

**GEOMETRIC DESIGNS IN THE INDIGENOUS ATTIRES  
OF THE BONTOC TRIBE: AN EVIDENCE OF  
“ETHNOMATHEMATICS”**

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**ABSTRACT**

*This paper primarily intended to describe and discuss the geometric designs in the indigenous attires specifically in the lufid, wakhes, and wanes of the Bontoc Tribe in Mountain Province. It employed descriptive ethnographic study approach, a semi-structured interview guide and document analysis of the existing geometric designs the 3 indigenous attires. Results show that the geometric designs that can be found in the indigenous attires applying sinnawed method of weaving are matmata, tiktiko, tagtakho, kalasag, tufay, pinang, u-uweg, fatawer, sokyong faniyas, and sabsabong. Each design may be classified as pinagpagan, kulibangbang, and kinaut. The designs generally represent an object in the environment and represent some cultural beliefs and traditions of the ancestors of the Bontoc tribe. The geometric designs are associated to elements of lines and shapes. The creativity of the weavers with the rapid growth of technology and the development of the tourism industry of the Mountain Province made it possible for the weavers to make same variations on the designs. Combinations of these elements of shape resulted to these variations. At a practical level, the findings will provide valuable resources to the teachers of the Bontoc tribe as they teach mathematics through their mother tongue. The findings may serve as additional information on how and why mathematics specifically geometry and indigenous knowledge and practices are interrelated.*

**Keywords**

Geometric design, indigenous attire, *sinnawed* weaving method

## INTRODUCTION

*Sinnawed* or backstrap weaving method is an income-generating activity among the women of the Bontoc tribe. It has been preserved by the tribe for it is practiced as of the present even though that loom weaving has been introduced and which is more advantageous in terms of volume of produced woven materials. The output of weavers such as indigenous attires through the *sinnawed weaving method* is an evidence of the existence of ethnomathematics. Ethnomathematics as defined by D'Ambrosio (1984, as cited by Rapanut, Teofina A, et al., 1996 ) refer to the forms of mathematics that vary as a consequence of being embedded in cultural activities whose purpose is other than doing mathematics. The entire cycle of the *sinnawed* weaving method requires weavers of their knowledge and skills on mathematics; from determining the amount and cost of raw material (thread), identifying an appropriate geometric design, proper counting and pairing of strips of thread to create the geometric designs, time to finish weaving the indigenous attire, and determining the cost of a finish product considering time, labor, and cost of the raw material.

The parallel relationship of geometry and arts can be seen in many art works (Bernstein, Lee and Shell, 2011). They are commonly found in the different decorative designs on buildings, pottery, clothing, and in many other objects or places. Artists use shapes in different ways when they attempt to create a piece that looks natural, flowing, soft or calming and to create a sense of chaos, anger and rigidity (Ontavilla, 2012).

Mountain Province is among the different places where geometric designs are found through their indigenous attires. These are showcase in their different local festivals specifically during the Lang-ay Festival. Anyone can easily distinguish each tribe due to the respective designs, colors, and symbols embedded in their indigenous attires. These are showcase of their artistry and commitment to cultural identity. Recent symmetrical analysis in this province expose that the designs and patterns of the have preserved their indigenous culture, centuries-old traditions and practices up to this day. These design, patterns and motifs are festive expressions in the celebration of life and also the Kankana-ey's reverence towards their natural surroundings and their harmonious relations with the environment (Baylas IV, et al, 2012). Patterns creates evidence of clarity and exactness of the designer's (weaver's) mind and their ability to fuse the horizontal and vertical elements to create their patterns in their designs (De Las Peñas, et al, 2016).

Recent trends in the international level such as the Asian Integration and local educational reforms though the K-12 curriculum brought challenges in the educational sector specifically to the teachers and the students. Teachers are required to contextualize and localized the curriculum to fit in to their respective localities in response to Indigenized Formal Education by DepEd, RA 10533 (Enhanced Basic Education Act of 2013) as well as DepEd Order No. 51 s. 2014 (Guidelines on the Conduct of Activities and Use of Materials Involving Aspects of Indigenous People Culture). Examining the geometric designs will enable the learners to explore the real-life applications of geometry hence, engaging students to the local setting. Students' engagement in their schoolwork increases significantly when they are taught why they are learning the concepts and how these concepts can be used in real-world contexts (Garin, 2017).

Having been aware of the rich indigenous designs of Mountain Province, the challenges brought by new trends in education, and the researcher's desire to contribute in his specialization, this study was conceptualized to examine and describe the geometric designs in the indigenous attires specifically in the *lufid*, *wakhes*, and *wanes* of the Bontoc Tribe in Mountain Province. Discussion will begin by identifying and describing the designs in the *lufid*, *wakhes*, and *wanes* (Appendix B) as manifestation of their unique identity. Then to determine what mathematical ideas are revealed by the designs as an evidence of ethnomathematics.

### ***Statement of the Problem***

The purpose of this study is to describe and discuss the geometric designs in the indigenous attires specifically in the *lufid*, *wakhes*, and *wanes* of the Bontoc Tribe in Mountain Province. Specifically answered the following research questions;

1. What are the geometric designs in the identified indigenous attires?
2. What are the meanings of the geometric designs?
3. What mathematical ideas are revealed by the designs?

## **METHODOLOGY**

### ***Design***

This qualitative study employed ethnography as its research design. Ethnography as defined by Harris (1968, cited by Creswell, 2007) is a qualitative design in which the researcher describes and interprets the shared and learned patterns of values, behaviors, beliefs, and language of a culture-sharing group. In this ethnographic study, the geometric designs in the indigenous attires of the Bontoc tribe in Mountain Province were described and discussed relevant to values and beliefs of the Bontoc Tribe.

### ***Study Site and Selection***

To identify and have access to the participants, the research used snowball purposive sampling, where he seek the assistance of respondent weavers or old folks whom they consider to be the ideal respondents of the study. The participants of this study ware old folks and weavers of the traditional *sinnawed* or backstrap weaving.

### ***Data Collection and Mode of Analysis***

To determine what the different geometric designs are, the research first conduct photo documentation. Then qualitative interviewing was employed to describe the designs and identify their meanings relevant to the values, and beliefs of the Bontoc tribe. A semi-structured interview guide serve as a prime data collection source. A copy of the interview guide was given to the participants to aide memoire during the interview

process. Local language was used during the interview since most participants are old folks. Their sharing revolved around the questions “What are the geometric designs in the *lufid*, *wakhes*, and *wanes* of the Bontoc Tribe? What are the meanings of the geometric designs? What mathematical ideas are commonly applied by the weavers of these designs?” Photographs of the named designs were then taken. Date of interview was scheduled with their consent in their available and convenient time. Discussion on their extent of their involvement were done prior to the conduct of the formal interview. Document analysis was also employed to determine some mathematical aspects that are revealed by the designs.

Interviews are open-ended where participants were the one to determine the flow of information, although when needed, the interviewer opt to ask questions for clarifications as well as additional information. Questions were translated to their local dialect to avoid miscommunication. The data gathered were read and reread for clear understanding. To ensure validity and truthfulness and trustworthiness of information engaging the designs, participants were asked to look into the final output. Participants were interviewed to validate such analysis. The researcher also seek assistance from experts.

## FINDINGS AND DISCUSSIONS

### *Findings*






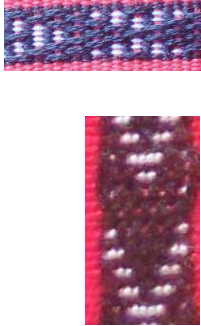
Findings were limited to the *lufid*, *wakes*, and *wanes* of the tribe because these are the commonly produced by the weavers applying *sinnawed* or backstrap weaving method. *Lufid*, and *wakhes*, are backstrap wove products use as skirt and belt respectively by women and *wanes* is a backstrap wove products use as g-string by men. These are made available for these are easily bought at the market due to their usefulness and importance during cultural activities of the Tribe as well as during celebrations of festivals in the Mountain Province. Other woven products are made available only by order.




The warm analysis of the gathered data from the respondents resulted to the identification of the local names and meanings of some of the geometric designs in the *lufid*, *wakhes*, and *wanes*, and some mathematical ideas revealed by these designs.

### *The Geometric Designs and Their Meanings;*

The basic designs are created based on geometric patterns such as parallel and intersecting lines, parallelograms, and triangles. The weavers of the Bontoc tribe who are practicing the *sinnawed* method of weaving claims that the basic geometric designs they create are *matmata*, *tiktiko*, *tagtakho*, *kalasag*, *tufay*, *pinang*, *u-uweg*, *fatawer*, *sokyoung* and *talaw*. The rapid development in technology have great effect on the innovations in these designs. Some of which are on color combination, size of the design, and type of thread that are used. Some of the new designs such as *faniyas*, *sabsafong*, and *pigpiki*. These basic designs are patterned from objects that are seen in the environment and are believed to represent cultural traditions, an expression of their unique culture. These designs are created as a way of valuing nature and preservation of cultural heritage.

Fig 1. The Basic Designs

Name	Meanings/Representations
<p>Matmata</p> 	<p>Matmata corresponds to the shape of an eye in a diamond figure. This represents the eyes of the Lumawig (the Almighty) who is watching all His children on Earth.</p>
<p>Tiktiko</p> 	<p>Tiktiko as shown in the indigenous attires is a zigzag line representing the mountainous place of the Tribe.</p>
<p>Tagtakho</p> 	<p>Tagtakho corresponds to a human shape representing the people. It also represents the warriors of the ancestors of the tribe.</p>
<p>Kalasag, Tufay, Pinpinnang</p> 	<p>Kalasag, tufay, and pinang corresponds to shape of the shield, spear, and axe. These are materials used by the warriors to protect the tribe from their enemies during tribal conflict. These are also used as hunting materials for food.</p>
<p>U-uweg, Faniyas</p> 	<p>U-uweg is a snake-like design while faniyas is a lizard-like design. They represent other creatures (<i>inkutkuti</i>). The snake also represents the good and the bad sign of warriors going to war. This snake is a good sign if the warriors see a snake going a head of their way. It is a bad omen if the snake crosses their way, hence it means that they have to go back.</p>
<p>Fatawer, Sokyong,</p> 	<p><i>Fatawer</i>, X-shape design based from traditional material used by men to carry and transport materials. This material is still use as of today due to an easier and comfortable use. It is believed that this represent the two rods used by men of Bontoc to carry the two sons of <i>Lumawig</i> killed Can-<i>eo</i> told in some versions of <i>Lumawig</i> stories. <i>Sokyong</i> is a V-shaped design which was used to hold the blood of the sons of Lumawig.</p>

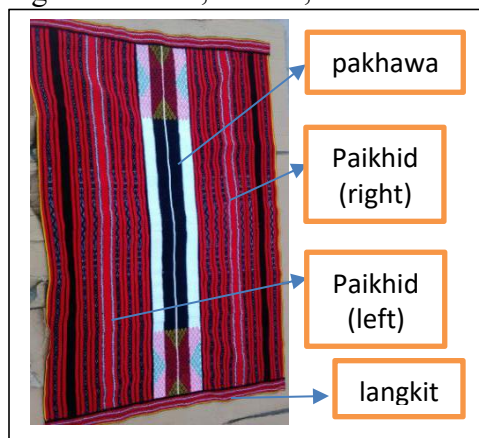
Name	Meanings/Representations
Sabsabong 	<i>Sabsafong</i> is a new design based from the shape of a flower. It denotes <i>layad</i> or love among the <i>fafalo</i> and <i>balasang</i> .
Talaw 	<i>Talaw</i> is a star-like design. It is believed to be the star from the sky that had seen the death of the two son's of <i>Lumawig</i> .
Pigpiki 	<i>Pigpiki</i> a new design based from a corn plant. Corns are one of the crops that commonly planted by farmers during rainy seasons.

The *lufid*, *wakhes*, and *wanes* have parts with major common designs called *pinagpakhan*, *kinaut* and *kinulibangbang* for which the basic designs may be classified. *Kinulibangbang* includes recent designs. *Pinagpakhan*, and *kinulibangbang* requires continues weaving since the designs are already *set* (*during* the setting of the designs-*ipili*) while *kinaut* requires some weaving techniques by which the weaver weave the design by inserting threads by hand.

Basic designs in the *pinagpakhan* are *matmata*, *tiktiko*, *tagtakho*, and *u-uweg*. The design of *kinaut* is *matmata* only for which the shape of a *kalasag* is formed when *matmata* and color combination of threads are considered. *Kinulibangbang* includes *tagtakho*, *kalasag*, *faniyas*, and *sabsabong*. Some *kinulibangbang* designs includes letters for which names of the owner is interweaved in the indigenous attire.

As claimed by the weavers, the *lufid* has three parts namely *paikhid*, *pakhawa*, and *langkhit*. The designs in the *paikhid* are either *pinagpakhan* or *kinulibangbang* with *pinagpakhan* being the common design. The designs in the *pakhawa* are either *kinulibangbang* or *kinain/kinaut*. And the *langkit* has *pinagpagan* has its design. The design in the *wakhes* are *sabsabong* and *tiktiko* while the designs in the *wanes* are *matmata* and *toktiko*.

Figure 2: Lufid, Wakes, and Wanes



The *lufid* used by women as a wrap-around skirt has panels representing the geographical location of Bontoc (refer to the picture in Appendix B). According to ARM-The Bontoc Culture (2011), the middle panel called *pakhawa* represents the clean Chico River that divides Bontoc into two the left and right panels called *paikhid* representing Churya-a (left) and Kidla-a (right). The *langkit* represents the boundaries of Bontoc.



The *wakhes* is used by women as a belt to support their waist as they do their day-to-day activities. Mothers who just gave birth to a child use also the *wakhes* to support their stomach.



The *wanes* is used by man as g-string (use to cover the buttocks and genital area). It represents the long Chico River. The designs called *pagpag* represents the mountainous place. Some of which were excavated for their rice fields by the elders of the Bontoc tribe. These mountainous place as of today are rich of natural resources and are still preserved by the Bontoc tribe.

*The Mathematical Ideas Revealed by the Geometric Designs;*

Mathematical has always been part of the *sinnawed* weaving method. The steps of the *sinnawed* method of weaving as claimed by respondents requires mathematical skills and attitude. The weaver should have be able to perform the steps logically. Preparing the thread requires the weavers’ knowledge and skill on determining the amount of material (thread) to be used. The step where the weaver set the designs (*ipili*) requires mastery and skill in the proper pairing and counting of threads and proper arrangement of sticks are considered. And during the actual weaving of the indigenous, the weaver must be familiar with the sequence of pulling the sticks to create designs. A weaver should consider time management, cost and labor while she weave a particular indigenous material. “As one respondent stated that based on her experience during their earlier years in the industry, they carry their handwoven products in neighboring municipalities like Sagada, Mankayan, and as far as Baguio to sell their products. And the only have their snacks or meals if the products are sold. Anus ya khaget nan puunan mi ay da men afer”

Figure 3. Setting and Creating the Designs



Setting designs



the


Creating the Designs

Aside from the mathematical attitudes of a weaver, mathematical ideas are also revealed in the designs. The basic designs are created based on geometric patterns (elements of shapes) such as parallel and intersecting lines, parallelograms, and triangles. The *kinaut or kinain*, *kulibangbang* and *pinagpakhan* are designed using combination of the shapes repeated in a recurring and regular arrangements.

Fig 4. The Major Designs

Indigenous Attire	Major Designs (Considering the Basic Designs)
Lufid	<p data-bbox="440 583 578 615">Pinagpagan</p>  <p data-bbox="440 940 623 972">Kinulibangbang</p>  <p data-bbox="440 1157 516 1188">Kinaut</p>  <p data-bbox="440 1440 659 1472">Geometric Figures</p> <p data-bbox="440 1476 1446 1577">One can observe the following geometric figures in the given pictures. Each of the design or part of the design may correspond to an angle, diamond, kite, triangles, trapezoid, parallel lines, horizontal and zigzag lines, and intersecting lines.</p> <p data-bbox="440 1581 1484 1724">When considering the <i>lufid</i> as a one, some of the designs may fall to some geometric ideas such as symmetry, reflection, rotation, glide reflection, and translation. The major designs show variations on the different basic designs. Variations and color combination are considered to give beauty and emphasis on these major designs.</p>



Indigenous Attire	Major Designs (Considering the Basic Designs)	
Wakhes	<p>Sabosafong</p>  <p>Tiningkar</p> 	<p>Geometric Figures</p> <p>Each of the design or part of the design may correspond to an angle, parallel lines, horizontal and zigzag lines.</p> <p>The designs may fall to some geometric ideas such as symmetry, and reflection.</p>
Wanes	<p>Kinaut</p>  <p>Pinagpagan</p> 	<p>Geometric Figures</p> <p>Each of the design or part of the design may correspond to an angle, diamond, triangles, and zigzag lines.</p> <p>The designs may fall to some geometric ideas such as symmetry, and reflection.</p>

The rapid growth of technology, great development in the tourism industry of the province, and creativity and mastery among the weavers of the tribe made it possible for these new innovations on the original designs. Combinations on these variations with the elements of shapes results to other beautiful indigenous attires and woven materials.

Figure 5. Variations of the Basic Designs

Name	Some Variations
Matmata 	
Tiktiko 	
Tagtakho 	
Kalasag, 	
Pinpinnang 	
Tufai 	
U-uweg 	
Faniyas 	
Sabsabong 	
Talaw 	

## Discussions

*Lufid*, *wakes*, and *wanes* through the *sinnawed* or backstrap weaving method are some of masterpieces of the women of the Bontoc tribe in Mountain Province. This is a form of income-generating socio economic activity among the women of the tribe. These are proof of their preserved cultural heritage and their rich indigenous knowledge and practices. A proof of their cultural values such as respect, and perseverance to keep their identity.

The steps of the *sinnawed* method of weaving as practiced by the tribe to create the geometric designs in their indigenous attires includes *intabfay*, *inarmichor*, *inmokon*, *inkhan-ay*, *ipili*, and *inafer*. Primarily, the first process is to prepare the needed material (thread). Preparing the needed material is very much needed for a smooth weaving of the identified indigenous attire. First the weaver will fasten the thread (*intabfay*) with the use of *ulawan* a weaving material to remove the thread from its cone or its factory package. Then the weaver will soaked the thread in the water and dried it up (*inarmichor*) in order to give more strength to the material. This is to help avoid the possibility for the thread to get easily cut during the actual process of weaving. After which the weaver with the help other family members will prepare (*inmokon*) balls of thread (*minokon*).

After preparing the thread, follows the actual weaving. The weaver will prepare the thread ready for actual weaving using the weaving materials (*inkhan-ay*). Then, the weaver will set the designs (*ipili*) where proper counting and pairing of threads are considered by the weaver to create a particular design. The weaver will also make a guide by separating strands of threads considering necessary color combination with the use of sticks. Then comes now, the actual weaving (*inafer*) where proper steps in picking up the sticks to create the designs must be considered.

It must be noted that values such as cooperation, respect, patience, and perseverance are developed and practiced among the members of the Bontoc tribe. These values made it possible for the preservation and continuous practice of the *sinnawed* method.

The basic designs are created based on geometric patterns such as parallel and intersecting lines, parallelograms, and triangles. The weavers of the Bontoc tribe claimed that the recent basic geometric designs they create are *matmata*, *tiktiko*, *tagtakho*, *kalasag*, *tufay*, *pinpinang*, *u-uweg*, *fatawer*, *sokyong*, *faniyas*, and *sabsafong*. These basic designs are patterned from objects that are seen in the environment. They are representations of the beliefs, and traditions of the ancestors of the tribe. This is similar to the findings of Baylas IV (et al., 2012) that the design in the woven products of the kankanna-ey (another tribe in the province, the patterns and motifs are festive expressions in the celebration of life and also the Kankana-ey's reverence towards their natural surroundings and their harmonious relations with the environment. Recent studies in the nearby provinces such as Kalinga and Abra reveal similar findings. Geometric motifs in the embroideries of Kalinga symbolize extraordinary rich heritage and culture which provide connection to their ancestors and traditions (Tuguic, 2016). The shapes in their designs are related to the elements of their everyday life, ceremonies, nature or cosmology. In the loom woven cloth of Abra, geometric concepts and transformations produced from color combinations of the warp and weft threads (Pablo Bose Jr., et al,

2015). Also, there are ethnic meanings of the different embroidery stitch designs present in the loom woven cloth. This proves the connection found between mathematics and culture.

Mathematical has always been part of the *sinnawed* weaving method. Bontoc Mountain province like other places, *sinnawed* is evidence of ethnomatimatics. The steps of the *sinnawed* method of weaving as claimed by respondents requires mathematical skills and attitude. The basic designs in the indigenous attires are created based on geometric patterns such as parallel and intersecting lines, parallelograms, and triangles. Patterns creates evidence of clarity and exactness of the designer's (weaver's) mind and their ability to fuse the horizontal and vertical elements to create their patterns in their designs (De Las Peñas, et al, 2016). The designs using combination of the shapes repeated in a recurring and regular arrangements.

*"The author would like to end this discussion with his desire to add up to the growing study on ethnomathematics. He hope that these study serves as encouragement to keep on preserving our culture through continuous documentation of our different stories as proof of our unique identity."*

## CONCLUSIONS

The primary purpose of this ethnographic study was describe and discuss the geometric designs in the indigenous attires specifically in the *lufid*, *wakhes*, and *wanes* of the *Bontoc Tribe* in Mountain Province. *Lufid*, *wakes*, and *wanes* through the *sinnawed* or backstrap weaving method are some of masterpieces of the women of the Bontoc tribe in Mountain Province. These are proof of their preserved cultural heritage and their rich indigenous knowledge and practices. A proof of their cultural values such as respect, and perseverance to keep their identity. The creativity of the weavers with the rapid growth of technology and the development of the tourism industry of the Mountain Province made it possible for the weavers to make same variations on the designs. Combinations of the elements of shape resulted to these different variations.

This findings add up to growing body of ethnomathematics. Examining the geometric designs in the indigenous attires will give a light of the practical applications of geometry to real-life applications of geometry. At a practical level, the findings will provide valuable resources to the teachers in the Bontoc tribe as they teach mathematics specifically lines and shapes through the mother tongue for grade 1 to 3. The findings may encourage teachers to provide opportunities to the learners to explore the culturally relevant contexts to the curriculum. Hence, students will be exploring the presence and importance of the curriculum in their locality, activities, and cultural heritage. With the weaving industry of the Bontoc tribe, students may study or make an analysis of the patterns in the different woven products.

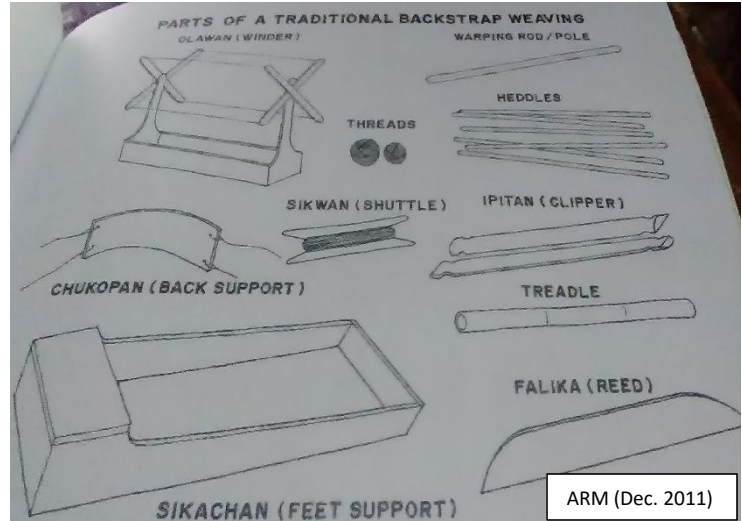
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**APPENDICES**

Appendix A  
**Sample Pictures**

**THE SINNAWED OR BACKSTRAP WEAVING**



The *sinnawed* weaving method requires proper pairing and counting of tread, logical arrangement of weaving materials, and sequential steps in creating the designs. The picture below shows a weaver doing these mathematical ideas as she sets and creates a design to come-up with her masterpiece.

Appendix B

**Sample Picture: Bontoc Mountain Province**



**Sample Pictures: Lufid, Wakhes, and Wanes**

Lufid: *Original color and design*

*Includes some innovations*



Wakhes

Wanes

