# An Ethnomodel of a Penobscot Lodge

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**Abstract**
When considering Pike's (1967) linguistic work that introduced "emic" and "etic" through the ethnomathematics lens, new questions arise. With these new questions, emerge new perspectives. The building of a Penobscot hemispherical lodge, considered through the emic view, complimented with the etic view is the focus of this paper. An ethnomodel of a Penobscot hemispherical lodge contributes to the ethnomathematics scholarship and supports the emerging research in ethnomodeling.

## Introduction

### Ethnomodeling

Rosa and Orey (2013a) state that ethnomodelling is "a practical application of ethnomathematics, and which adds the cultural perspective to modelling concepts" (p. 78). A cultural perspective broadens views of modeling, which Bassanezi (2002, cited in Rosa & Orey 2013a) recognizes as a potential pedagogical bridge for students in their learning of mathematics. "Inclusion of a diversity of ideas brought by students from other cultural groups can give confidence and dignity to students, while allowing them to see a variety of perspectives and provide a base for learning academic-Western mathematics" (Bassenezi 2002, cited in Rosay & Orey 2013a, p. 78). In 1990 when D'Ambrosio introduced "mathememtatise," this set the stage for emerging scholarship in ethnomodelling. According to Rosa and Orey (2006) "mathematisation is a process in which individuals from different cultural groups come up with different mathematical tools that help them organize, analyze, comprehend, understand, and solve specific problems located in the context of their real-life situation"(cited in Rosa & Orey 2013b, p. 118). Rosa and Orey's (2013) "cultural perspective" is a different way to state what Pike (1967) was discussing in when he introduced the "emic" perspective, which is the insiders' view.

This described collaboration between Mitchell, Penobscot, and Shockey on the construction of a hemispherical lodge brings two perspectives to bear on the "practical

application" of ethnomathematics. Mitchell is a member of the Penobscot Nation, a Native American population in the United States. Shockey is a mathematics educator. Mitchell is frequently invited to teach about his culture and the broader cultures of New England and the Maritimes. Wabanaki, "People of the Dawn," is the referent to four tribes: Penobscot; Passamaquoddy; Micmac; and Maliseet. When Mitchell was invited to oversee the construction of a traditional village on the Great Salt Bay of Maine, Shockey invited himself to attend with two intentions; first to begin to understand Mitchell's Native pedagogy; and second to focus attention on the mathematics embedded in the activities that Mitchell directed.

Previously Shockey and Mitchell (2006) wrote of this experience, with an emphasis on the "etic view." Shockey is trained as a mathematics educator and does not bring the important Native perspective of Mitchell. With the emergence of ethnomodelling in English, the two have revisited their previous work to bring the Native perspective to the forefront. Important implications emerge with the emic view, implications for connecting Western-mathematics to Indigenous views as well as implications for pedagogy.

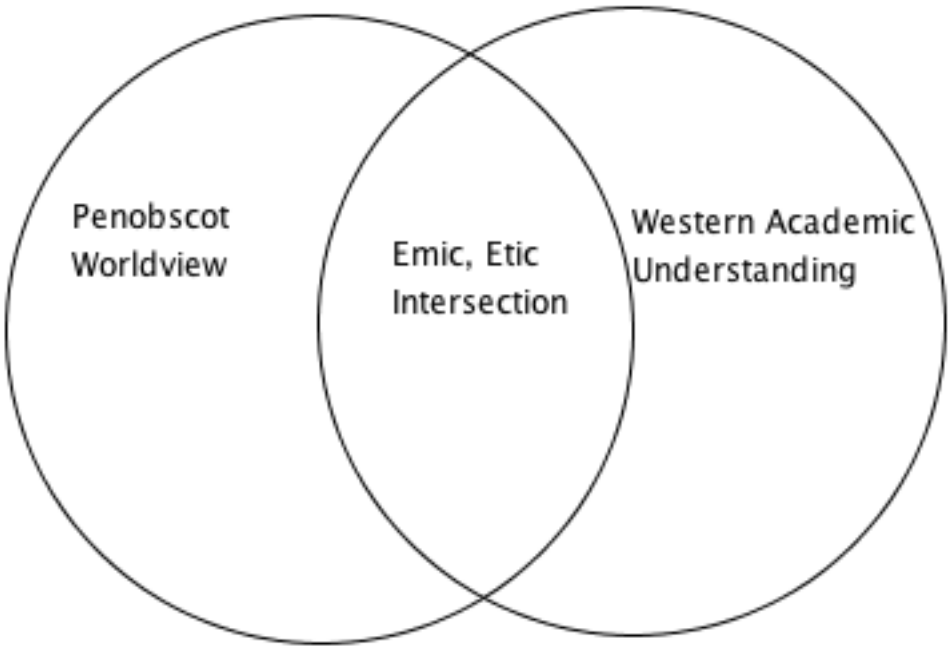
**Etic and Emic**

Ethnomathematics continues to rely on multiple scholarships to further understandings. Linguist Pike (1967) provided the emic, etic perspective that has implications in the building of this summer lodge. Citing his work from 1947, Pike (1967) stated: "…emic systems and emic units of these systems are in some sense to be discovered by the analyst, not created by him" (p. 64). The etic, according to Pike, "etic systems on the other hand, are assumed to be classifications created by the analyst" (p. 64). For our purposes, we borrow the units of analysis from Bishop (1991).

As mentioned above, Shockey is a western trained academic and Mitchell is Penobscot. Shockey was not able to anticipate or oftentimes Mitchell's motivations from mere observation. Conversation between the two of them led to and opened insights through the emic, etic dialogue. According to Pike, the emic perspective is that of the insider, Mitchell, and the etic perspective is that of the outsider, Shockey. From a western perspective, if these two perspectives are considered as a Venn diagram, there is overlap (intersection), but more importantly is the understandings, perspectives that do not lie in the intersection. The academic, western, circle of the Venn diagram is shared understanding for Mitchell and Shockey, the learning occurred for Shockey as Mitchell described his emic view, his Penobscot worldview, see Figure 3. "But in any society as Edward Sapir said, "Forms and significances which seem obvious to an outsider will be denied outright by those who carry out patterns; outlines and implications that are perfectly clear to these may be absent to the eye of the onlooker" (cited in Kluckhohn, 1949, p. 36). Shockey, in the role of the onlooker, was not understanding or seeing everything that was occurring. Kluckhohn (1949) again quoting Sapir, "The fact of the matter is that the "real world" is to a large extent unconsciously built up on the language habits of the group…We see and hear other experiences as we do because the language habits of our community predispose certain choices of interpretation" (cited in Kluckhohn, 1949, p. 167). Shockey's western training as a mathematics educator predisposed him to certain choices, choices that will be highlighted below with (etic) to bring a focus for the reader on the influence of western academic influence. The use of a Venn diagram highlights the disposition that Shockey brings. For clarity, Mitchell and

Shockey are both English speakers and that is language of interaction. Mitchell has the Pasamaquoddy language, but used English in his interactions.

While this paper has a primary focus on views of a Native educator and a Western trained academic, it is important to acknowledge that there were many different cultural groups interacting in the construction. When D'Ambrosio (1985) defined ethnomathematics, he included "children of a certain age bracket" (p. 45). We acknowledge the children, predominantly middle school age (in the United States these are children in grades six, seven, and eight) that come from varied backgrounds as described below.



## Methodology

For two weeks Shockey and Mitchell were on site at the Great Salt Bay in Maine (USA). It is worth stating; initially the pair had no idea as to what "mathematics" would emerge during the sessions. Shockey was unaware of what it meant to construct a hemispherical lodge and could only guess as to emerging mathematics relative to the type of lodge. Mitchell did not see this as an exercise in mathematics, nor was that the intent. As Jorgenson (1989) stated:

> The methodology of participant observation is appropriate for studies of almost every aspect of human existence. Through participant observation, it is possible to describe what goes on, who or what is involved, when and where things happen, how they occur and why… (p. 12)

Shockey and Mitchell are revisiting this project from 2005 with the purpose of exploring the linguistic themes of etic and emic as put forth by Pike (1967). Neither of them were aware of ethnomodeling in 2005.

The first mention of this experience by Mitchell resulted in Shockey imposing himself to be included as the mathematics educator. Jorgenson (1989) states that there are seven basic features of participant observation. His first defined feature: "a special interest in human meaning and interactions as viewed from the perspective of people who are insiders or members of particular situations and settings" (p. 13) best captures Shockey's motivation. Shockey was interested in the experience, interested in ethnomathematics as a lens to develop understanding of what was going to occur, and very motivated to observe a Native educator, educating. This qualitative study has no intent of generalization. During this time data was collected through videotaping and field notes. Videos were transcribed verbatim and images captured from the videos that are used throughout this manuscript to assist the reader's understanding. Throughout the included transcripts we include "Remark" section to state our conjecture inferences of meaning

## Constructing the Lodge, Pedagogical Implications

The Penobscot hemispherical lodge that Mitchell oversaw the construction of was built by visiting groups of school children. For two weeks students from public, private, and home-schooled environments visited the site and "built" the lodge. Students would arrive for two time periods each day, typically a group of students would arrive near 9:00 a.m. and return to their respective school for lunch at noon. A new group of students would arrive near noon and work until about 3:00 p.m. Home schooled children would frequently stay for the entire day. Verbatim transcripts are included below. The legend for the transcripts are as follows: JB – John Bear Mitchell speaking; S – student or students speaking; FN – field notes; events that fit Ancestral Engineering are noted as such; T – teacher speaking; and pedagogical remarks are contained in parenthesis. Pedagogical remarks are not noted as such.

## Preparing the Lodge Base and Setting Lodge Poles

This is the introduction to laying out the circular base to the lodge. The etic is placed in square brackets in italic.

JB: …so it's even on all sides, are there sides to a circle?
S: well not sides
JB: you're right, so we want it even, so how does this make it even? I'm putting this peg in the ground, this is the center of my lodge right here [pounds the peg into the ground], how does that make my lodge even? [*Here John Bear has a short stake he drives into the ground, this stake will serve as the center of the circle, the circumference of the circle will define where lodge poles are placed for the hemispherical lodge. John Bear's use of "even" is a remark about radius and all the lodge poles being equi-spaced about the center he defined with the stake*.]
JB: If I'm going to make this perfectly round, how much string am I going to use? Keeping in mind those are the size of our trees over there, you guys carried them down. Could I make a lodge that's as round as the circle? [*He is trying to get the students to recognize the size of the trees is a variable to consider since their size will determine how big of a lodge that can be built.*]
(With respect to pedagogy, A reader might be wondering about language repetition and pauses by John Bear. This is the first time he has shared his knowledge of lodge construction, so he frequently pauses to consider his articulation of the sequence of events and that these events are in the correct order.)
S: half of one of those trees [*This student's remark has to do with the lodge radius. Since lodge poles are opposite one another on the circle circumference and have to be bent inward and lashed together, the diameter of the lodge cannot exceed the ability of opposite poles lengths*.]
(FN: Pedagogically, John Bear does not have a habit of repeating students, his repetition is usually of his own thoughts.)
JB: Okay you're right, so I've already looked at the trees and the trees are approximately how long in feet?
S: ten feet
JB: ten feet?
S: seven or eight
S: six feet
JB: Maybe about, I was thinking about eight feet, all about eight (he is getting student consensus on this length), the ones you guys brought down, probably about eight feet on average and there are some up there that are longer [*this makes sense since his remark is about average*] I know if I get an eight foot tree and I'm going to bend it in and make two trees come together by bending them in, I'm going to my lodge to about ten to twelve feet across. [*diameter*]
JB: What's your name?
S: Thor
JB: Thor, how far are we apart, stay right there, how far do you guys think we're s tanding apart from each other?
Thor: about nine feet
JB: I would say about nine feet, so if I went one more foot, that's how long [diameter], that's how big that the lodge would be, which is huge. [*At nine feet the area of the circular base would be* $4.5^2 pi$*, increasing the diameter by a foot, increases the area to 25 pi. The area difference is approximately 15 square feet,*

*or an increase of approximately 19%. With a 4.5 foot radius the area is about 63.62 square feet and a radius of 5 feet yields an area of about 78.54 square feet. This is defined as "huge."*]

I think if we come together a little bit more, what's going to happen, we're going to have a lodge that was only meant to sleep in, normally was only this high, like this high right about here [John Bear holds his hand above the ground about shoulder high, describing the height of a sleeping lodge.]

Like about this high cause we're not going to walk around in there, it's a sleeping lodge, a summer lodge. I mean there's very few tents that we set up nowadays we actually, I mean some of you might have them, you get a tent, you're in it, you're hanging out, you're walking around changing and all that without standing right up, but normally these were our sleeping lodges. Now if we got closer, what would happen to our dome? If we go closer what would happen to it, it gets what?

S: smaller

JB: it gets smaller, but does the roof go lower?

S: no

JB: what happens?

S: it gets higher

JB: it gets higher, I'd rather have one a little bit higher, about here (holds his hand up to his nose) so we're probably about eight feet, maybe six to eight feet, let's say eight feet and how tall am I? (John Bear stretches out a piece of twine fingertip to fingertip, arms stretched approximating his height]

S: (after John Bear says "I love you this much" to student laughter) five foot ten, eleven

JB: Well about five nine or ten, I want to be taller, guys want to be taller, I don't know why, doesn't make you see any better (humor is part of his pedagogy) So let's say I went like this, it's like five and a half feet right, then I'm going to estimate a little bit more. Why am taking a little bit more?

S: for your knot [*this is good estimation on the students part, considering that length of the radius would be lost if "a little bit more" was not added*]

JB: for my knot, I'm going to tie it around my pole now. Okay so let's take a try because this is not like a serious math problem where…you know you got people that are actually watching you do this you know [In the discussions leading up to this event, John Bear did not present that he was convinced that mathematics, western, would be used, at this point he began to realize that mathematics was playing a role] It's going to hit or miss, so if I have this string here and I have Mari come stand on the end of it [*John Bear has established the radius which allows him to place the first lodge pole*] (John Bear drives a steel bar into the ground to create a hole for placing the lodge pole in the ground)

JB: Okay so here I am, this is huge and this is probably about six feet, I don't want it to be this big [*six feet is a reference to radius, but now we have determined that the "little bit more" for the knot, that was added to the five and a half feet, created a radius of about six feet*] because looking at the trees over there we got, because we didn't go out hunting for trees, we landed (history reference, building based on local materials) and used what we had, so this is huge, I don't think we

want to do one this big [*Now the lodge floor has grown to 36 pi, approximately 113 square feet, an increase of about 35 square feet from the previous dimensions*]

JB: Okay I like this a little better, this is going to give us a lodge that's about how far [*a question about diameter*]

S: eight feet

JB: I would say about eight feet.

**Discussion of the Circular Base Layout**

The above-described interactions are the negotiations between John Bear and the students for laying out the circular base on the lodge. The discourse between them encourages mental estimation, introduced using body dimensions for approximating lengths, and reveal that John Bear is considering many of the variable that play a role in determining the size of the circle. Particularly, he is concerned that they avoid too large of a lodge, that the trees used for establishing the hemisphere will be long enough when arched over to lash together, and he wants to a have a lodge with a height such that a person could stand upright inside. He has brought the students along with his thinking based on the questions he has posed and revealed a mutual understanding that by decreasing the diameter the height of the lodge will be increased.

The emic perspective for the floor layout reveals the importance of approximation, body dimensions for measurement, and the use of the word "huge" that is not quantified. Recall this is a summer sleeping lodge that John Bear described would serve a family of four. The lodge's purpose beyond sleeping is that it would allow the family a place to retreat from inclement weather and be large enough that if the family had a visitor, there would be ample room for the guest to sleep as well. John Bear faced many practical problems associated with this base layout. In the instances where he was repeating a students' remark, it allowed him mental time to determine if the dimensions associated the circular base, tree length, and height were going to work. From an etic perspective, there was a tremendous amount of spatial reasoning occurring on his part.

**Creating the Circumference**

The second phase of the lodge layout dealt with laying out the circumference and spacing of the lodge poles. The emic is contained within square brackets in italic.

JB: Now we need to start getting poles and we will do one at a time. We'll put on pole in a hole right there and then we'll completely opposite [$180^0$]. Can we use an odd number of poles, can we use thirteen poles?

S: no

JB: What would happen?

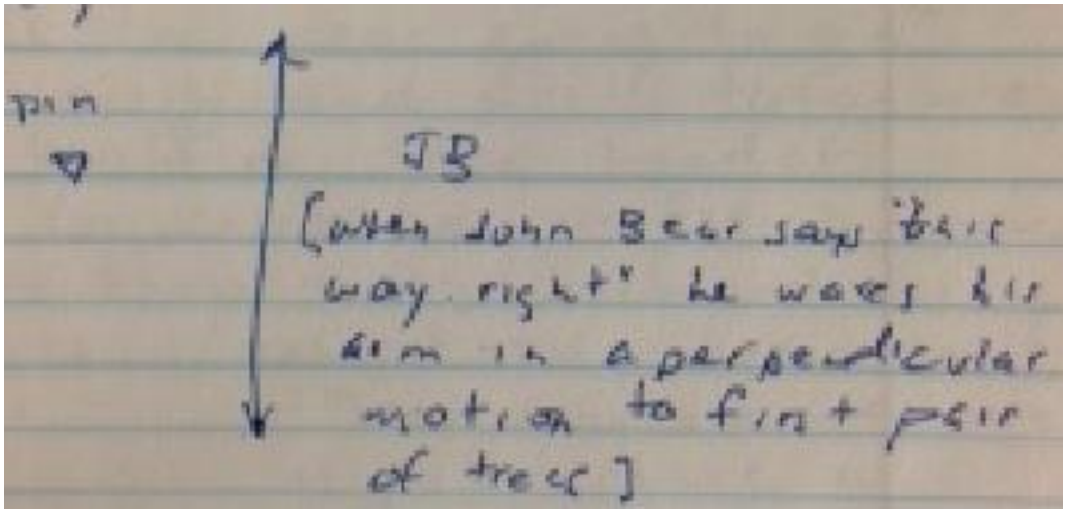
S: (the students chorus of response was not understandable)

JB: Yeah, it would be bad, in that we have an odd number of poles and we're trying to make a dome and you have two pole connecting [*opposite poles, $180^0$, are arched toward the center of the circular base and lashed together, so there is a need for pairs*].

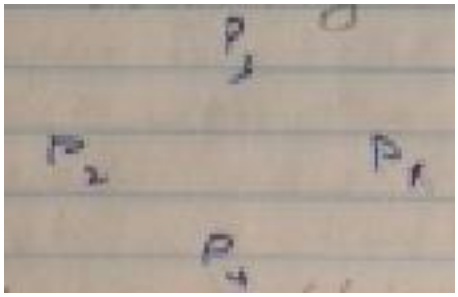
JB: Where would be a better place to go? This way right? [This question is about the placement of he second lodge pole, one strategy would be to estimate arc length and place lodge poles equi-spaced on the circumference. There is no response from the students as none of them have ever built a hemispherical lodge.]

Remark:

When John Bear states "this way right?" he waves is arm in a perpendicular motion with respect to an imaginary segment joining the first two lodge poles. With this gesture he has created two perpendicular axes that intersect at the stake that serves as the center of the circular base, see Figure below from field notes.



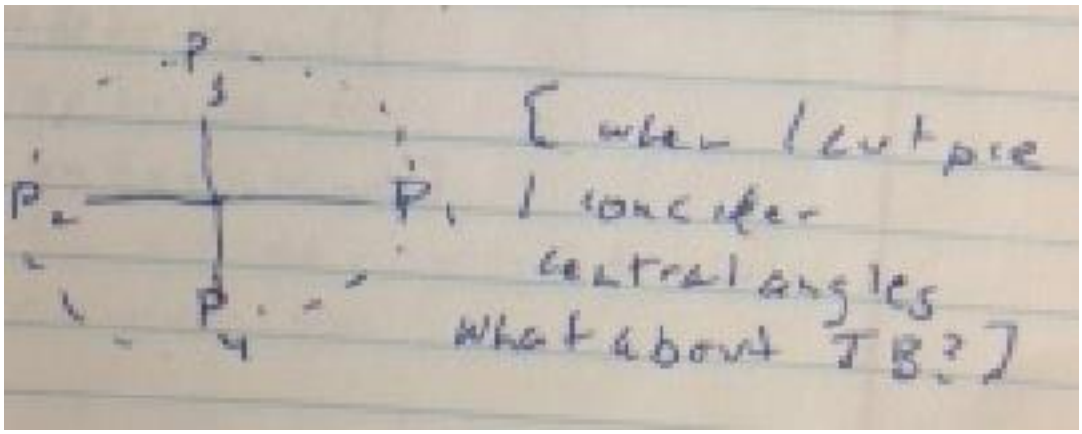

A result of this motion is the mental image of the first four lodge pole place, oriented about the "pin," which is the center of the circular base, see Figure below.




This orthogonal arrangement, imagining the center pin, creates a mental image of four quadrants. This action of using "completely opposite" allows the first four poles to be equal spaced about the circumference, allowing for placement of the remaining poles to equal spaced as well.

JB: And then, so we have our four poles, we have our four poles standing (FN: this repetition allows time for John to think about the next event in the sequence of laying out the lodge poles), and then we probably want to go in between again,

we're going to estimate the distance between poles [*this is arc length or central angle*], so it's like we're cutting a pieces of pie, see Figure below.




Remark:

John Bear's analogy, represented etically above, could be about central angle or arc length from a western perspective. His creation through language of this mental image gives the students an insight into what is going to occur next and how he is visualizing the process.

JB: We've got to go really even [*making sure that opposite lodge poles lash together, can be considered from a symmetry perspective*] and we have another issue here that we have to look at, that's where is the door going to go? Traditionally and still today when we're building one of these kind of lodges we always go to the east, we always face our door to the east. That way when the sun rose over our head that's a ceremonial direction, that's the direction we come from (John Bear points to himself) as Wabanaki, the Dawn People, but it's also good to have the door to the east because we didn't have any windows right, so what happens when the sun comes up on a cold morning?

S: [the chorus of response is not understandable]

JB: Okay, it's colder right before the sun come up, when the sun starts coming up, the sun throws off this stuff and makes us feel wew (he begins fanning himself, pulling his shirt as if he's sweating)

S: heat

JB: Heat, that you that's basic science and when you open your door the heat will come into your house right? And it will warm it up if you have door facing east. [Ancestral Engineering] So our doors going to face the east, where's the east? Just point to it.

S: (there is pointing and discussion, the sun is directly overhead when this question is posed, so the students have to negotiate from their collective understanding, they finally reach consensus and point toward a pick-up truck)

JB: Yeah, it's right about where that truck is, east is right there so it came down from somewhere over here [*This fits with Bishop's (1991) location but it also fits with the above discussion of the placement of the lodge poles being*

*opposite one another or 180$^0$, the sunrise and sunset are opposites.*] We're going to have a door facing about where that truck is, so is this a good place to have a pole? Put our door in the middle of a pole? It wouldn't be good, so we want our door facing east, well we're going to have a pole here (John Bear is physically locating the spot for students to see) and we're going to have a door here, so our door could go right here between these two poles, is this east?

S's: No

JB: Not exactly, but is it close enough?

S's: Yeah

JB: Yeah, it will do right? So we're going to put our door here so this is a good place.

Remark:

While the initial four poles are placed as shown above, from an etic perspective as described above, the remaining four poles would be placed either by central angle or arc length, making sure each pair is opposite. As an outsider looking in, what is "obvious" is not: Kluckhohn (1949) was clear on his view of the outsider looking in when he quoted Sapir: "But in any society as Edward Sapir said, "Forms and significances which seem obvious to an outsider will be denied outright by those who carry out patterns; outlines and implications that are perfectly clear to these may be absent to the eye of the onlooker" (p. 36). As the outsider looking in, there was no consideration of the door placement and how that might impact the placement of the final four lodge poles.

JB: I think we're doing an eight pole lodge, one, two, three, four, five, six, seven, eight [*he is counting while pointing to the circumference*]. I made a mistake when I was thinking to myself earlier, twelve pole lodges are ceremonial lodges, if we did a twelve pole lodge you're going to be able to crawl on the thing it's going to be so solid, eight pole lodge is going to be solid as well, so I need eight poles, could somebody go, could we have eight people go choose, may we get teachers to help? [At the lodge pole pile, students are trying to dig through the pile to choose eight, while John Bear is culling out the poles that don't look bendable.] Okay without having to say it, you guys paired these trees up pretty good, now we're not pairing up from the base, we're pairing up from the top, right?

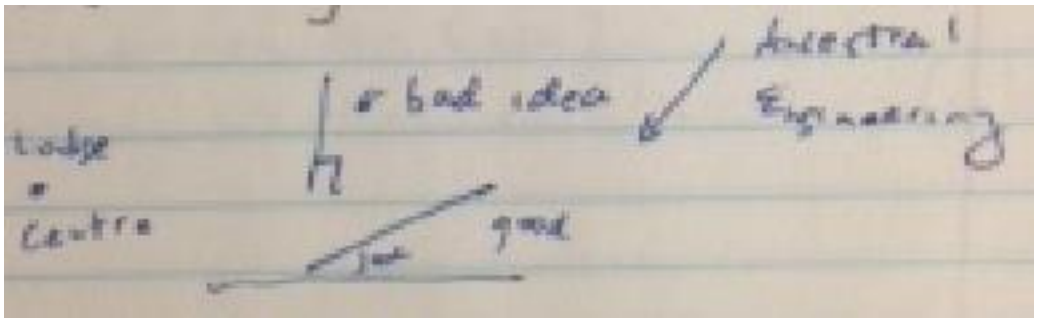
S's: Yes

JB: So what we're going to do is, I have a number of adults here, probably three of us that can do this, we have to sharpen the bottom of these poles. And so what we need to do is take a look at the bases and the base of this one is pretty bent, right? But, when we're building this lodge are we going to put the poles straight like this? [*Here John Bear models is question by holding the pole perpendicular to the ground*] And then bend them this way [toward the center of the circular floor], what happens if we put a pole here and we tried to bend it?

S: It's going to break.

JB: It's going to break, because it's standing straight up and we're just pulling it over right? Something else is going to happen to it, it will pop out [Ancestral Engineering] So I want to get an angle on here that's not straight [*straight is the insider view for perpendicular*] (John Bear has a five foot steel bar that he uses to

create holes about the circumference where the sharpened base of the lodge poles will be inserted) What we're going to do is we're going to come in at an angle with the poles, okay? (see Figure below) [This is an instance of the pole position being "perfectly clear" but "absent to the eye of the onlooker" ( Kluckholm, 1949, p. 36).




JB: So basically we're going to put the pole in the ground, we're going down, just try to make the hole at about this angle so that's where our tree going to stick in, so if this tree that I am holding, watch your head over there, and I stick it in the ground, is this a good angle?

S: Yeah

JB: This one will work, , it just so happens the one I, another one I cut was real squiggly and it just doesn't work, so what we need is someone to hold this up and someone to sharpen it (John bear is modeling holding the pole with the base against a log, someone else will then use an axe to sharpen the resting base of the pole. A teacher volunteers to hold the tree allowing John Bear to demonstrate how to use the axe to sharpen the base of the tree, making it easier to place in the hole on the circumference.)

Remark:

To this point in the construction, John Bear has layed out the radius for the circular lodge base and has begun giving instructions and demonstrating how to place the lodge poles. Before he places the first lodge pole, he says to the students "so basically we know our concept, right?" This statement was met with agreement by the students.

JB: What I'm going to do, I'm going to do one of these by myself and let volunteers do the rest. (Pedagogically, John Bear emphasized modeling what was to occur next in the construction of the lodge.) I just want the hole to get kind of wide, but not too wide (he places the first lodge pole), okay that's probably good, now we want to go opposite this [*this can be visualized as placing the second lodge pole* $180^0$ *around the circumference from the first lodge pole*] our strings down here somewhere [the string represents the radius] you want to make sure it goes at an angle (John Bear has already modeled how to create the hole for the lodge pole, this remark is a reminder of the needed angle. John Bear is not actively engaged in placing the second pole, he is standing opposite holding the first lodge pole.) Want to go down about a foot and a half (this is how deep the lodge poles are

placed in the ground) that means we need to sharpen another pole. (As for sharpening the poles, while this has been modeled, it is not something the students are allowed to do, due to the axe being very sharp. John Bear continues to sharpen the poles so as not put anyone in harms way.)

T: At this angle, then jam that thing in there (The first adult that John Bear modeled using the steel bar to create an angled hole in the ground for placing a lodge pole, in this statement is now modeling for a student of how to use the steel bar for that purpose. For this part of placing the lodge poles, creating a hole in the earth about a foot and a half deep at an acute angle, John Bear is now done as others have taken over that responsibility.)

Remark

At this point in time, the lodge poles are all placed about the circumference of the circular base. What follows are the instructions for how to bend opposite lodge poles together so these can be lashed together, see Figure below which shows how the poles are placed prior to being lashed together.

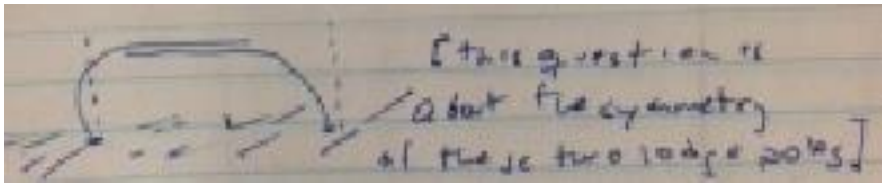
JB: I'm left handed so I've got to stand with my back to you (John Bear has his back to everyone in the Figure above and is preparing to model how to bend the lodge pole toward the center of the circular base.) I'm going to bend it this way, but what we're going to do, I'm going to stand on the base [Ancestral Engineering],

we're going to need someone in the middle who's tall, your job is going to be to grab the tree, but not pull it, just hold it. And then what we'll do is let somebody eyeball it when they (the lodge poles) come together, they're probably going to bend way over each other, that's okay, you're going to hold them at the middle, at the peak where they touch and we're going to tie them. This will be the quick first tie and then we'll cut the branches where they come down too far, okay? So this is what I'm going to do, I'm standing here right (there is a student at the opposite lodge pole, John Bear is talking her through and modeling the process for bending the lodge pole. In the Figure above, the student is wearing a short sleeve green t-shirt.) Notice my feet are in the lodge (Referring to being inside the circle, which is the position he wants the student opposite him to also be in.) I kind of walk (John Bear's hands are "walking" up the pole, pulling it toward the center to initiate an arch. With his feet placed firmly against the base of the lodge pole, he assures that the lodge pole will stay fixed in the earth.) very slowly, don't pull.

Remark

From the field notes, an interesting, intrusive event occurred at this time. The student opposite John Bear was following how to move her hands so that she was "walking" her hands up the lodge pole. John Bear was speaking directly to her when he said "don't pull." The students' impatient teacher physically pushed her out of the way and took over the process of bending the lodge pole toward the center. From the field notes "the teacher's actions are not following what John Bear modeled, he has managed to stand the pole vertical (he did not place his feet against the base of the lodge pole) without regard for the student attempting to walk her hands up the lodge pole." The rudeness of this teacher is noteworthy for two reasons. First, his actions demonstrated that he did not value the effort of the student and second, he imposed his own strategy for bending the lodge pole which resulted in the lodge pole not being in the ground at an angle, but perpendicular to the surface of the earth. Later in the day John Bear and Shockey pondered how frequently teachers get impatient with students, resulting in the teacher not allowing the student to participate in the learning moment.

JB: Come down, now are these pretty even *["Pretty even" is about symmetry, see F igure from field notes below.*]



S: Not bad (FN: the poles can be adjusted before being tied, so a viewer away from t he lodge makes the symmetry determination)

JB: Let's tie this, go ahead you've got the string, kind of wrap it in the middle. Now this lodge is huge, we can stand up in it. (With the lashing of the first two lodge poles John Bear realizes that he standing under these with plenty of space

between the top of his head and this first arch.) [FN: previously the estimated lodge pole lengths were guessed to be about nine feet, these lodge poles are probably twelve to fifteen feet in length, maybe longer.] And I've actually made these so big that we've had to use ladders in the back of a pickup truck to reach the middle.

Remark

This process of bending lodge poles continues until all eight poles are secured forming the dome. The next phase in this construction is the placement of poles around the perimeter of the lodge poles, and these poles are parallel to the ground.

JB: You'll see the true shape of the lodge. What you're going to do, you're going to take string and you're just going to tie it around here like an X. So you probably want to get a piece of string that's about four feet long and you want to wrap it around and wrap it around the other way and just tie it off. [FN: the instructions are vague enough that students have to make decisions.] We're going to do our first row about here [FN: about knee height] and we're going to do another one about a foot and half and in the smaller space we're going to start putting sticks across. (These side poles add tensile strength to the lodge. The "smaller space" is a reference to the moving toward the top of the dome, the lodge poles converge on the top and distance between them shortens.)

Remark

From the field notes: "The students are busy putting the "rails" on the lodge, taller students are working on the top, shorter students are working closer to the ground, lots of eager hands. John Bear was off to the side talking with an adult, watching the students.

His role was that of helper, now as he has modeled what the students needed to do, he is an observer. A student had a question, John Bear stopped his talking to help." These notes are shared to reinforce how John Bear's pedagogy engaged the students and how after he modeled a situation, he would get out of the way and allow the students to work. During this process, students were making decisions, negotiating meaning, and on the occasion when a question was posed to John Bear, it typically meant that the students had reached an impasse and were uncertain of to do next.

JB: Okay buddy, how highs our door going to be? We don't want it too high, no too high (Here a student is placing a horizontal stick that will serve as the top of the entry way.) Okay, so what you're going to do is take a piece of string, okay swing around here, want to come out on the other side. (Here John Bear is giving verbal instructions for the student as he wraps the string around the horizontal stick to secure the two ends to lodge poles.)

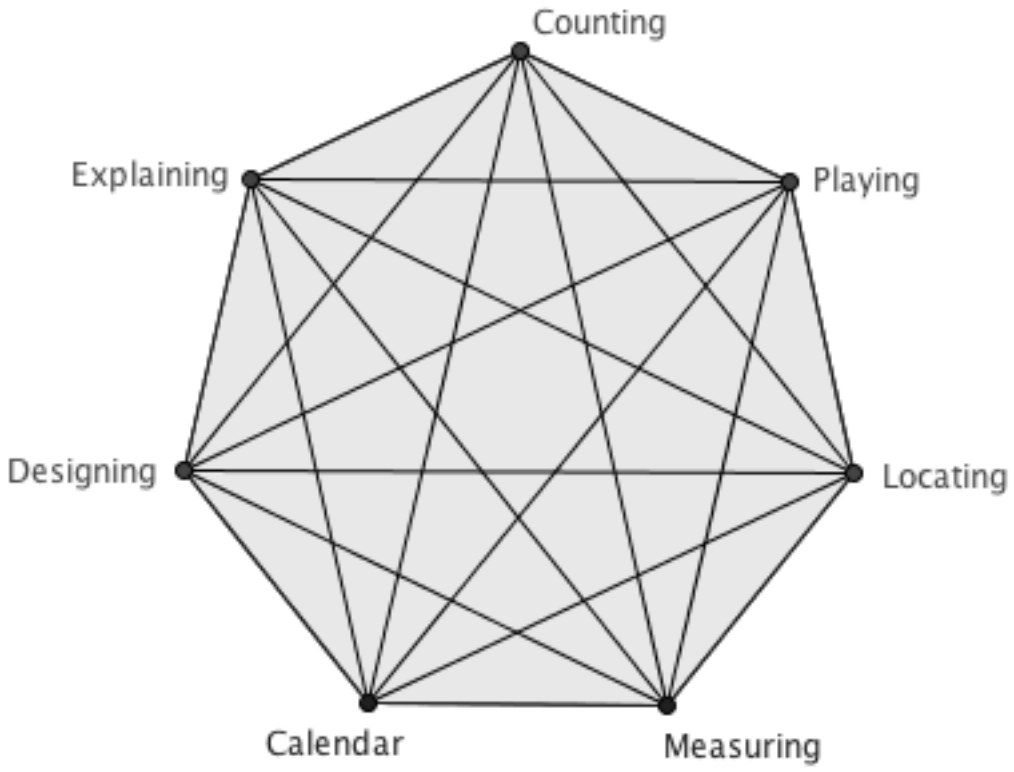
Remark

From the field notes: "Without roles being assigned students have just taken over, some are bringing poles to be lashed, some are distributing strings, adults are cutting strings, students are holding poles while other lash, just in a general sense of cooperation." This is important, at this point the students "own" the project. They have come to understand what needs to happen next and have embraced to construction. In the episode described

above of the placement and lashing of the horizontal poles, the video shows a girl stopping the placement of the horizontal poles as she realizes they are not parallel. The first horizontal pole was placed about a foot and a half from the ground, but when the horizontal pole above it was placed, the gap was not even, not parallel. This student imposed a unit of measure to assure that these poles would be parallel, the distance between her elbow and closed fist. She walked about the lodge, would place her arm to make sure poles were parallel and other students would lash the horizontal pole in place, it was brilliant.

**Practical Applications**

Considering the Ancestral Engineering (Corrine Mt. Pleasant Jette, personal communication) perspective that Mitchell brought to this construction, it is rich in relationships. Lodges were typically built based on location using available materials, which led to Shockey and Silverman (2016) to expand Bishop's (1991) six cultural activities to seven, inclusive of calendar (see Figure below). Each of the vertices are connected in the Figure below as we feel these are not independent events, we go so far as to suggest that the activities would potentially be different based on the time of year. For example, this is a summer lodge being described; a winter lodge would begin with circular base that was a "cylinder" as it would be dug into the earth that would provide insulation and opportunities for heating during the winter.




Calendar as considered in this application was an important consideration, the types of materials that were available in the autumn, the time of this construction, were different than early summer materials. For this construction, built on the Great Salt Bay, the consideration for a hemispherical lodge was important, as it would withstand strong winds. The Great Salt Bay is a tidal area, considerations for wind as well as tide were taken into consideration with respect to the type of lodge as well as the location of the lodge to avoid flooding, see Figure below.

The circular base of the lodge was purposeful. Mitchell, approximated his height with outstretched arms, which served as a "radius" for the lodge floor. Mitchell cut a piece of twine to represent this radius, attached the twine to a center post allowing him to construct a circle as he walked around the center post as he held the twine. As Mitchell was establishing the perimeter of the base, he was also considering the purpose of the floor space. The floor space served as sleeping space as well as working space inside the lodge. Children, adults, and guests would sleep in different regions of the lodge and if there were no guests then there was interior workspace for preparing food. Cooking was not done inside the lodge, the workspace would allow getting out of inclement weather.

Another practical application of using body height to approximate the floor space dealt with the interior height of the lodge. Mitchell understood from his perspective and experience that a summer lodge with the stated radius would also provide an interior height so that he would not have to stoop while insider. This consideration of interior height is important for the inhabitants of the dwelling to be comfortable.

To this point in "designing and building" Mitchell was considering the practical elements of the lodge. Another consideration was the length of the poles that would be placed about the boundary of the circular base. In his mind he was "calculating" the length of the needed poles, such that opposite poles would be lashed together over the center of the hemisphere. The lodge poles had to be long enough to satisfy three conditions, the portion of the pole that would buried in the ground, the length of the pole that while arched would be long enough to cover the lodge radius and the third portion has to be of suitable length such that when opposite poles were lashed together there was enough overlap.

Tall grass was available, which would be weaved into mats that would serve as one layer of the lodge covering. The lodge could not be larger than half the length of the lodge poles, but had to be large enough to be functional. The placement of eight lodge poles about the circumference was needed, but the placement had to allow for the placement of the lodge entrance to face the East. As Mitchell shared with the students, "but we always go to the east, we always face our door to the east and that way the sun rose over our head. Now two different things, first of all that's a ceremonial direction, that's the direction we came from as Wabanaki, the Dawn People. But it's also good to have your door to the east because we didn't have any windows right, so what happens when the sun comes up on a cold morning?"

The lodge had a circular base with eight lodge poles equi-spaced about the circumference. The etic perspective can focus on the determination of the placement of the lodge poles on the circumference, while the emic perspective brings much broader considerations. With the placement of a stake in the ground to represent the center of the lodge and a string to determine the base radius (etic), Mitchell supports the response of the students with respect to making the lodge "even." Students immediately recognized that the lodge poles and the lodge radius are related. When a lodge pole is placed in the ground, it is then bent toward the lodge center and tied to an opposing lodge pole that is also bent toward the center. Symmetry (etic) of the placement of the poles is important, but as important is how the length of the poles determines the area of the circular base of the lodge (emic). The circular base serves three distinct purposes: two areas for sleeping, children and adults; and a workspace. The lodge was a summer lodge that provided shelter from summer heat and summer rain.

Mitchell's pedagogy related to the initial placement of the lodge poles and the east-facing door revealed a Native pedagogy based on modeling and questioning. As noted above, the placement of the lodge door to the east allowed the heat of the sun to heat the lodge in the morning. The placement of the lodge poles into the earth revealed learned engineering that Mitchell modeled for the students. Lodge poles were stuck in the ground at an acute angle, with the pole facing away from the lodge center (emic). Had the pole been placed straight into the ground, the likelihood that it would spring out of the ground causing harm was much greater than with the acute angle placement. Once this placement was modeled, Mitchell would step aside and allow the students, and their teachers, to take over the construction. If assistance was needed, the learners understood that it was appropriate to pose questions. Once the eight lodge poles were placed and the placement of the door was negotiated, Mitchell intervened to provide modeling of how to secure two, opposite lodge poles together over the center of the lodge. Once this was modeled, Mitchell would again step aside and observe. Mitchell's pedagogy was also conversational. When he posed a question, he was very attentive to the students' responses. As Mitchell directed the dialog, sense making occurred, meanings were negotiated, and connections were made. For example, once the lodge poles were placed and secured to construct the dome frame additional poles were placed about the lodge, parallel to the ground, adding strength to the lodge. It became immediately apparent to one student that these poles were not parallel. She quickly determined that the unit of measure determined by the distance between her elbow and fist would ensure that these additional poles would be parallel.

## Challenges

Gilsdorf (2012) in his seminal book Introduction to Cultural Mathematics, makes clear that using Western mathematics to describe cultural phenomena is problematic.

> Writing about the topic of cultural mathematics for readers with backgrounds primarily in Western mathematics brings one to a dilemma: On one hand, using Western terminology and notation to describe mathematics of non-Western cultures is inherently inaccurate because people in such cultures would not think of the mathematical content in the same way as it is perceived in Western culture. On the other hand, if the goal is for people of Western backgrounds to understand how cultural activities can be understood as mathematics, then one must speak to readers in familiar mathematical terms. (p. xii)

This is a dilemma for the authors as well. Shockey, a Western trained mathematics educator does not understand the Passamaquoddy language of Mitchell, thus the descriptions are in English, allowing Shockey to understand.

As a western trained mathematics educator, Shockey experienced the 'because of the language habits of his community,' (Kluckhohn, 1949, p. 167), the community of mathematics educators. While a challenge, this is important to bring the etic forward. Certainly Shockey and Mitchell have similar linguistic backgrounds (Whorf, 1956c) but only with respect to English. And as Whorf (1956c) states, "We are thus introduced to a new principle of relativity, which holds that all observers are not led by the same physical evidence to the same picture of the universe" (p. 214). How Mitchell viewed this and how Shockey viewed did not all reveal the "same picture."

## Concluding Remarks

In Tribal education, knowledge gained from first-hand experience in the world is transmitted or explored through ritual, ceremony, art, and appropriate technology. Knowledge gained through these vehicles is then used in everyday living. Education, in this context, becomes education for life's sake. Education is, at its essence, learning about life through participation and relationship in community, including not only people, but plants, animals, and the whole of Nature. (Cajete, 1994, p. 26)

We concede the argument that the practicality of the lodge is questionable in modern society. The "mathematisation" that was captured and discussed is valuable. The "first hand" experience of these students and what value it brought to them personally and educationally, we can never know. Although: during this two-week event, many students self revealed in confidence that they were Native. These students would mention a family member that lived on the reservation to learn if Mitchell knew them. This emerging "dignity and confidence" was emotional. We can only conjecture that the experience of working on the site directed by a Native Educator was respectful enough of each learner, such that the Native youth found the confidence to share who they were.

We feel that this adds to the ethnomodeling literature. Rosa and Orey (2013) state that ethnomodelling is "a practical application of ethnomathematics, and which adds the cultural perspective to modelling concepts" (p. 78). Throughout we highlight the Penobscot perspective that Mitchell brings to this. We illuminate how important modeling is.

We acknowledge that the analysis using etic and emic may be problematic:

> So analysis from a western perspective breaks everything down to look at it. So you are breaking it down into its smallest pieces and then looking at those small pieces. And if we are saying that an Indigenous methodology includes all of these relationships, if you are breaking things down into their smallest pieces, you are destroying all of the relationships around it. So an Indigenous style of analysis has to look at all those relationships as a whole instead of breaking it down, cause it just won't work. (Wilson, 2008, p. 119)

We include Wilson's remark above, acknowledging that while we did not engage an Indigenous methodology, we respect the importance of relationships.

While Mitchell is western trained as an educator, the teaching cliché of 'we teach the way we are taught deserves elaborations. Had Mitchell taught the way the academy prepared him, the outcome, we believe would be very different. Fortunately Mitchell taught the way his Elders taught him. He would model activities in the sequence that when finalized would yield the dwelling. This was not a linear trajectory. His teachings were mixed with stories and opportunities for discussion. Once he was convinced that students understood, he would stand by and allow them to work, to make sense, and to serve as a helper if the students needed help.

In 1928 Schlauch wrote:

> Any normal child is blessed with natural curiosity – that heritage of the evolutionary struggle during which not to comprehend the environment and its dangers meant death. Children take joy in mastering knowledge which they can see has some relation to the phenomena of their lives. It is only the mass of abstract material in a dull curriculum, unpedagogically presented, that finally kills the desire to learn. (p. 28)

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