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Article

Indigenous Knowledge Systems and Practices Based - Workbook for Teaching Selected Topics in Science

Ruth A. Tumaneng
Apayao State College, Luna, Apayao
Correspondence: ascrde@gmail.com

Abstract

This study focused on the development and validation of an Indigenous Knowledge Systems and Practices (IKSP)-Based Workbook designed for teaching selected topics in Science I. The workbook comprised five structured lessons aligned with the Philippine Secondary Schools Learning Competencies (PSSLC) and the K–12 Curriculum, ensuring both curricular relevance and pedagogical soundness. It integrated indigenous cultural artefacts and traditional practices as instructional anchors to make abstract scientific concepts more concrete, meaningful, and accessible to learners. The material was systematically organized into four major components: objectives, content, activities, and assessment, each carefully constructed to respond to students' cognitive and cultural needs. A mixed-methods research design, combining both quantitative and qualitative approaches, was employed. Data were gathered through a survey questionnaire and key informant interviews with members of the cultural community to guarantee authenticity and contextual accuracy. For validation, the workbook was evaluated by a panel of ten (10) science experts, secondary school teachers from Calanasan and Pudtol, Apayao, who themselves belong to indigenous groups, thereby enriching the process with insider perspectives. Using a five-point Likert scale checklist, the experts assessed the workbook in terms of its objectives, content quality, learning activities, assessment features, and overall instructional characteristics. The data gathered were analyzed using descriptive statistics, which revealed a consistently high level of agreement among the evaluators. The computed grand mean of 4.56 corresponded to a verbal interpretation of "very highly satisfactory," indicating that the IKSP-based workbook was not only academically valid but also culturally responsive and pedagogically effective.

Keywords: *Philippine Secondary Schools Learning Competencies, K -12 curriculum, indigenous People, workbook, science*

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Introduction

Science education is a significant factor in a nation's progress and development. How students learn, equipped with essential science skills, and how to measure student performance in the knowledge is thus a priority concern of educators and curriculum designers worldwide. However, despite these efforts, many students find no interest in learning science and perceive science concepts as complex and tedious subjects that are full of abstract concepts which they cannot connect to real-life situations (Osborne, J., & Dillon, J.,22008; Speering, W., & Rennie, L., 1996).

Moreover, research studies have shown that assessing students' performance in the different learning areas, especially science, revealed low proficiency (Imam, O. A. et.al., 2014) despite many teaching strategies and instructional material being utilized in teaching science.

With this, science educators continuously construct, develop strategies, and make learning resources that would make science teaching interesting to students (Aquino, 1995). One way of making science teaching meaningful to the learner is the development of a workbook that motivates, enriches learning, and provides a better understanding of the science concepts (Zhu, X., Chen, A., 2009; Ancheta, G., 1997).

The use of workbooks in science can enhance students' achievement. Workbooks are essential study guides for students that contain exercises, problem practice materials, directions for use, and, frequently, a means of evaluating the work done. This teaching material is basically seatwork experiences the students undergo with minimum supervision from the teacher, which plays a significant role in developing concepts and skills (Ancheta, G., 1997). Workbooks can serve other purposes, such as behavior reinforcement. This teaching tool can provide the learner with meaningful feedback, which becomes a reinforcement.

Moreover, an instructional device like a workbook can be made of materials available in the community, such as the locality's indigenous knowledge, system, and practices (Setiawan, B. 2017). The indigenous knowledge, system, and practices (IKSP) include the cultural practices, livelihood, and indigenous material like farming, fishing, and hunting tools and implements. The workbook with Indigenous knowledge, system, and practices (IKSP) may enhance awareness, foster, and deepen understanding and appreciation of the students on the cultural practices that constitute the daily chores and ways of life of the province's people (Patricio,2001). Furthermore, teaching science using IKSP-based workbooks is effective when teachers utilize locally-based teaching resources (Sutherland, D., & Swayze, N., 2012).

Meanwhile, studies have shown that integrating culture into the different topics in science and technology accounts for significant student performance. Knowing the

cultural practices of indigenous people and understanding the scientific explanation for these may serve as a benchmark for possible integration of community life activities in physical science class (Patricio, 2001). Some educational institutions used indigenous knowledge to contextualize science curricula within a cultural context (Chandra 2014; Hamlin 2013; Kimmerer 2012; Sumida Huaman 2016; van Lopik 2012).

Using culturally based workbooks may help students comprehend the lesson, especially since the material is within their reach. The workbook will serve as a guide to make teaching effective and engaging by presenting lessons in a simplified manner to facilitate learning. Values like awareness and appreciation of indigenous materials and practices within the locality will also be inculcated in their minds.

Hence, the researcher sought to develop and validate an IKP-based workbook for teaching selected topics in science.

Objectives

The study developed an indigenous knowledge system and practices-based or IKSP–based workbook in science. More specifically, the study intended to address the following:

1. Identify the science topics that the learners find difficult.
2. Develop a workbook using the identified indigenous knowledge, systems, and practices (IKSP) in Apayao.
3. Validate the workbook with experts in terms of its
   Objectives,
   - 3.1. Content,
   - 3.2. Activities,
   - 3.3. Assessment and
   - 3.4. Instructional characteristics

Methodology

Research Design

The study focused on developing and validating a workbook in science and utilized qualitative and quantitative research methods to gather the needed data. The study's data were gathered through a survey questionnaire for the content validation of the instructional material and an interview with the key informant.

Locale of the Study and Respondents

This study was conducted in Apayao for the school year 2019-2020. The public high schools and their location are shown in Table 1.

The study was conducted at the different high schools in Calanasan and Pudtol. Only seven (7) Science Teachers in Calanasan and three (3) science experts who are teachers from Pudtol were used as respondents in the study. Only the expert science teachers who belong to the indigenous groups in the public high schools were tapped as respondents in validating the IKSP-Based workbook.

Research Instrument

The research tools used in gathering data were the needs assessment survey for identifying the science topics the learners find difficult, the survey questionnaire for validating the IKSP-based workbook, and guide questions for the key informant interview. The survey questionnaire consisted of 20 items that were divided into criteria. It assessed the validity of each criterion as follows: the objectives, content, activities, assessment, and instructional characteristics. Space for comments and suggestions was included in the questionnaire.

Data Gathering

Three phases were involved in gathering data. The first phase included the researcher seeking clearances from the Dep Ed for the needs assessment survey to identify science topics that the science teachers consider difficult, followed by the clearances from NCIP and the municipality of Calanasan, Apayao. The key informant was interviewed regarding their IKSP concepts for making the workbook. The second phase involved constructing and designing the workbook, including the learning competencies. The third phase is clearance from DepEd and validation of the workbook developed by science teachers who teach in the indigenous cultural community.

Statistical Analysis

The study employed various descriptive statistical tools in the analysis of data to systematically interpret the findings. Primarily, the mean was utilized to determine the extent to which teachers considered specific science topics difficult, as revealed in the needs assessment survey. This measure of central tendency provided a reliable indicator of the general perception of difficulty across all respondents, thus offering a clearer picture of priority areas that require instructional support or intervention.

In addition, the range of means served as the basis for interpreting the survey results. Each computed mean score was classified according to a pre-established set of intervals, which corresponded to categories such as *"Very Difficult," "Difficult," "Moderately Difficult," "Slightly Difficult,"* and *"Not Difficult."* This interpretation

scheme enabled the data to be presented quantitatively and qualitatively, thereby translating numerical values into meaningful insights about teachers' perceptions. By adopting this approach, the study ensured that the analysis moved beyond mere numerical reporting and provided an evidence-based framework for understanding the specific areas in science where teachers expressed greater instructional challenges.

Using descriptive statistics in this context was appropriate, as it allowed the researcher to summarize the perceptions of a large group of respondents in a way that was accurate and easy to communicate. Moreover, by categorizing the computed means into interpretable levels, the study identified priority content areas for teacher training and curriculum enhancement, which aligned with the overall objective of addressing the professional development needs of science educators.

Scale	Limits of description	Verbal Description
5	4.51 - 5.00	Very Difficult (VD)
4	3.51 - 4.50	Difficult (D)
3	2.51 - 3.50	Moderately Difficult (MD)
2	1.51 - 2.50	Easy (E)
1	1.00 - 1.50	Very Easy (VE)

The mean was likewise employed to establish the content validity of the IKSP-Based workbook as evaluated by ten science experts and teachers. Their evaluation focused on the workbook's five essential dimensions: objectives, content, activities, assessment, and instructional characteristics. By computing the meaning of their ratings, the study provided an aggregated measure that reflected the degree to which the workbook met established standards of instructional quality and cultural responsiveness. This process ensured that individual variations in judgment were consolidated into a single, reliable index of validity, allowing for a systematic and objective appraisal of the workbook.

The evaluators' responses were anchored on Likert's scale, which provided a structured and quantifiable means of rating the quality and relevance of each component. This scale ranged from the lowest level of agreement (e.g., *"Strongly Disagree"* or *"Not Valid")* to the highest (e.g., *"Strongly Agree"* or *"Highly Valid"),* with corresponding numerical values assigned to each point on the scale. The use of Likert's scale allowed the study to capture the presence of agreement and the degree of consensus among experts. This facilitated a nuanced interpretation of the workbook's strengths and weaknesses across its various instructional elements.

Through this methodological approach, the study established both the face validity (perceived appropriateness and clarity of the workbook) and the content

validity (alignment of the workbook with scientific and pedagogical standards, as well as with indigenous knowledge systems). In turn, the computed means provided a concrete basis for determining which aspects of the workbook were highly effective and which areas required further refinement. The results of this analysis formed a critical step in validating the IKSP-Based workbook as a culturally responsive teaching material, ensuring that it was not only scientifically sound but also pedagogically and culturally relevant.

Scale	Limits of description	Verbal Description
5	4.51 - 5.00	Very Highly Satisfactory (VHS)
4	3.51 - 4.50	Very Satisfactory (VS)
3	2.51 - 3.50	Satisfactory (S)
2	1.51 - 2.50	Moderately Satisfactory (MS)
1	1.00 - 1.50	Needs Improvement (NI)

Discussion of Results

The findings of the study, which is focused on the validation of the IKSP-based workbook for better comprehension of the selected topics in science I, are as follows:

Topics in Science Considered by the Science Experts as Difficult Among the Grade 7 Learners

The primary intent of identifying the science topics students find most challenging to understand, as perceived by their teachers, was to design and develop an instructional material that directly addresses these learning gaps. The proposed material could enhance comprehension, strengthen conceptual mastery, and improve overall academic performance in science by tailoring the content to the specific areas where students struggle. In this study, the critical topics highlighted included forces around us, motion or kinematics, work, energy in our environment, and the machine and its efficiency. Science teachers consistently noted these areas as problematic, given their abstract nature and the level of mathematical and conceptual reasoning they require from learners.

The quantitative analysis further validated these observations. An overall mean of 3.78, with composite scores for individual topics ranging from 3.40 to 4.60, indicated that students experienced varying difficulty levels across all identified content areas. Specifically, the computed means for the five major topics were: Forces Around Us (3.70), Motion or Kinematics (3.65), Work (3.70), Energy in Our Environment (3.90), and The Machine and Its Efficiency (3.93). These values fall within the interpretation

range of "moderate to high difficulty," confirming that these subject areas posed consistent challenges in classroom teaching and learning.

From a pedagogical standpoint, the results emphasized the necessity of including all five topics in the proposed Indigenous Knowledge System and Practices (IKSP)-Based Workbook. Their inclusion ensured that the instructional material was relevant and responsive to the documented needs of both learners and teachers. By focusing on these complex but fundamental science concepts, the workbook aimed to bridge gaps in comprehension through contextualized strategies, culturally relevant examples, and interactive activities that could demystify abstract ideas. This approach is aligned with contemporary calls for learner-centered and culturally responsive instruction, making science learning more meaningful and accessible to students in diverse educational settings.

Table 1. Topics in Science Considered by the Science Experts as Difficult Among the Learners

Topics	Weighted Mean	Descriptive Interpretation
Forces Around Us		
Types of Force	3.60	Difficult
Fundamental force of nature	3.80	Difficult
Composite Mean	**3.70**	**Difficult**
Motion (Kinematics)		
Concept of Motion	3.40	Moderately Difficult
Newton's Law of Motion	3.90	Difficult
	3.65	**Difficult**
Work		
Work in science	3.40	Moderately Difficult
Calculating the amount of work done	4.00	Difficult
Composite Mean	**3.70**	**Difficult**
Energy in our Environment		
Forms of energy	3.60	Difficult
Transformation of energy	4.00	Difficult
Principles of energy conservation	4.10	Difficult
Composite Mean	**3.90**	**Difficult**
Machine and its Efficiency		
Concepts of the machine	3.40	Difficult
Kinds and uses of machines	3.80	Difficult
Mechanical advantage of the machine and its efficiency	4.60	Very Difficult
Composite Mean	**3.93**	**Difficult**
Over-all Mean	**3.78**	**Difficult**

Legend:

Scale	Limits of description	Verbal Description
5	4.51 - 5.00	Very Difficult (VD)
4	3.51 - 4.50	Difficult (D)
3	2.51 - 3.50	Moderately Difficult (MD)
2	1.51 - 2.50	Easy (E)
1	1.00 - 1.50	Very Easy (VE)

IKSP Workbook for Teaching Science

Based on the needs assessment survey results, the identified Indigenous Knowledge Systems and Practices (IKSPs) of the cultural community, particularly their material culture and customary practices used in daily living, were systematically incorporated into the IKSP-based science workbook developed in this study. The integration process aimed to contextualize abstract science concepts into familiar cultural tools and practices, bridging the gap between indigenous learners' lived realities and formal scientific knowledge. By aligning cultural heritage with curriculum content, the workbook ensured that learners could view science not as a foreign or disconnected subject, but as a discipline embedded within their own way of life.

The material culture and cultural practices of the Apayao community served as rich entry points for embedding scientific principles. Traditional implements such as *aliwa* (bolo), *binnawit* (long bolo), *palu* (hand hoe), *rakam* (hand sickle), *sagwa* (drilling rod), *lawig* (fish hook), *sulti* (small fish gun), *baraba* (fish container), *karison* (wooden-wheeled cart), *pasagad* (sled), *arado* (plough), *pana* (spear), *palsiit* (sling), *la'ba* (wide-mouthed basket), *iku'* (knife), *allu* (pestle), and *altung* (mortar) were not merely presented as artifacts, but as functional tools that could concretely demonstrate science concepts. For instance, using the *arado* (plough) and *karison* (wooden-wheeled cart) was connected to lessons on machines, efficiency, and mechanical advantage. At the same time, the *palu* (hand hoe) and *rakam* (hand sickle) were linked to discussions on work, force, and energy transfer.

The science topics identified as most difficult by teachers, namely, machines and their efficiency, work, energy, and kinematics, were prioritized for integration into the workbook. Each of these abstract concepts was contextualized using IKSP examples: energy transformations illustrated using traditional tools; kinematics explained through the motion of sleds *(pasagad)* and carts *(karison*); and efficiency explored through comparisons of indigenous farming tools and their mechanical functions. By incorporating these cultural exemplars, the workbook simplified

complex concepts and validated indigenous knowledge as scientifically relevant and pedagogically robust.

In this way, the workbook functioned as both an academic resource and a cultural preservation tool, addressing learning difficulties while simultaneously promoting appreciation of Apayao's cultural heritage. The integration highlighted that science education, when contextualized within indigenous material culture, can be both meaningful and empowering for learners, ultimately advancing the goals of inclusive and culturally responsive pedagogy.

Science experts/ teachers' degree of agreement in the developed IKSP-Based Workbook in Science I

To determine the validity of the five developed lessons (Lesson 1 to Lesson 5) of the IKSP-Based Workbook in Science I, a validation process was conducted with ten experienced science teachers who served as expert respondents. These teachers were purposively selected based on their professional expertise and years of experience in handling science subjects at both secondary and tertiary levels.

A structured questionnaire and a validation checklist were utilized to gather their evaluative feedback. The checklist was designed to measure the degree of agreement on each component of the workbook, covering essential domains such as clarity and appropriateness of objectives, adequacy and depth of content, relevance of activities, alignment of assessment tools, and overall instructional characteristics. These domains served as specific criteria or indicators to elicit the experts' judgments on the pedagogical and cultural merit of the instructional material.

The validation findings revealed that the five lessons were rated very positively by the panel of experts. The overall mean ratings per lesson were as follows: Lesson 1 = 4.64, Lesson 2 = 4.57, Lesson 3 = 4.52, Lesson 4 = 4.51, and Lesson 5 = 4.57. These values fall under the "Very Highly Satisfactory" descriptive category, indicating strong acceptance of the instructional materials. The computed grand mean of 4.56 further reinforces that the workbook was deemed highly valid, credible, and acceptable for classroom use.

In addition to the numerical ratings, the experts provided qualitative suggestions and recommendations to enhance the quality of the workbook further. These suggestions focused on refining activity instructions for clarity, aligning some terminologies with local dialects for cultural accuracy, and incorporating additional illustrations to aid visual learners. The researchers carefully considered such feedback in revising the final version of the workbook, ensuring that both scientific rigor and cultural responsiveness were maintained.

The results, summarized in Table 2, underscore that the IKSP-Based workbook was pedagogically sound and culturally grounded, thereby demonstrating its potential to serve as an effective instructional material for improving science comprehension among indigenous learners.

Table 2. Results of the validation made by the science experts on the proposed IKSP-based Workbook (Lessons 1-5).

Criterion	Workbook					Overall Mean Rating	Description Rating
	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5		
A. Objectives	4.67	4.60	4.60	4.63	4.70	4.64	VHS
B. Content	4.57	4.60	4.53	4.53	4.60	4.57	VHS
C. Activities	4.56	4.52	4.54	4.42	4.56	4.52	VHS
D. Assessment	4.35	4.53	4.53	4.55	4.58	4.51	VHS
E. Instructional Characteristics	4.60	4.58	4.57	4.55	4.53	4.57	VHS
Grand Mean						**4.56**	**Very Highly Satisfactory**

The teacher-respondents offered valuable feedback during the validation process of the IKSP-Based workbook. One of their key recommendations was to ensure that the statements and questions in the assessment sections are expressed with greater clarity and precision. They emphasized that ambiguously worded items may confuse students, potentially hindering their ability to demonstrate their understanding of the science concepts being measured. By revising the phrasing of questions to make them simpler, direct, and age-appropriate, the workbook could better support students in responding accurately and confidently.

Additionally, the respondents highlighted the importance of incorporating game-based learning strategies, particularly by including puzzle-type activities. Since the workbook is designed for high school learners, the experts believed that integrating puzzles such as crosswords, word hunts, matching games, and logic-based challenges would enrich the learning experience. These puzzle activities were suggested not merely as entertainment but as pedagogical tools that could make science learning more engaging, interactive, and challenging. By tapping into students' natural curiosity and problem-solving abilities, the workbook could enhance

motivation, reinforce retention of key concepts, and cultivate higher-order thinking skills.

Therefore, the respondents' recommendations underscored the need to balance rigor and enjoyment in instructional materials. Clearer assessment questions would strengthen the reliability of the evaluation, while the infusion of puzzle games would sustain learner interest and encourage active participation. These suggestions provided meaningful directions for refining the workbook, ensuring it remains culturally relevant and pedagogically sound for indigenous high school learners.

Conclusion

The study demonstrated that developing and validating an IKSP-based Science workbook provided a viable instructional material that effectively addressed the identified learning difficulties of Grade 7 students in selected science topics such as forces, motion, work, energy, and machines. By embedding the cultural tools and practices of the Apayao indigenous community into science lessons, the workbook bridged the gap between abstract scientific principles and the lived experiences of learners. This integration affirmed that contextualized pedagogy enhances students' comprehension of complex topics and their cultural appreciation and sense of identity.

The findings further established that science experts highly accepted the workbook, which rated it highly satisfactory regarding objectives, content, activities, assessment, and instructional characteristics. Such validation underscores the material's academic soundness, cultural relevance, and pedagogical potential to strengthen localized science instruction in indigenous settings. Teacher feedback also highlighted areas for refinement, such as clearer assessment questions and the inclusion of interactive elements like puzzles to foster greater engagement, demonstrating the iterative nature of instructional material development.

Ultimately, the study concluded that an IKSP-based approach to science education enriches learning by making abstract concepts more relatable, fostering resilience in resource-limited environments, and aligning with the goals of the K–12 curriculum and DepEd's advocacy for contextualized learning. The workbook is both a practical resource for teachers and a meaningful tool for students, affirming the value of indigenous knowledge as a foundation for culturally responsive and effective science education.

Recommendation

Based on the study's research findings, the strategic intervention materials can be a tool for teaching science concepts and principles. Furthermore, it can also enhance the learning comprehension of the students.

In view of the findings and the conclusion, the following recommendations are proposed:

Secondary science teachers should be encouraged to indigenize their instructional materials when teaching other disciplines. Further, the school administrators should encourage every teacher to prepare and utilize IKSP-based workbooks in their teaching. A field test in Grade 7 is recommended to refine the workbook. Future researchers may conduct a similar study involving more students to verify this investigation's results.

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