

## Ethnomathematical Practices Among Ifugao: Input To Learning Package In Plane And Solid Geometry

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**Abstract:** This study focused on the development of a culture-based learning package in Ethnomathematical Plane and Solid Geometry based on the ethnomathematical practices of the Ifugaos. Descriptive developmental approach was used to assess the ethnomathematical practices, and the level of validity and readability of the developed learning package. Results revealed that the following ethnomathematical practices are still very much observed by the Ifugaos: festivals and dances, rice farming, musical instruments, ethnic food preparations, basket weaving, and wood carving. The validity of the developed learning package obtained a rating of passed in content, format, presentation, and organization and up-to-datedness of information. The readability statistics showed that the developed learning package is easy to comprehend and suitable to intended readers and learners since it can be understood by at least Grade 7 students. The developed learning package is recommended for use as teaching learning instructional material in Plane and Solid Geometry subject.

**Keywords:** Mathematics education, culture-based instructional material, ethnomathematics, learning package

### 1. Introduction

A quiet revolution has been taking place in the area education for the Indigenous People (IP) of the Philippines. There are initiatives and programs on IP education all over the country in formal and non-formal settings in an effort to provide a culturally rooted and relevant education to the indigenous youth and adults (Alangui, 2017). The Philippine government, through the Department of Education exerted efforts to offer a kind of education that is non-alienating and sensitive to the needs and aspirations of the indigenous people. The increase of IP education programs may be seen as a response to years of discrimination, marginalization and neglect of the Philippine government for the indigenous people's education (Abadiano, Turner, & Valerie, 2011). A national framework opens the way for an IP education that is approachable, to their context, respects their identities and encourages the value of their traditional knowledge, skills and other aspects of their cultural heritage.

Today, Mathematics is confronted with a dilemma and issues that are more challenging and that it encompasses the diversity of the learners. It implies that the socio-cultural background of every individual should be taken into account as part of the learning process Rubio (2016), Sharma and Neupane (2016), and Balamurugan (2015). Moreover, the DepEd Order No. 62 s. 2011 by adopting the National Indigenous People Education Policy Framework also emphasizes the country's commitment to achieve its Education for All (EFA) advocacy. This is important particularly in the policy declaration no. 15 letter c, which is to provide resources and environment to IP learners.

In response to the need for accounting for the socio-cultural background of each learner, schools have been preserving the culture through Ethnomathematics as a research program in the history and philosophy of mathematics with pedagogical implications (Alangui, 2017, & Abacan-Tuguic, 2016). The contention of this study, is to give ideas on how mathematics as subject can be valued by students and even teachers through understanding its cultural aspects. The connection of the students with the concepts is relevant in order to learn the applications of some mathematical concepts in real life situations (Lipka & Irhke, 2008).

In any learning situation and for learning of ethnomathematics to take place we have to consider the different concerns based on Bruner's Theory. They are understanding, readiness, independence and motivation (David, 2017). A learning package is specially designed to provide the learners the most explicit information the students need. Learners can continue from one lesson to the other without difficulty of understanding concepts since topics were arranged from the most basic to the most complex one.

Readiness is another concern in learning. Subject matter and learning experiences must be provided at the level of the learner. The teacher should consider previous the personal experiences with the subject matter of the students. Although readiness may take a longer time, the teacher must bring down the level of simplicity of the lesson to the level of understanding of the learners so that they will be ready to receive instruction (Gagto, 2018).

Learning package sequence of activities, demonstrate specific lessons; hence, the learners are expected to acquire maximum understanding. The developed learning package was made to be a learner-friendly that is why the learning designs and skills activities used were simple that is within students' comprehension level and follows procedural process that makes it understandable and learnable. It starts with the basic concepts leading to a higher level of learning that provided a gradual development of learners' acquisition of skills.

The learning package contain a set of activities, where the students are provided to determine and measure the preparedness of the students' mastery of a particular lesson. They are considered instructional materials or exercises that would give a much better learning that could reinforce mastery learning (Nardo & Hufana, 2014). The learning package sum up the learning theories and specifically applied the effect of each learning theory in the illustrative example provided in the module (Gagto, 2018). Furthermore, the exercise skills provided directly related learning opportunities for the students' self-assessment.

Given all these, to the best knowledge of the researcher, there has been little discussion on the incorporation of culture or indigenous knowledge systems in mathematics education and in concretizing principles of Ethnomathematics in the curriculum through the development of an instructional material to be used in the culturally-rich province of Ifugao with no studies yet dealt with the preparation of ethnomathematical learning package. The ideas of mathematics in cultural practices involves designing tasks that are contextualized in the cultural heritage based on different ways of knowing in order to help us to replicate on certain mathematical concepts as well as on the nature of mathematical knowledge. Several studies on the same aspect were also tried in our country. However, several challenges were observed like the inadequacy of learning materials; change of curriculum to K-12; inadequate preparedness of teachers to teach the Ethnomathematics approach and learning readiness of the students.

Ethnomathematics approach can be a means in achieving and providing students with mathematical content and skills that allow them to successfully command modern mathematics (Rowlands & Carson, 2002). As Lipka (2002) observed, students who learn Mathematics in an ethnomathematical program do better on standardized mathematics tests. Integrating mathematical methods and principles from the learner's culture into the formal academic curriculum can support them with their own mathematical experience to have a better understanding and can apply mathematical principles (Adam, 2004).

The development of the learning package will contribute to the effective learning competences of the student and effective teaching competency of the Mathematics teachers. It adds to the body of knowledge in ethnomathematics education and can also be used as an important indigenous model in Mathematics education.

## **2. Framework of the Study**

This study is anchored in the Mathematics Education Framework; learning theories (cooperative learning theory, constructivism, experiential learning, discovery and inquiry based and reflective learning); the ethnomathematical practices as the indigenous knowledge; and the ADDIE model in the development of the learning package.

The twin goals of the mathematics education are critical thinking and problem solving. Critical thinking is the intellectually disciplined method of actively and skillfully conceptualizing synthesizing, analyzing, applying and evaluating information generated by experience. Mathematical problem solving is finding a way around a difficulty around an obstacle and finding a solution to a problem that is unknown. The theories and concepts used in the study were significant in the development of the learning package focused on culture-based learning in ethnomathematics education.

Cooperative learning theory is a student-centered and instructor-facilitated instructional strategy in which a small group of students is responsible for its own learning and the learning of all group members. Interaction among students of the same group can acquire and practice the elements of a subject matter in solving a problem and complete a task or achieve a goal. Students will work in the group during different activities. As such students will develop a positive relationship and establish an environment where academic accomplishments are valued (Har, 2013).

Theory of constructivism is a theory views learning as an active process that results from self-constructed meaning. Constructivist learning environment entails students to use their prior knowledge and experience to in formulating new, related and adaptive concepts in learning. In order for the students to develop the ability to construct their own knowledge, the role of the teacher becomes more of a facilitator (Kurt, 2011).

Experiential learning according to Yardley (2012) involves constructing knowledge and meaning from real-life experience. This could serve either as an alternative or as a complement to lectures. The different activities that will be experienced by the students will enable them to have fun while learning. Experiential learning are enhancers of student's cognitive growth by means of observing and developing true to life ethnomathematical practices that brings learning to action as depicted in all activities in the developed learning package.

Discovery and inquiry-based learning backing the idea that students learn when they make use of personal experiences to discover concepts, facts and relationships. Justice, Rice and Warry (2009) believes that discovery and inquiry-based learning increase students' motivation, active approach to learning, academic skills and intellectual habits.

Reflective learning theory highlights that learning originates from our experiences and can be continuously updated through the process of recording and thinking about one's. A very important aspect of reflective learning is that it is a process in which one can learn about one's self (Mathew, Mathew, & Peechattu, 2017).

Ethnomathematics refers ethno as the code of behavior which came from their ethnomathematical practices; myth, on their belief when planting and harvesting rice, etc.; symbols in their design of native attire, hunting, fishing, and other equipment's used by the Ifugaos in their everyday living. Mathema refers to their performing activities such as measuring, classifying and modeling for instance in measuring the length and width in the construction of house and carving and basketry models. Ethnomathematics then relates the member of distinct cultural groups that have a cultural tradition, codes, symbols, myths and specific ways of reasoning (Amit & Quoder, 2016).

The ADDIE model which is the most-known instructional model was used as a basis in developing the learning module of Ethnomathematics. This model refers to Analysis, Design, Development, Implementation, and Evaluation (Macaraeg, 2014) which provided a step by step process that enabled instructional designers plan and create training programs with this framework in order to make sure that their instructional products are effective and procedures are efficient. The *analysis* involves the initial practices that determines the learning problem, sets goals and objectives and analyzes the audiences' schema and other essential attributes of the target audience. *Design* is the method of clarifying the learning goals, deciding an appropriate assessment tool, determining and analyzing an effective learning content and selecting learning materials that support the content is the scope of this stage. *Development* is an alignment to the second stage, that comprises the formation of the learning content and the production of the learning materials. *Implementation* is the plan put into practice. The training procedures for both learner and teacher were laid out. Additionally, learning materials were disseminated to the target learners and material evaluation was done subsequently. *Evaluation* is integrated into each stage of the ADDIE framework. The summative evaluation identified what has been learned and reported to the target learners and teachers the progress in alignment to the learning objectives.

Mathematical Curriculum in Philippine IP Education Program was based on the Philippine 1987 Constitution under Article XIV mandates to education: "encourage non-formal, informal, and indigenous learning systems as well as independent, self-learning, and out of school youth study programs, mostly those that answer to community needs." One of the most important policy declarations on IP Education Policy Framework was on providing adequate and culturally-appropriate learning resources and environment to IP learners. Rosa and Orey (2016) stressed that educators should understand the cultural roots of other culture in order to value the ideas, procedures and ethnomathematical practices used by the students. There are many approaches that can be used in teaching ethnomathematics that use the cultural experience as vehicles to making mathematics learning more meaningful, and to provide the students with understanding of mathematical knowledge as rooted in their socio-cultural environments (Yee & Bostic, 2014, Rosa, 2015, Alangui, 2017).

The researcher gained better insight and comprehension of the aforementioned theories, concepts, ethnomathematical practices and ADDIE model that, have great essence in the teaching and the learning of mathematics which have a significant bearing in the conceptualization of this study and the development of the output material.

### 3. Objectives

The study aimed to develop a culture-based learning package in Ethnomathematical Plane and Solid Geometry crafted from the observed ethnomathematical practices of the Ifugaos.

Specifically, this study determined the 1) extent of observance of the ethnomathematical practices among the Ifugaos; 2) the learning package in Plane and Solid Geometry that can be developed using the observed ethnomathematical practices; 3) the level of validity of the developed learning package; and 4) the level of readability of the developed learning package.

#### 4. Research Design

This study utilized the descriptive developmental research method. It is descriptive in nature since it described the ethnomathematical practices and the validity of the learning package. There were twelve (12) experts in the field of Mathematics and Culture who served as evaluators of the developed learning package in Ethnomathematical Plane and Solid Geometry.

In developing the learning package in Ethnomathematical Plane and Solid Geometry, the researcher went through the following stages: planning, development and content validation.

In the planning stage, the researcher made a survey on the extent of observation of the ethnomathematical practices from experts in the field of culture and made a document analysis on CMO 75 s. 2017, the syllabus in Plane and Solid Geometry and the IP Education Program competencies.

In crafting the learning package, the researcher followed the ADDIE model (Analysis, Design, Development, Implementation and Evaluation). In order to check the accuracy and appropriateness of the content, the validators/evaluators validated the learning package twice leading to the readability index using the Test Readability Consensus Calculator.

#### 5. Results and Discussion

##### Extent of observance on the Ethnomathematical Practices of the Ifugaos

The ethnomathematical practices observed and performed by the local residents of Ifugao as indicated in Table 1 showed that the very much observed practices of the Ifugao were on landforms (2.50), rice production (2.43), festivals and dances (2.56), costumes and accessories (2.51), rice wine making (2.77), basket weaving (2.49) and wood carving (2.61) and the moderately observed were on fishing tools (1.98), stone walls (2.19), house constructions (2.23), and musical instruments (2.33). A grand mean of 2.42 which was described to be very much observed was the overall rating on the extent of observance of the ethnomathematical practices of the Ifugaos. These practices were inputs in the development of the learning package.

**Table 1.** Extent of Observance of Ethnomathematical Practices of the Ifugaos

ETHNOMATHEMATICAL PRACTICES	Mean	DR
1. Landforms	2.50	VMO
2. Fishing tools	1.98	MO
3. Rice Production	2.43	VMO
4. Stones Walls (Topeng/tuping)	2.19	MO
5. House Construction, Ifugao Architecture and types of Ifugao Houses	2.23	MO
6. Festivals and Dances	2.56	VMO
7. Weaving and wearing costumes/accessories	2.51	VMO
8. Playing musical Instruments	2.33	MO
9. Bayya (rice wine making)	2.77	VMO
10. Indigenous rice recipe making	2.47	VMO
11. Munlaga (Basket weaving)	2.49	VMO
12. Munpaot/ Munpa-ot (Wood carving)	2.61	VMO
Grand Mean	2.42	VMO

*Legend:*

<i>Weighted Mean</i>	<i>Descriptive Equivalent</i>
2.34 – 3.00	Very Much Observed (VMO)
1.67 – 2.33	Moderately Observed (MO)
1.00 – 1.66	Least Observed (LO)

These findings are supported by Ngohayon (2011) and Carating, et al (2014) who mentioned that the mountain peaks of the Cordillera mountain have fertile slope that where root crops and vegetables are produced and the water coming from the forests goes down to creeks and gullies which drain into the rice terraces of Ifugao province.

Ngohayon (2011) and Habito and Ealdama (2019) mentioned that rice production of native rice using indigenous farming tools is part of the Ifugao culture.

The results of the findings are similar with the study of Sarmiento (1999) and Matenge, et al (2015) stating that among the cultural communities, food provides a way for them to relate to others especially in social gatherings, etc. which are usually planned around food. To them sharing or preparing traditional ethnic foods for different occasions has symbolic meaning attached to the food they served (Eusebio, et al 2015).

Labhat et al (2011), Gonzales and Ngohayon (2015) and Remme (2017) recorded that the native dances performed during rituals, festivals and weddings, have rhythmic steps, body and hand movements. Again Labhat et al. (2011) supports the above findings and described that gangha (gongs) are commonly used only in the Ifugao native dances. Zamora (2012), and Reyes (2014) also confirmed the above result by saying that local music using local instruments is a major source of enjoyment and satisfactions to visitors and tourist in a destination.

The Ifugao house architectural design is strongly created from amugawan trees which are used mainly for the posts (buried 50 centimeters below the ground) and locked in with stones (Balangcod, 2010).

Another result is supported by Reyes (2014) and Pazon and Del Rio (2018) when they stressed that locally made baskets and wood carving are more durable that attracts tourist to a destination.

## **6. The Learning Package**

The crafting of the learning package for Ethnomathematical Plane and Solid Geometry was based on CMO 75 series of 2017. Ethnomathematical Plane and Solid Geometry is composed of four (4) chapters and aimed at developing reasoning, applying properties and problem-solving skills in the study of Geometric Relation, Triangle Congruent, Quadrilaterals, Similarities, Inequalities, Circles, Coordinate Geometry, and Measurement of Geometric Figures.

Each chapter was divided into several lessons that follow a logical sequence appropriate to the learning needs of the students and considering the prerequisite skills of each mathematical concept. The flow of the lesson follows the ADIDS (Activity, Discussion, Input, Discussion, and Synthesis) method of teaching integrating Ifugao culture specifically the ethnomathematical practices with an overreaching objective of providing an effective and engaging learning experience for the students.

Every chapter was divided into lessons. The number of lessons depends on the coverage of the chapter. Each lesson or group of lessons had the following elements: title, exploration, develop your skills, practice your skill, essential learning, and exercise your skill.

The third part of the developed learning package consists of the appendices for the necessary tables test answers and references. The learning package contains margin features to reinforce understanding on salient points and give interesting facts and trivia related to the lesson.

## **7. Level of Validity of the Learning Package**

The learning package in Ethnomathematical Plane and Solid Geometry was subjected to a validity test along the following indicators: content, format, presentation and organization, and accuracy and up-to-datedness of information. The questionnaire was adopted from the Department of Education (DepEd) Guidelines and Processes for Learning Resources Management Development System (LRMDS) Assessment and Evaluation (2009), DO no. 76 (2011) and DM no. 441 (2019) rating Sheet for Print Supplementary Materials.

A group of professional experts in the field of Mathematics and culture from the academe evaluated the level of validity of the learning package from one (1) to three (3) where 3 and above were passing score and below three (3) as the failing score. The learning package must have a total mean score of 21 and above for content and format; 15 and above for presentation and organization; and 18 and above for up-to-datedness of information to be able to pass the validation criteria.

Table 2 shows the level of validity of the learning package in the four areas namely: content, format, presentation and organization and accuracy and up-to-datedness of information. The learning package was evaluated with validity index of 28.00 as to content, 71.50 as to format, 20.00 as to presentation and organization and 23.92 for accuracy and up-to-datedness of information. Overall, the learning package obtained an overall total score of 143.42 describe as a highly valid instructional material.

The results obtained clearly emphasize that the developed learning package is an appropriate instructional material for first year college, that is now ready to be used by both the students and teachers to enhance new learning in Ethnomathematical Plane and Solid Geometry.

**Table 2.** Summary Evaluation of the Validity of the Learning Package

Feature of the Learning Package	Score	DR
Content	28.00	Passed
Format	71.50	Passed
Presentation and Organization	20.00	Passed
Accuracy and Up-to-datedness of Information	23.92	Passed
Overall	143.42	Passed

*Legend:*

Status	Content	Format	Presentation and Organization	Up-to-datedness of Information	Overall
Passed	21 and above	15 and above	15 and above	18 and above	108 and above
Failed	below 21	below 15	below 15	below 18	below 108

The finding conforms with Rivera (2011) interpretation that high validity means that topics in the learning package is a salient matter in mathematical competency of the students. It is also well-organized according to the sequence of topics which was designed to cater the needs of the students in learning mathematics.

The findings of high validity also mean that the material is an acceptable reference material for the students in helping them to think logically, systematically and scientifically in order to have a better understanding of the concepts to be learned.

## 8. Readability of the Learning Package

The developed learning package were subjected to readability testing. Readability as defined by Shen (2017), is the attempt to improve texts, to derive rules for communicating more effectively and for accessing success at communication. The two factors affecting readability are the physical factors such as typeface, font size, spacing, layout, and extratextual aids like charts, diagrams, pictures, semantic mapping, etc. and the reader factors such as the readers' prior knowledge about the subject discussion, their motivation, their interest and reading ability.

The Flesch Reading Ease tool, a software readability online utility, was used to determine the level of readability of the developed learning package. The four measures that were used from this tool are: 1) the Flesch Kincaid Reading Ease which measures the reading difficulty of the learning package, 2) the Gunning Fog Score, 3) Smog Index, and 4) the Coleman Liau Index which was used to determine the grade level of the students who can comprehend the text.

Table 3 on next page shows the readability statistics of the learning package. The mean index on Flesch Kincaid Reading Ease is 65.82. It indicates that the learning package has a description rating of Easily Understood by 12 to 15-year-old students. The text on the learning package are easy to comprehend and understood by the Grade 11 students since it is within their capability level.

**Table 3.** Readability Score of the Developed of the Learning Package

Readability Statistics (U.S. Grade Level)	Chapter				Mean Score	Grade Level
	1	2	3	4		
Flesch Kincaid Reading Ease	61.98	64.4	70.81	66.1	65.82	8th to 9th grade
Gunning Fog Score	10.51	10.68	10.98	10.98	10.79	HS Junior
SMOG Index	10.81	10.72	10.7	10.92	10.79	HS Junior
Coleman Liau Index	8.37	7.63	4.5	6.14	6.66	7 <sup>th</sup> Grade

*Legend:*

*Flesch Kincaid Reading Ease Scoring Key:*

Range of Score	School Level	Descriptive Equivalent
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60 – 70	8 <sup>th</sup> & 9 <sup>th</sup> Grade	Easily Understood
<i>Gunning Fog Score, Smog Index, and Coleman Liau Index Index Scoring Key:</i>		
Score Index	Reading Level by grade	
11	High School Junior	
10	High School Sophomore	
9	High School Freshman	
8	Eighth Grade	
7	Seventh Grade	
6	Sixth grade	

The mean Gunning Fog Score is 10.79 which shows that the learning package are readable that even a high school junior student can read and understand it. The mean SMOG Index is 10.79 which also shows that it is readable even with high school junior students. The mean Coleman Liau Index is 6.66, indicates that the learning package is also readable for the 7<sup>th</sup> grader students. The results imply that the developed learning package may be understood on its first reading by seventh to eleventh grade students.

Based on the findings on the readability of the developed learning package, it ensures that the contents of the learning package are easy to comprehend and suitable to the intended readers and learners since it can be understood by at least Grade 7 students. These are basically the learners who graduated in the K to 12 Basic Education Curriculum who have undergone the 12-year basic education cycle. These findings jive with the study of Bansiong (2019) whose localized and contextualized science textbooks had a standard level of difficulty and appropriate to its intended learners.

## **9. Conclusions**

Based on the findings of the study, it can be concluded that the ethnomathematical practices were highly observed by the Ifugaos and were extensively expressed and utilized in the development of the learning package in Ethnomathematical Plane and Solid Geometry; the ethnomathematical practices among the Ifugaos can be integrated into developing learning packages in Plane and Solid Geometry; the high validity level of the developed learning package implies that the learning package in Ethnomathematical Plane and Solid Geometry is deemed appropriate and suitable to the target students; and the developed learning package has a standard level of difficulty in terms of readability, thus, it is easy to understand and are comprehensible to the expected end-users.

## **10. Recommendations**

On the basis of the above conclusions, the following recommendations are offered.

1. Classroom teacher may use the ethnomathematical practices in the different phases of mathematics instruction to provide students localized and contextualized learning experiences.
2. Learning materials developers may include ethnomathematical approach in developing learning materials in all level of education.
3. Administrators and teachers may adopt this developed learning package as a textbook or learning material.
4. The developed ethnomathematics learning package may be utilized by other State Colleges and Universities who have students with diverse cultural groups.
5. Seminars, workshops and trainings may be organized for Mathematics teachers in using ethnomathematical approach in teaching for all levels.
6. Further study may be conducted in using ethnomathematics in agri-business subjects and allied courses

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