The Mathematical Ways of an Aboriginal People: The Northern Ute

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Math is a part of our lifestyle too but we don't have it in the way that the White man has it, say… math like times tables, and addition or subtraction. We have those things also in our traditional ways of beading, our raising of our horses and cattle, or building fences, putting up teepees, etc. If you don't have your culture, if you don't have your language, your arts and crafts you are just another person out there in the world. If we have our beadwork, our songs and dances, if we believe in our old ways, our traditional ways then that is going to uplift us someday while the world fails around us. We will have something to fall back on. Right now we can still live in a White world; we are in a White world. My dad says we're considered White people because we speak their language; we go to work and pay bills. We are not like Indian people the way we used to be but we still have a part of our Indian ways and that belongs to us. We should hang on to that. It's good to have your culture and your language to fall back on. It gives you a good feeling to know it is a part of you and that is where you came from.

(Personal conversation with Fabian Jenks, Ute Tribal Elder, February 2001)

Ethnomathematics, the study of the relationship between mathematics and cultures represents a complex and multifaceted dynamic, which illustrates the culturally influenced uses of mathematics through its applications. D'Ambrosio's (1991) proposes that mathematics have been culturally derived since people first walked the Earth. The evolving use of mathematical ability as a component of human intelligence, helped human beings to not only survive but to succeed in their environment. The term Ethnomathematics is descriptive of both past and present histories of mathematical development and applications throughout the world related to and shaped by cultural influences across the millennia. (Zaslavsky, 1996).

Native American cultures are seldom recognized for their uses of mathematical processes yet it is through an examination of such applications in daily living practices that our understanding of the American Indian can be enhanced. This article depicts a Native American people, the Northern Ute and illustrates how mathematics was and is an integral aspect of

Northern Ute culture highlighted in a variety of traditional and contemporary living practices. Ute elders, those with a deep understanding of their cultural heritage, beliefs, values, and traditions provided the insights and information upon which the article is based. The categories of counting, measuring, locating, designing, explaining, and playing (Bishop, 1994) will be used to frame how math has been used and explained in Ute culture. The history, richness, and complexities of the Ute culture are far too detailed to be easily described and certainly surpass what is known by the authors. Nevertheless, several important aspects of the Ute story will be shared.

A Brief History of the Northern Ute

The Ute successfully and continuously lived for centuries throughout the Rocky Mountain region in the western United States in what are now parts of Colorado and Utah. Traditionally the Ute were known as the Nuciu meaning "The People." (Lewis, 1994). The Ute language belongs to the Numic group of Uto-Aztecan languages shared by a number of other tribes living in the region. Historically, the Ute lived and traveled in small bands of extended family groups in numbers ranging from 20 to 100 persons. Twelve separate bands of Ute people existed, typically defined by the environment they inhabited. Occasionally these small bands of people would gather to trade, intermarry, participate in ceremonies or celebrations, or to conduct large hunts or foraging to obtain quantities of food for consumption or winter storage.

The people typically traversed the land following cyclical seasonal patterns where known foods such as seeds, nuts, berries, and roots, and medicinal plants could be gathered and harvested. Additionally, hunters supplemented food supplies with rabbits, birds and larger game such as deer, antelope, and bison. Fish were harvested in lakes and streams. The temporary homes of the Ute (wickiups) were cone-shaped and typically made of grasses and branches, the materials most readily available. In colder seasons when travel decreased and habitation sites became more permanent, teepees made of animal hides were constructed and warm blankets were woven from rabbit fur.

In the early 1700's, the Ute's acquisition of horses from the Spanish explorers indelibly changed life for the people. Increased mobility meant more efficient travel, successful hunting, and raiding on enemies. The Ute became known for their horsemanship and fearsome exploits

and appear to have benefited from the increased interactions of explorers through trading and bartering.

Beginning in 1847 the Ute traditional lifestyle changed dramatically with the arrival of the Mormon pioneers. The Mormon, who sought new lands where they could practice their religion unfettered, cherished the seemingly unclaimed land and set out to establish permanent towns and cities. Initially, relationships between the Ute and these new Mormon arrivals were peaceful. Eventually tensions arose over the contested resources; resources the Ute had managed and used for centuries. Violent conflicts between the pioneers and the Ute resulted. The Ute were eventually subjugated through military force and relocated to barren reservations set for them by the United States government.

Efforts were made to teach the Ute farming and ranching skills and were successful for some. Ute children were collected from their families and taken to boarding schools where they were taught to speak English and to learn skills seen necessary for integration into the dominating culture. This "educational" process disrupted and damaged the traditional practice of Ute culture and what a child would have normally learned within their family.

Today over 3000 people belong to the Northern Ute Nation, representing three different bands, live on or near the Uintah Basin reservation in northeastern Utah. Senior members or Elders of local reservation communities are those who most frequently practice traditional Ute culture. Spiritual significance is embodied in almost every aspect of daily living in traditional Ute culture. Life and living is seen as being circular, relational, and reciprocal. The Ute reflect a humility and respect for life and the plants and animals with which they share the land. Efforts are being made to save and to renew cultural practices and awareness. Children are once again being taught the Ute language and the traditional ways of the people. The Ute today are a very proud people with a rich past and a challenging yet promising future.

Ute Mathematics

The following description of Ute math sets the starting point for further work that can and should occur by the current authors and others. Before this work, there does not appear to have been any description in the literature for teachers/researchers to access and use for elucidation of Ute math. The decision this article reflects, therefore, is to describe the Ute way of naming numbers, measuring things, and the like, rather than describing and analyzing the details of a Ute

games, for example. Revealing the beautiful mathematical nuances that make the math of the Ute, their math, rather than another culture's mathematics, guided this ethnomathematical study.

In the Ute language, there is no one specific word for mathematics. Rather, mathematics is something you do as you live. Mathematics is witnessed through its many uses; in Ute culture it is a verb rather than a noun unlike the Eurocentric perspective. Some consider mathematics to be a gift from the Creator whose use allows for a successful life. The description of the traditional uses of mathematics of the Ute will begin with the act of counting.

Counting - nee nee aye (making a name)

The counting system of the Ute was based on groupings of ten that was used to quantify objects, people, and events encountered in daily living. It was not always necessary to name an exact count when describing a group of objects. Sometimes quantities were explained simply as "a lot, many, or a few."

When necessary, values ranging from one to endless (infinity) could be described. Zero meant, "having nothing or there is no more." Numbers too large to count were said to "just go on and on" or "those having no end." Virtually any quantity could be verbally described. Values through the tens and up to a few hundred were those most frequently explained because of their actual daily use. Very large numbers could be named but if there were no real use for them this was seldom necessary.

Hand gestures, similar to finger counting today were common and could accompany verbal counting or could be used in isolation. For values more than ten, the speaker would verbally indicate the value, such as tens or hundreds prior to gesturing. Usually the context of the conversation made such clarification unnecessary. Names for numbers one through nineteen and the 10s through 100 are listed:

1	suwees	11	turgumsuweenee soocoos cheepeewahgudt
2	wyanee	12	turgumsuweenee wykh cheepeewahgudt
3	bpaynee	13	turgumsuweenee bpaykwh cheepeewahgudt
4	whcheweenee	14	turgumsuweenee whchook cheepeewahgudt
5	muhnugheenee	15	turgumsuweenee muhnuhgk cheepeewahgudt
6	nahvayannee	16	turgumsuweenee nahvayouk cheepeewahgudt
7	nahvakahvuhnnee	17	turgumsuweenee nahvaykahvahouk cheepeewahgudt
8	wowh whcheweenee	18	turgumsuweenee wowh whchook cheepeewahgudt
9	suwah turgumsuweenee	19	turgumsuweenee suwah turgurmsok cheepeewahgudt
10	turgumsuweenee	20	wahmsuweenee
30	paymsuweenee	40	wh chewee turgumsuweenee
50	muhnuhgkee turgumsuweenee	60	nahvah muhnugheenee
70	nahvahkahvah turgumsuweenee	80	wowh whchewee turgumsuweenee
90	suwah turgurmsuwe turgumsuweenee	100	sookoosmurh

Eleven, twelve, etc. were literally translated as “one on top of ten,” “two on top of ten”, etc. 20, 30, were translated as “two counts of ten”, “three counts of ten”. Nine is one less than ten and the same pattern holds for other values immediately preceding groups of 10. Written numerals did not exist. Drawings of objects on hides, other objects, or rock faces also indicated quantities. Tally-like marks could be used to keep a count.

Ute elders described uses for the basic math operations of adding, (combining) subtracting (taking away), and dividing (sharing or splitting up). Repeatedly adding similar quantities when such amounts were counted took the place of multiplication. Division and fractional quantities were aspects of sharing items such as food and calculations were rather intuitive. One might get “a half” of the bounty and another might get another portion of what was left. Equal shares did not always mean everyone got the same amount but rather got what they and their family needed. “One-half” was described as “in the middle or center.”

Measuring – tuehgyh (measuring)

Rather than creating a set of universal measurement standards Ute measurement was very contextualized and individual. A stick or a length of rawhide for instance possessed its own length that could then be used as a standard or comparison with another object. One Elder stated, "Everything was built with a measurement within itself." Parts of the body such as hands, length of an outstretched arm, paces, etc. were used and were specific to the person to which they belonged. In essence, each person carried with them their own standard units and thereby what one constructed was proportionately appropriate for the user. Hide shirts, buckskin dresses, moccasin footwear, and even tools and weapons were made with the body of the person acting as a measurement template.

Perimeter, area, volume were measured in very practical ways. A person constructing a shadehouse to provide comfortable, cool protection against the summer sun for instance, would "step off" a distance and count the steps that were taken to create the size of house to comfort ones family. The floor area of a shadehouse or teepee was determined adequate if its space served the function for which it was constructed.

Distances were described as a function of time and/or speed it took one to make the trip. A long journey was described by counting the number of sunsets, which elapsed during the travel. The light of the day was important; it was less difficult and safer to travel during daylight so sunsets provided an obvious stop to a day. Travelers would segment a trip into increments based on the time from sunrise to sunset. The speed of travel (on foot or on horseback) influenced the "distance" traveled making the trip faster or longer.

Volume was considered by how much of something a vessel or container could hold. Weight of an item was always considered in relation to the person hefting or feeling; they made the determination if to them something was heavy or light.

For cooking and food preparation, measurement again played an important function. Those doing the cooking used pinches, handfuls, and dashes of ingredients (such as crushed berries, salt, and other flavorings) as standard units. The experienced cook knew that a particular bowl or woven container when filled to a certain level would produce a specified amount to food. If the cook was preparing a meal for a greater number of people the container could have more added to it as the cook knew from previous experience how much more food would result.

The size of the container thereby functioned as a measurement device.

Designing – pur ur kut (how it is drawn or written down)

Designs carry messages and tell stories. A Ute beadworker for instance may use bead colors and the specific pattern of a flower or a geometric shape that has been passed down through their family for generations. Other people know their work and their identity in this way. The actual meaning of the pattern could be very personal and spiritual. Mathematical calculations were intrinsically applied in beadwork from which the Ute are known. For instance, Ute beadwork involves balance and symmetry denoting a sense of beauty and harmony. The beadworker typically uses their sense of what looks good rather than making strict mathematical calculations to produce their work.

The applied mathematics functioned both as a guide to the construction of the object and as a nearly invisible byproduct. Beadwork was used to decorate clothing and items of daily use. Ute beadwork patterns are typically symmetrical as are those of most Native American populations. The balance inherent in beaded designs reflects spiritual understandings is thought to illustrate harmony, joy, and beauty; each of which are values respected for living a good life. The construction of a structure, tool, or beadwork design incorporated many geometrical and mathematical principles such as tessellations, transformational geometric concepts, or the use of a radius (rawhide strip) to draw a circle. A person who knew how to make an object implicitly used the mathematics necessary for construction in a most practical way.

Shapes were named by their characteristics. The shapes were not named simply to identify a geometry term but rather referred to the physical appearance of something real. The literal translation for the Ute word for "triangle" for instance is "having three corners." Hand gestures complemented verbal expression and could indicate length and width. The circle, known as "something round" was perhaps the most important geometric shape to the Ute. The circle had significance because it was considered to have no starting or ending point. The circle illustrate the multiple circles or cycles a person observed everywhere around him or her such as the cycles of life and movement governing people, plants, and animals as well as those related to weather, the earth, moon, and the stars.

The circle also provided the most typical base shape for the traditional home. Mathematically for a given perimeter of a home, a circular shape provided the greatest amount of

interior floor area. Building materials were collected from nature (sticks and branches) and the use of circular-shaped constructions reduced the impact on the environment because of the economical use of materials to achieve the greatest area for a fixed amount of resource and the amount of work required to gather those resources.

Locating – myh (finding)

Elders were respected for their knowledge of the land, its geography, geology, and resources. “Maps” existed in the memories of those that made a journey previously who would lead a group of travelers or describe verbally specific landmarks and distances expected. Occasionally, maps depicting routes were drawn on the ground or on hides using charcoal that one could then carry.

Cardinal directions were important and determined in relation to the rising or setting of the sun, the location of a mountain, river, lake or some other significant feature. Hand signals indicated directionality and appear to have been used consistently when describing a location to another. One could also situate their location by careful observation of the rising and location of the sun, moon, or stars which could then also be used to comprehend the time of year and events that could be expected (animals, plants, weather, etc.). Such insight and knowledge were paramount to continued survival. Pictographs and petroglyphs (drawings made on rock walls) helped communicate where people had previously hunted and camped. Certain signs or symbols were used to represent certain geographic or resource features. Spatial or topographical orientations such as right or left, above or below were very specifically described in relation where an object stood in relation to the person making the distinction. Again the context of the observation greatly influenced its description.

Explaining – myh kueh uhm (telling you something)

Mathematics is a form of communicating ideas and therefore is a form of explaining. The numbers four and seven were significant to the Ute and influenced cultural behaviors, construction, and design. The number four could indicate the cardinal directions or the number of times a prayer or ceremony was repeated or a song sung. An Elder described the importance of

seven stating, “The seven are north, east, west, and south, and then we have the sky and the earth, and then the middle would be ourselves, our hearts, and that is the seven directions.”

Time could be told by watching shadows and the directions in which they pointed. A stick could be placed in the ground or shadows created naturally could be observed. A shadow pointing west in the morning confirmed it was before noon. Exact time measurement was not considered necessary. The activities and actions of a person throughout the day were related to more natural rhythms such as when one was hungry or sleepy. However parts of the day or night could be explained and were referenced in relation to a description of where the sun appeared in the sky or by the color of the sky at dawn or dusk.

The Ute calendar was organized in relation to the moon and the various positions and shapes of it. Careful observation of the lunar cycle allowed those knowledgeable to know clearly what part of year it was and even more precisely phases of the night. A new moon indicated a new month was starting. This knowledge again was vital to Ute survival in knowing when berries would be right for picking, roots to be dug, plants to be gathered, animals to be hunted, and meat to be dried. There were four seasons described and within those times event representing the months could be described. The beginning and ending of a particular season was often related to the observation of a cyclical environmental or climatic event and may vary a bit from year to year. The naming of a month within a season noted, for instance, when eagles mated, when birds flew north or south, when plants budded, or when special foods could be gathered.

Wealth and prominence could be illustrated in the number of horses or cattle a Ute owned but were not merely determined by material possessions. A traditional Ute was considered wealthy if he or she possessed certain valued skills such as if one was a good beadworker or could dance or sing well. If you knew the traditional Ute ways, demonstrated humility in life, knew how to provide for your family, had a strong and healthy family with wise elders from which to learn, had fancy colors to design ones traditional clothing, you held a place of prominence.

Playing – keeyakyh (more than one person playing)

Playfulness was valued in Ute culture and a number of games existed. In some games, the use of mathematics was apparent, such as in those games where scores were kept. In others, the mathematics were embedded in the activities. Measuring, counting, probability were several of the mathematical aspects of the games. Invariably, scores were calculated to determine the winners.

There were games specifically for men, women, or mixed groups. The games could demand physical skills such as in running races, shooting arrows, or playing "Shinny", a game, which resembled field hockey of today. Other games were more cognitive such as those of the "Hand Game" or the "Stick Game." The "Hand Game" was and still is a popular guessing game played by two teams comprised of any number of men and women who gathered on either side of two long sticks or poles laid parallel to each other. Each team began the game with ten or twelve short sticks and several bones measuring two to three inches in length. One of the bones would have a piece of rawhide strip wrapped around it. The object of the game was to guess the hand in which one of the players on the opposing team was hiding the white bone (with no rawhide strip). When the opposing team guessed correctly, the losing team passed them one of their short sticks. The first team to lose all of their sticks lost the game and the bets that preceded the game. Items such as hides, clothing, personal items, and even horses were wagered.

The game of tu-roo-kweep was a stick game played on a two-to-three-foot square of buckskin using four playing sticks painted with combinations of colors and or markings, which represented certain numerical values which were determined by the players. Marks were drawn or painted on the buckskin along its edges. A flat rock was placed in the middle on which to bounce the playing sticks as players sat on opposite sides of the hide and took turns. Scores were determined in noting how the sticks landed and players moved their marker around the hide. The first one to mover their marker completely around the hide won the game.

Conclusion

This brief summary of traditional Ute uses of mathematics reflects its practical application by a people whose very existence relied on the effective use of mathematical

concepts and principles. Ute mathematics defined the people through its many applications. The ingenuity and mathematical intelligence demonstrated portray a people with a rich heritage who used mathematics to enhance their lives and their culture. Today, with this understanding of this proud mathematical tradition, Ute children can know they too have an obligation to learn and to use mathematics as they honor Ute ways.

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