteed withdrawal rights at any stage without penalty. All data were anonymized, securely stored, and restricted to academic purposes. To ensure cultural integrity, local traditions and values were treated with mutual respect, and Indigenous Knowledge Systems (IKS) were integrated accurately and sensitively into the educational framework. The authors declare no conflicts of interest or financial ties influencing the study outcomes.

Data Analysis

Quantitative data were organized via spreadsheet software and analyzed using non-parametric statistical tools, as the dataset violated normality assumptions. Descriptive statistics, specifically mean and standard deviation, summarized the students' performance levels in physics (work, power, and energy). To evaluate the intervention, a Mann-Whitney U test was first used to assess baseline homogeneity between the control and experimental groups' pre-test scores. Within-group improvements from pre-test to post-test were evaluated using the Wilcoxon Signed-Rank test. Finally, a post-test comparison between the two groups was conducted using the Mann-Whitney U test to determine the relative effectiveness of the IKS-integrated instruction versus the conventional method.

RESULTS

Level of performance of the IP students before the intervention

Table 1 shows the level of performance in Physics of the IP students in the pre-test. The level of performance in Physics of the IP students in the pre-test, both in the conventional and experimental groups resulted as did not meet expectations. The control group had a mean score of 4.80, while the experimental group had a mean score of 4.00. The difference between the two groups was only 0.80 points.

Out of the 15 IP students in the control group, one achieved a score that was interpreted as fairly satisfactory, while 14 scored as did not meet expectations. In the experimental group, all 15 students obtained scores in the range of 0-7 which were considered as not meeting expectations.

Table 1. Level of performance of the IP students before the intervention.

Group	Mean	SD	Interpretation
Control	4.80	1.47	Did not meet expectations
Experimental	4.00	1.31	Did not meet expectations

Legend: 0.00-7.49=Did Not Meet Expectations; 7.50-9.49=Fairly Satisfactory; 9.50-11.49=Satisfactory; 11.50-13.49=Very Satisfactory; 13.50-15.00=Outstanding

Difference between the pre-test scores of the IP students from the two groups

The table 2 of a Mann-Whitney Test showed a z-value of 1.56, a p-value of .14 tested within the degrees of freedom (df = N − 2 = 28). Since the p-value is greater than the .05 level of significance, the difference in pre-test scores between the two groups is not significant. This suggests that both groups started with similar levels of understanding in Physics before the intervention.

Table 2. Difference between the pre-test scores of the IP students from the two groups.

Variables	z-value	p-value	Interpretation
Pre-test scores (control and experimental)	1.56	.14	Not Significant

Legend: p-value < 0.05 = significant

Level of performance of the IP students after the intervention

Table 3 shows the level of performance in Physics of the IP students in the post-test. The IP students instructed with the integration of IKS approach performed relatively higher than the IP students instructed through conventional teaching methods during the conduct of the post-test, as shown by the mean score of 13.20 (very satisfactory. Post-test results of students under the control group scored a mean of 10.67 (satisfactory).

Table 3. Level of performance of the IP students after the intervention.

Group	Mean	SD	Interpretation
Control	10.67	2.23	Satisfactory
Experimental	13.20	1.21	Very satisfactory

Legend: 0.00-7.49=Did Not Meet Expectations; 7.50-9.49=Fairly Satisfactory; 9.50-11.49=Satisfactory; 11.50-13.49=Very Satisfactory; 13.50-15.00=Outstanding

Difference between the performance of the IP students before and after being taught using conventional teaching method

Table 4 presents a Wilcoxon Signed Ranks Test which showed a significant difference in student performance between the two tests (z-value = 3.41, p-value = <.01).

Table 4. Difference between the pre- and the post-test scores of the IP students in the control group.

Variables	z-value	p-value	Interpretation
Pre and post test scores (control group)	3.41	<.01	Significant

Legend: p-value < 0.05 = significant

Difference between the performance of the IP students before and after being taught with the integration of IKS

Table 5 presents a Wilcoxon Signed Ranks Test which reveals a significant difference in student performance between the two tests (z-value = 3.45, p-value = <.01).

Table 5. Difference between the pre- and the post-test scores of the IP students in the experimental group.

Variables	z-value	p-value	Interpretation
Pre and post test scores (experimental group)	3.45	<.01	Significant

Legend: p-value < 0.05 = significant

Difference between the post-test scores of the IP students from the two groups

The table 6 showed significant differences between the post-test scores of the two groups were confirmed by the z-value of 2.99. Since the p-value is <.01.

Table 6. Difference between the post-test scores of the IP students from the two groups.

Variables	z-value	p-value	Interpretation
Post-test scores (conventional and intervention)	2.99	<.01	Significant

Legend: p-value < 0.05 = significant

DISCUSSION

Prior to the implementation of instructional interventions, both the control group (taught using conventional teaching methods) and the experimental group (taught with Indigenous Knowledge System (IKS)-integrated instruction) demonstrated low performance in the pre-test. The majority of students from both groups fell within the "Did Not Meet Expectations" category. Only one student from the control group achieved a "Fairly Satisfactory" rating. This low performance was generally due to the IP students' unfamiliarity with the topic as it had not yet been addressed in the curriculum. Pramesti et al. (2020) emphasizes that the students' misconceptions and lack of exposure to the Physics concepts affect their learning outcomes. Challenges in the teaching of the work-energy concept were identified in the study and were not restricted to one level of instruction. For example, there is always a difficulty among students in distinguishing the concept of energy as it is used in everyday language from the scientific use of the term. Many are unable to correctly identify the system and environment in work-energy processes, often confusing the sensation of physical exertion with the concept of mechanical energy. Wang (2022) also noted that traditional instruction often relies on rote memorization, which does not necessarily foster conceptual understanding or meaningful prior knowledge.

Assem et al. (2023) noted that Physics is considered as one of the branches of science that students find more challenging than Biology and Chemistry since it involves studying the universal laws, behavior and relationship among different physical phenomena, discovering and exploring the environment, and solving both theoretical and practical problems. This reinforces the observation of the IP students having low scores before the lesson was introduced.

Statistical analysis showed no significant difference in the pre-test scores between the control and the experimental groups. This is consistent with Zainuddin et al. (2024) who observed that students at the beginning are usually at the same level of prior knowledge, irrespective of the pedagogy used. Tong et al. (2023) classified the understanding of the students regarding the concepts of work, power and energy into novice, intermediate and expert. His study found that most students at the beginning were novice and did not have the requisite understanding to use concepts such as the work-energy theorem. Seifan et al. (2020) who also reported no meaningful differences between the groups on the pre-test scores from the same settings.

Using indigenous artifacts and knowledge is important in science teaching as a means of increasing relevance and learning (Govender and Mudzamiri, 2021). While traditional teaching methods also resulted in positive improvement because of its organized and theoretical base instruction (Almadrones and Tadifa, 2024), the application of IKS will result in higher positive learning outcomes in Physics (Moro and Billote, 2023). The performance of learners is also explained by Toli and Kallery (2021) who argued that the use of innovative teaching strategies that IKS includes, captures the learners' attention and enables them to learn the Physics concepts at a deeper level.

The traditional teaching methods can still result in positive and meaningful learning gains, particularly when this is applied properly who reported that in structured learning environments, these conventional pedagogies lead to positive student outcomes (Cordero et al., 2018). Moreover, CTM may also be beneficial in improving the performance of the IP students as implied by the positive learning gains. Khozaei et al. (2022) also stated that delivering the foundational content in science remains effective for these lecture-based approaches. Wang (2022) also stated that even though traditional lecture-style teaching is considered more boring than high-tech classrooms, it can be more effective at improving test scores. However, even though the test achievement of the IP students suggested that CTM yielded improvements, it still did not tackle the long-term recall which is very important for a comprehensive indigenous schooling.

Zidny and Eiks (2020) found that merging indigenous knowledge with Western Science enhances comprehension by connecting abstract concepts to the lived experiences of the students. IKS-integrated lessons as a learner-centered approach are necessary as Cinite and Barinovs (2021) stressed that in order to provide physics graduates with a good conceptual understanding of physics, a student-centered teaching approach is crucial. Paquin (2023) also supported this view, suggesting that aligning curriculum content with the cultural backgrounds of the learners can significantly improve the performance of the students. Therefore, integrating indigenous perspectives makes science more inclusive, allowing students from diverse cultural backgrounds to see themselves and their communities reflected in what they learn aligning with Ijatuyi, et al. (2025) stating that indigenous knowledge can act as a springboard for science knowledge to be put in traditional communities like the Hanunuo mangyan community to support their learning and growth and in the classroom, it might improve their interpretation of information leading to the improvement of the performance of the IP students.

Through closed-response assessments, the traditional teaching approaches dominated and remained effective in ensuring the content knowledge acquisition (Marcinauskas et al., 2024). Integrating indigenous knowledge into Physics instruction addresses the continuous issues of the poor performance in the subject and that students taught using indigenous knowledge-based strategies achieved better results than those taught using conventional means (Onyewuchi and Owolabi, 2022). This is further supported by Govender and Mutendera (2020) whose study reported that the IP students' instructional outcomes and performance improved when the teachers' instruction became more culturally connected and this only happened when the attitude of the teachers shifted from skepticism to appreciation of indigenous knowledge. These changes show the involvement of not just the students but also the teachers themselves to appreciate the transformative potential of integrating indigenous knowledge in education.

Limitations

Several limitations characterize this study and restrict the generalizability of its findings. First, the sample size was limited to 30 Grade 9 Indigenous Participant (IP) students from a single institution, which precludes broader generalizations to larger populations or diverse socio-economic school contexts. Second, the intervention was brief, spanning approximately 10 hours, limiting conclusions regarding the long-term retention or sustained impact of Indigenous Knowledge Systems (IKS) integration. Third, the curriculum was restricted to specific fourth-quarter Physics topics (work, power, and energy), meaning the outcomes may not apply to other science domains. Finally, student performance was evaluated exclusively via a researcher-made, 15-item pre- and post-test assessment; alternative instructional approaches, assessment modalities, and the isolated impact of individual indigenous elements were not explored.

CONCLUSIONS AND RECOMMENDATION

The study shows that the performance of the IP students prior to the discussion was generally poor. It was also found that the IP students from the control group and the experimental group were both struggling in Physics prior to the intervention. After the intervention, the Conventional Teaching Method (CTM) and IKS-integrated approach has shown effectiveness in improving the performance among the IP students in the control and experimental groups. Therefore, the study concluded that CTM was an effective mode for Physics instruction among the IP students. Moreover, the IKS-integrated approach showed that connecting scientific ideas to the cultural practices was also an effective approach for Physics instruction among the IP students. While both the Conventional Teaching Method and IKS-integrated approach showed effectiveness in improving the performance in Physics among the IP students in the control and the experimental groups, the integration of IKS was more effective in improving the Physics performance of the IP students compared to the CTM.

The study recommends the consideration of Indigenous Knowledge Systems (IKS) integration in Physics, particularly into the topic, work, power, and energy, as it showed an improved performance among the IP learners in this study. Training on culturally responsive teaching strategies may also be included in professional development programs for teachers to promote the effective and respectful integration of IKS into classroom instructions. Collaborations of schools with Hanunuo elders and knowledge holders may be considered for them to co-create learning materials that preserve their cultural identity to ensure the accurate integration of IKS into Science education. Assessment tools may be designed to measure not only knowledge gains but also the ability of students to apply scientific concepts in culturally rooted and practical contexts. Conventional Teaching Method (CTM) is also recommended as an effective approach in teaching Physics concepts, as it showed significant improvements in learning outcomes of the IP students and can serve as a solid instructional foundation. Furthermore, the integration of IKS may also be explored in other disciplines of Science such as Biology, Chemistry, and Earth Science, to assess its effectiveness in improving the performance across various content areas for indigenous learners. Furthermore, future researchers may replicate this study with a larger and more diverse group of IP learners to validate the findings and explore the broader applicability of IKS integration in Science.

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The authors declare no conflict of interest.

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The authors used Grammarly and Quillbot for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

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AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available due to the privacy restrictions regarding student academic records. However, anonymized data, along with the localized Physics curriculum integration materials, are available from the corresponding author upon reasonable request.