Yes, Mary, There is Math in Latte

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Math in Latte

This paper describes the latte, the building of a latte post and hypothetical explanations for the phenomena of the latte structures that existed thousands of years ago. The latte is an upright stone structure consisting of two parts. The *haligi*, the bottom part, is a trapezoidal vertical pillar averaging from four to fifteen feet in height. The upper part is the *tasa*, a large capstone, placed on top of the *haligi* with the smaller side touching the *haligi*. These latte structures were occupied by Chamorros on Guam, Rota, Tinian and Saipan around AD 400–800. Modern-day buildings in these four islands do not sit on top of latte structures. However, the latte form is still admired, as shown by the use of symbolic and artistic applications in much modern-day architecture in the four Marianas islands.

I chose the latte for my topic because I found it interesting and I believe not many of our young Chamorros know about latte. Even while growing up on Guam I do not remember studying a lot about latte in the classroom. The Chamorro classes taught cooking, weaving, some language, and several legends, dancing, and singing. While the latte may have been mentioned, it was not expanded on. Thus, when visiting latte sites I did not realize I was looking at something that played a significant part in Guam's history. I did not know what was involved in the making of the latte and its uses.

I believe that today even among a large portion of the Chamorro population, knowledge of the latte is limited. Perhaps only specialists, such as those who work at Department of Parks and Recreation and professors who study the culture and life of Micronesia, may have good background knowledge of the history of the latte. Even my eighty-one-year-old father said he did not know a lot about the building of the latte but related the latte to stories about *taotaomona*

(spirits of Chamorro ancestors). Unless a person was actually studying latte their knowledge would be minimal.

I know there is a lot of math involved in latte. The major math areas would be in geometry to study the shapes and even landscape and measurements to study the structure and other related areas such as the location of latte sites. Questions and activities could be developed for all grade levels from kindergarten to twelfth grade. It is unfortunate that most latte sites have been destroyed by nature as well as man. However, sites exist in each of the four islands listed above with at least a couple of latte sites having structures that are still upright. Reinman and his team reported over two hundred fifty latte house structures on Guam based on a site survey conducted between 1965 and 1966 (Reinman 1973). However many of these sites have been destroyed due to natural disasters, wars, and destruction to clear the area for whatever modern development.

My research on latte has inspired me to plan a trip to Rota, Tinian and Saipan to check out at least one of the sites in each to compare them with the ones on Guam. Rota has a site with the tallest or biggest latte but none of the *haligi* or *tasa* are upright. Tinian has the site with the tallest upright latte. I wonder which island was the first to build a latte.

I believe that lessons based on the latte could be presented according to the ability of the different grade levels. How it is presented would determine whether students want to study it and whether they will learn not only about the history of the latte but the math involved in it. It would be great if students would feel the excitement and interest in learning about what their ancestors built, and the past knowledge of resources, tools, lifestyle, and ways to survive, compared to the same ideals of today. Otherwise, we will have to learn how to catch their attention and foster learning through whatever video or techno games students play with today.

Methodology

I interviewed four people. William Hernandez, a historian for the Department of Parks and Recreation, was the first person I interviewed. He was the first who told me to say only "latte" and not "latte stone". He said that "latte" means stone, so if I say, "latte stone," I'm actually saying "stone stone" I was reminded to read up on latte before the next interview. However, the questions I had were enough for a two-hour interview. He also recommended that I interview three other people including Jose Garrido and Al Lizama.

My second interview was with Al Lizama. Mr. Lizama has been around the world and says that all his past experiences, whether good or bad, on Guam or in the mainland, contributed to the person he is today. He had a wealth of information about latte and has been to many latte sites on all four islands. He also has pictures of artifacts found in some of these sites. His interview reminded me of how the discussion of the latte can go off on a tangent to things related to or found at the site such as pottery, worship, cooking, medicine, burials and other aspects of Chamorro life in the past.

My third interview was with Mr. Jose Garrido. Mr. Garrido is a linguist and oral history specialist at the Department of Parks and Recreation. He touched a little on the counting system of Chamorros and its relation to the building not only of the latte but of the outrigger, and he talked about other observations he has made of the past. He reiterated what the first two interviewees said, that knowing how to build a latte structure showed that the Chamorros of the past were very intelligent and resourceful.

Dr. Larry Cunningham was the fourth person I interviewed. He gave me a paper on one of the activities his ninth grade class did in figuring out the weight of a *tasa* in Rota along with

other measurements on site. He shared a wealth of information in the short time we had before he had to leave for a presentation. He showed me many illustrations in a copy of a book that he had. Unfortunately, he was not able to lend me the copy as he was using it at the time.

William Morgan's chapter "The Mariana Islands" has many illustrations of individual latte posts with the *haligi* and *tasa,* maps of latte sets and pictures of latte in the four major Mariana islands (Morgan 1989). Victoriano April wrote a paper (2004) describing latte sets on Guam, Saipan, Rota and Tinian. He included descriptions along with measurements of capstone depressions found in the latte sites on the four islands. Rainbird's "*The Archaeology of Micronesia*" (2004) offers descriptions of the settlement of the Mariana Islands and how the latte was used to determine where the first inhabitants on Guam came from. He also agrees with many of the other authors who said there is a lack of facts and accurate information about the latte because the first people who wrote accounts about the latte were influenced by their own cultures and their beliefs.

I have also read articles on the latte that I found at the Micronesian Area Research Center. I was surprised at some of the information that I got from the articles. It was like standing outside a window and looking in to see things that other people wrote. It was kind of disappointing at times when people as well as articles say there is no written document or people alive who really have an in-depth knowledge of the latte. In most of the papers, authors, archaeologists, and researchers would cite earlier scientists and explorers. Each citation, however, would explain how difficult it was to be completely accurate because written reports or documents on the Pre-Latte or Latte Period by people living around that time could not be found.

Prior to the interviews, I believed that I would get accurate facts or responses. However, I have found that the answers given were conjectures that individuals developed from their

research, readings or studies of the latte. The papers I have read cite writings of other explorers, archaeologists and people who came after the Latte Period. However, the ancient Chamorros did not have a writing system and the visitors who came soon after the Latte Period did not study or record any information around that time. Any information written would be biased towards the culture of whomever was visiting Guam. Although extensive studies have been done of different cultures in Micronesia, the Marianas is unique in its development of the latte architecture. Thus comparison of the latte to other Micronesian cultures was and still is very limited.

I started out with the following questions but expanded or added more as people shared their thoughts and knowledge.

1. How or why was the shape of the *haligi* and *tasa* chosen?

2. How long did it take to build the latte house?

3. Were lattes built only at certain times of the year or could they be built at any time?

4. How is the building of latte houses related to the wind factor?

5. Did latte buildings have different numbers of latte posts underneath?
   a. If so what are some of the numbers?
   b. Why were these numbers used?

6. Did any of the latte posts use pivoting in its structure?

7. What types of measurement and tools did the Chamorros use?
   a. To shape the *haligi* and *tasa*
   b. To determine that all latte posts were at the same height level
   c. For accuracy or precision

8. Were there different-sized lattes within a site or within a village?
   a. If so, why were they different?
   b. Can individual groups have different-sized latte in the different villages? (Ex.: Are all latte homes for chiefs the same size in all the villages?)

9. Were patterns or lines of symmetry used in building the latte or latte sites?

10. In regards to the pottery and other artifacts found in latte sites.
    a. Did any of these artifacts have a similar shape to the latte?
    b. If so, which ones and why?

I believe my research on latte is not as complete as I would like it to be. However, even though it is not complete I have come to believe that math curricula could be developed around the latte. More research should be done to ensure that the factual content can be supported when questioned. While doing research and interviews, I realized what I needed to do if I plan to compare and check what each author or interviewee said. I would break down the different educated conjectures and then list the historians, archaeologists, authors and all people involved under the conjecture they support. I would also arrange them in chronological order. Just by doing this I can picture math activities that can come out of the list or table.

Each time I review my paper, I see something that I could add to be used for a math curriculum. It seems the possibilities are endless. I could touch primarily on geometry and measurement as major skills involved in the latte. Then we can add on more activities in other skills that arise during the initial creation of the math curricula on latte.

Description

Scholars have been interested in the latte for understanding cultural sequences in the history of Guam. The latte is important for its use in studying the development and organization of Chamorro society before, during and after the latte periods. The three historians and professor whom I interviewed spoke about the Pre-Latte and the Latte Periods. All the people I have interviewed and papers I have read say there is no documentation that states absolutely who were the first occupants on Guam. Mr. Garrido, a linguistic historian, along with other archaeologists such as Peter Bellwood and architects such as William Morgan believe that the first people on

Guam came from the Philippines. Dr. Cunningham believes they came from the Caroline Islands. All the people I interviewed believe that Guam was first occupied at least 3,000 years ago.

The three historians, professor and documents indicate that burial sites and latte sites they studied first existed around AD 400–800. They claim that the strata of soil that they observed and the artifacts found in each layer helped them to date each layer. Thus they assigned an approximate date for the beginning of the Latte Period. Others used reports written by visitors to Guam to estimate different time periods. However, reports were biased according to the interests and intent of the visitors such as religion and military occupation.

There are many caves throughout the island with artifacts, and charcoal on the ground and ceiling, which indicate that Chamorros at some time temporarily used the caves for special purposes. Houses that were built on the ground with coconut and other types of wood were found to be impractical and easily destroyed. Later, still during Pre Latte times, structures were raised on posts that were usually made of wood. These were good during the dry season but during the typhoon season the wooden posts were easily washed away, bringing down the house and all that was within it or around it. It was the custom to have family burial sites around the homes. So, when the house and posts were washed away, landmarks of their homes or their burial sites were also washed away. This made it difficult to locate where loved ones were buried. This also forced the people to rebuild after each storm.

It is around this time that the Latte Period started. Again, we don't know which group of people started this and we are estimating the time. The Chamorros needed strong posts to keep their structures intact during a storm. The posts had to be strong enough to withstand typhoons

so that it was no longer necessary to rebuild after typhoons. It is easier to replace thatched walls and roof than it is to replace the house posts.

Most authors and people interviewed agree that the latte was unique to the Marianas specifically Guam, Rota, Tinian and Saipan. They agree about how the *haligi* and *tasa* were formed, the least and greatest number of posts, and the possible uses of the latte houses. They agree because they have seen the latte posts still standing even if the *tasa* has fallen off. Artifacts and relics are found around the site from which they can conjecture. However, there is disagreement about the shape of the houses on top of the latte posts.

Sister Felicia Plaza, former research specialist at the University Of Guam Micronesian Area Research Center, believed that the houses above the posts were apartment-like with windows and a door on the sides. She speculated there were different houses for sleeping which were on higher ground, cooking on lower ground and large communal houses for storing large proas and possibly used for meetings. Other conjectures were that the shorter latte structures were owned by the lowest social class *manachang* who kept their living and storage area separate from the higher classes,the *achaot* and *chamorri*.

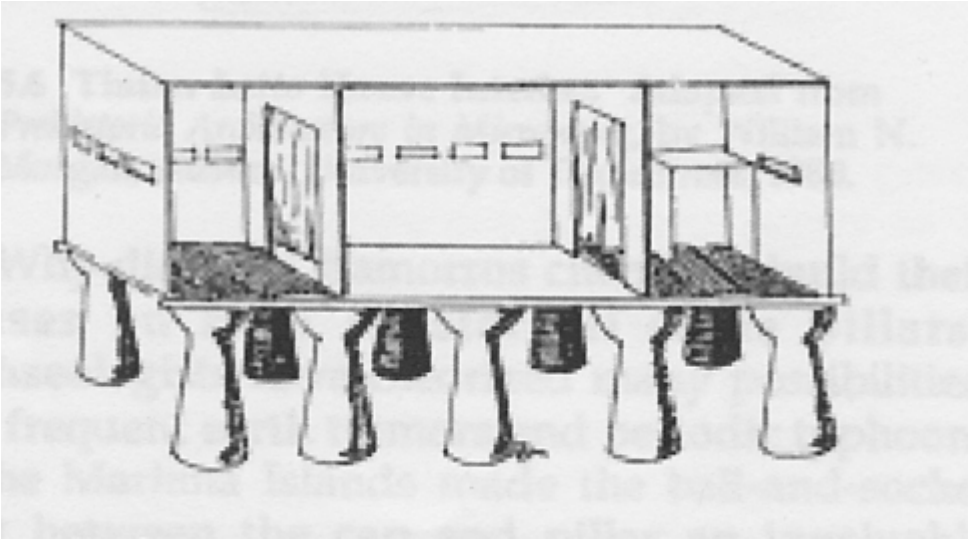

Figure 1: Box frame (Plaza, 1973, p. 7)

The historians that I interviewed believe that latte posts supported an A-frame building. There were no doors on the sides of the structure to enter the latte homes. The entrance was on the floor with possibly some kind of ladder for access into the house. Mr. Lizama sketched a side view of how he believes the houses were built. The sketch also shows how the floor was lashed to the latte posts, a pair at a time.

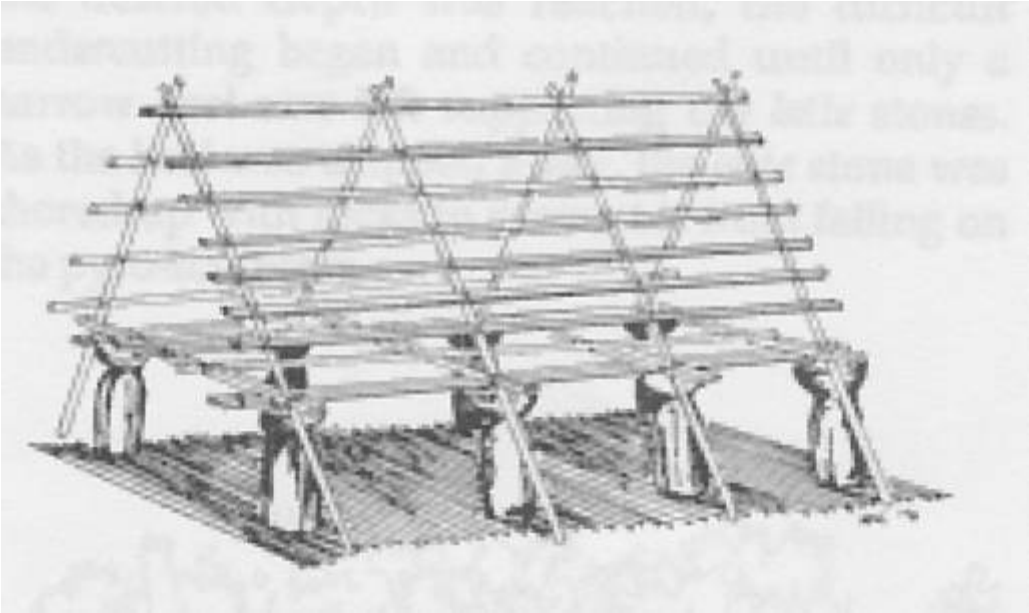

Figure 2: A Frame by Al Lizama (May 16, 1976, Pacific Daily News)

Some scholars have suggested that the size of a latte structure was dependent on the social level of the owners. Interviewees as well as articles describe three classes of people. They were the *matao, achaot* and *manachang.* Mr. Garrido describes the *matao* as being 100% Chamorro. The *achaot* had one parent who was *matao*. Mr. Garrido believes that the other parent may have been an outsider of royal blood as well, who somehow ended up settling on Guam. This meant that the *achaot* had a chance at being at the same level as the *matao,* but never above them. The *manachang* were like commoners and would never become *matao*. Mr. Garrido proposes that the *manachang* were from other islands. Again, these proposals were educated guesses based on descriptions made by Europeans who first wrote about the latte but

injected their ideas of different levels of society rather than investigate what system the Chamorro used.

Some people propose that the *matao* had the tallest latte structure which would imply that the *manachang* had the shortest structures. There were also conjectures that the number of latte posts would determine status as well as what type of living facility it would be. For example, the four-post latte structures were for storage of valuables such as food (mostly dried fish), and weapons or ammunition. The twenty-two or twenty-four-post latte structures are conjectured to belong to the chief of the village or could have been a community building for meetings or gatherings. Again, there is no written document to support these conjectures.

The latte posts have two parts. The bottom part is the *haligi* and the top part is called the *tasa*. I had always thought that the *haligi* was conical in shape but they are not necessarily constructed that way. Some *haligi* have a trapezoidal shape with the bottom portion being about two to three inches wider on each side than the top portion. The width varies from two feet to four feet and I am assuming that the reason was dependent on the number of posts with which it was to be used. The breadth of the *haligi* ranges from approximately eight inches to three feet. The *haligi* ranges from four feet to twenty feet in height.

In some *haligi* there is a rectangular protrusion approximately 4” by 12” in the center at the top. This was designed to fit into at carved-out portion at the bottom of the *tasa* in the manner of a tongue-and-groove joint.

I was told by all the interviewees that the number of posts ranged from four to twenty-four. Dr. Cunningham believed twenty-two was the maximum number of latte posts. There was always an even number of posts. Mr. Lizama explained the reason behind this. The illustration below from Morgan and the sketch from Mr. Lizama indicate how wooden strips were placed on

top of two lattes and then tied down with six strong pieces of rope to the *tasa*. This was for securing the latte against typhoons. If strong winds were to lift up the first of the latte post, the paired latte post it was tied to would be pressed down as in a teeter totter. Thus, the manner in which the lattes were placed on the ground and tied together made them able to withstand typhoons as well as earthquakes.

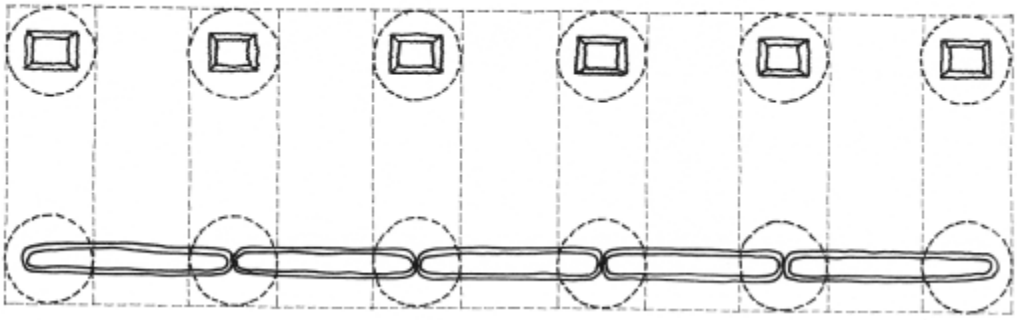

Figure 3: Tying of paired latte (Morgan, 1989, p.145)

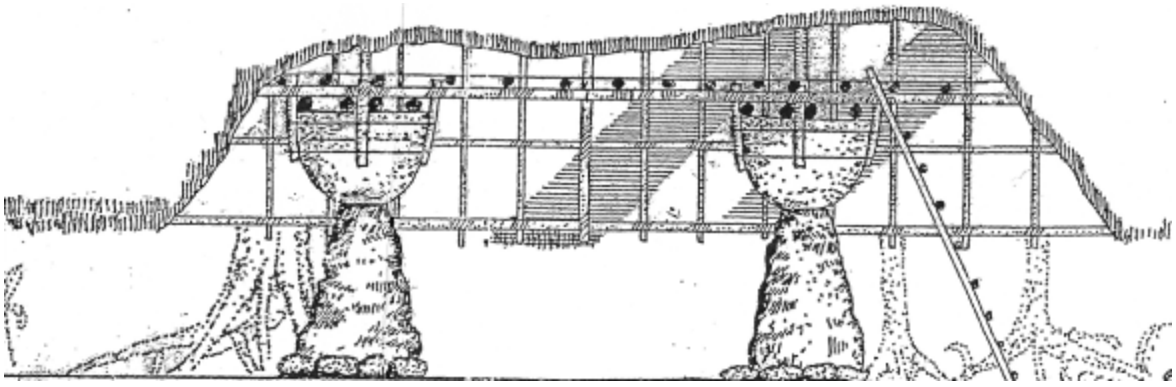

Figure 4: Securing floor to tasa, Unpublished sketch Al Lizama, 2010

Hans G. Hornbostel, a representative of the Bernice P. Bishop Museum of Honolulu, believed that fire and water were used to quarry the stones for the *haligi* and *tasa*. Access to faultless limestone, plenty of hot-burning firewood, and proximity to the building site were the reasons Chamorros used to build on a certain area. According to Dr. Cunningham, this does not mean that the area was easily accessible. Depending on the distance between the quarry and the

building site, Chamorros had to figure out how to bring the latte to the location where they were going to build.

When an area was found, it would be cleared and firewood would be stacked. The shapes of the *haligi* and *tasa* would be formed on the ground and fires would be started on the margins of the outlines. The fire would soften the limestone which made it easy to scrape out and break into the shape needed.

Figure 5: Quarry by fire (Cunningham, 1992, p. 50)

When there was only a narrow keel supporting the stones, the keel would be chipped away and the rocks were dropped into the form. Workers had to be careful that the latte forms would not fall on them while they worked around the stone as shown in the illustration below. Levers and broken rocks were then used to move the gigantic stone out of its bedrock home. When the latte was removed from its matrix, basalt chisels and adzes were then used to shape the *haligi* and *tasa*. Then it was time to move the *haligi* and *tasa* to the building site.

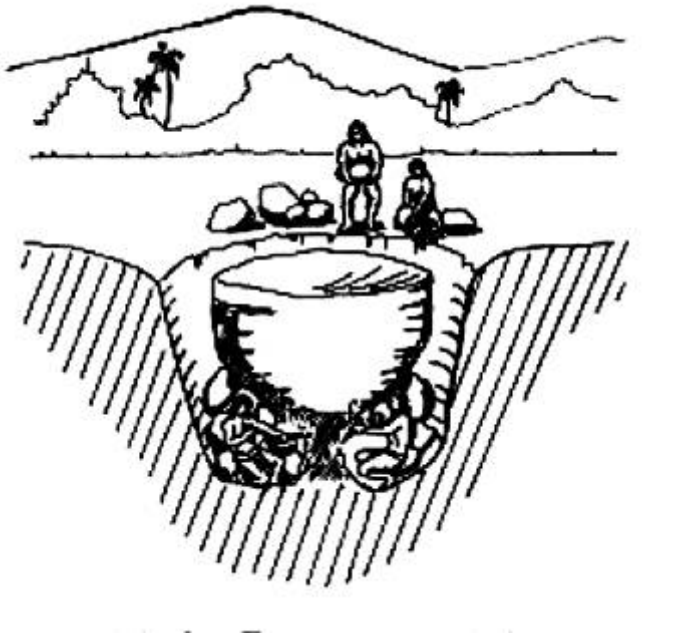

Figure 6: Reaching the keel (Cunningham, 1992, p. 51)

Latte sites found in the interior of the island were near resources that were used to build the latte posts. Aside from the fire and quarry method on the ground, Mr. Garrido stated that some latte, specifically in the Urunao area, were quarried from the base of the cliff and some were cut out of the outcropping of the limestone on the beach. The workers would find a pre-formed *haligi* shape with at least eight inches of thickness on the shore limestone. They would then cut it out and use it. Also, there were areas where the workers would find outcrops of the shape and thickness that they needed at the base of a cliff. They would cut around the outcrops and peel them off from the cliff. Mr. Garrido compares the peeling off of the limestone from a cliff face to another meaning of latte which is to peel off the scab of a dried sore. These pre-formed shapes made it convenient for workers in the building of the latte.

Cunningham explains how the ancient Chamorro may have used the leverage of a bipod to move the stones. The sketch below shows two large tree trunks tied together near the top. Rope was tied around the latte and the other end to the apex of the tied tree trunks. When the

workers pulled, they lifted the front end of the stone reducing friction at the back end and were able to pull the stone forward. The pulling movement would move forward and then drop the latte to the ground. They continued this slow forward movement until they reached the area where they were going to build the latte house.

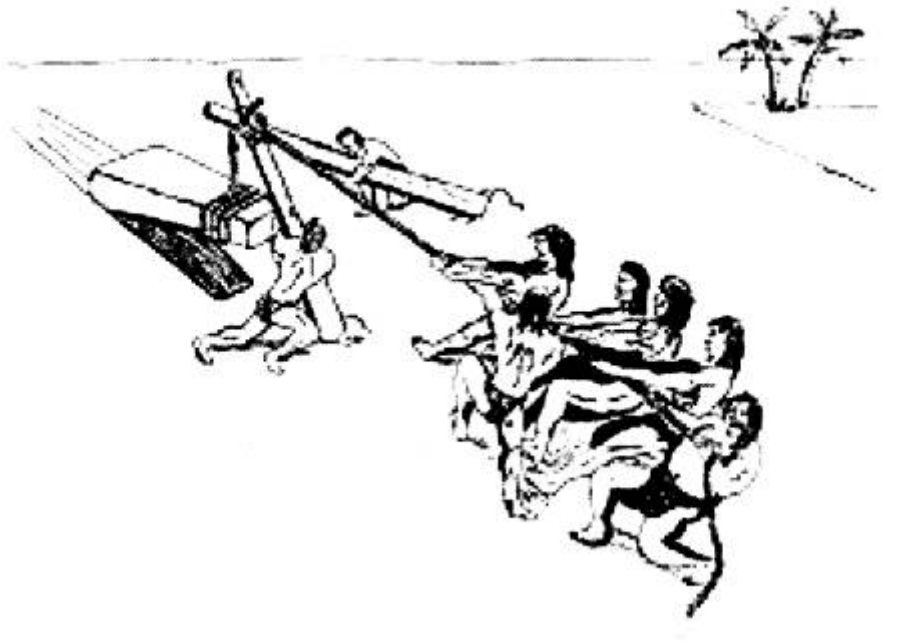

Figure 7: Using bipod to move *haligi* (Cunningham, 1992, p. 51)

The *haligi* would be put in place first. A hole at least two feet deep would be dug for each *haligi*. The space around the *haligi* in the hole would be tightly filled with rocks and sand to keep it stable. The weight of the *haligi* only added in ensuring the stability. William Morgan has illustrations in his book showing the *haligi* inserted in a hole at least two feet deep and then filled. Below is one illustration showing the depth of the hole the haligi is placed in and a comparison of the height of the latte to a man of average height (approximately five feet eight).

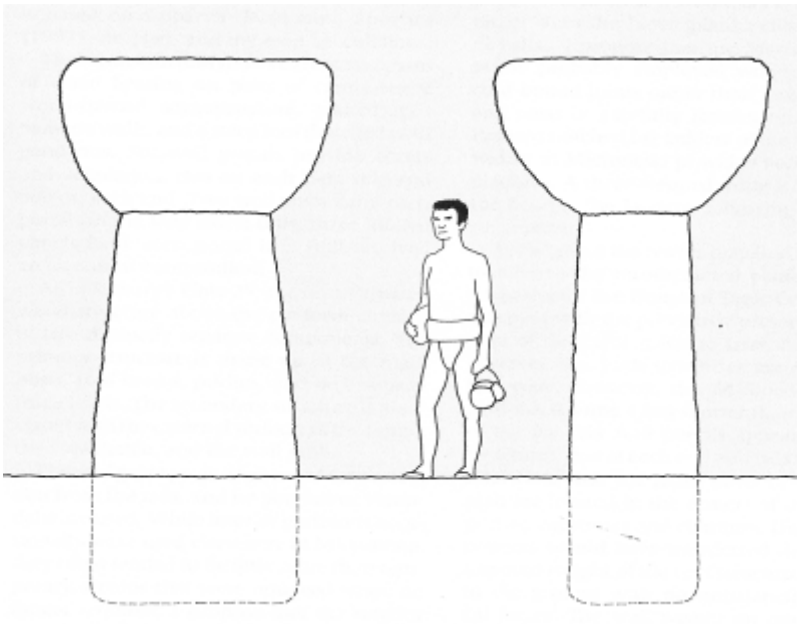

Figure 8: Depth of *haligi* (Morgan, 1989, p. 124)

Cunningham sketched three ways that the *tasa* may have been placed on top of the *haligi*. The first way was to use the bipod in the same manner that the latte was dragged from the quarry to its new site. Instead of lashing the *haligi,* the *tasa* would be lashed and the other end of the rope would be tied around the apex of the two tied tree trunks. Then the workers would pull the rope and bipod towards the *haligi*. Once centered it would be lowered down from the center of the *tasa* to the center of the *haligi* as shown in the illustration below. In the instances where there was a "tongue and groove" in the *haligi* and *tasa,* the workers had to ensure that the tongue met the groove. This method also helped keep the structures together during earthquakes.

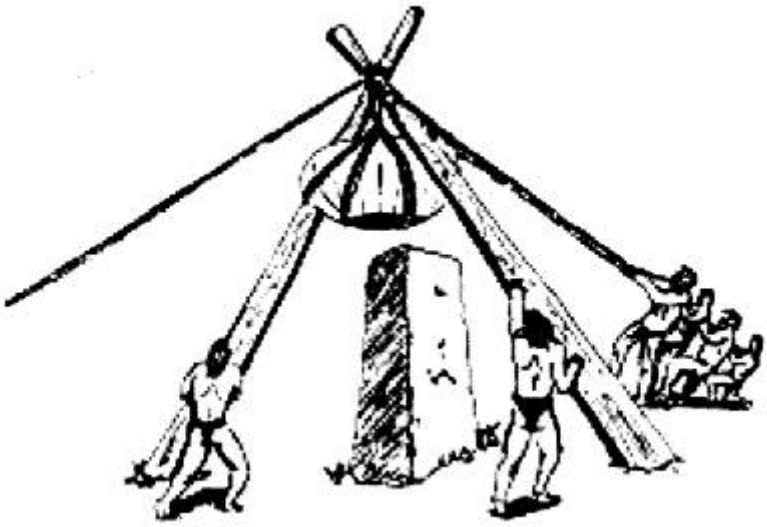

Figure 9: Using bipod to place tasa (Cunningham, 1992 p. 52)

The second method of placing the *tasa* may have been to build a ramp from the ground to the top of the *tasa*. Cunningham illustrates how the workers might have packed rocks and soil from the ground and moved the *tasa* on top. The level of the stacked rocks and dirt would incline upward. Workers would build the incline and move the *tasa* upwards a little at a time. Then when they reached the top of the *haligi*, they would push it to the *haligi* making sure it was centered. Again the weight of the *tasa* would keep it stable atop the *haligi*. When the *tasa* was in place, the inclined rocks and dirt would be removed. This method would be repeated for each haligi. The illustration below shows the workers moving the *tasa* towards the top of the *haligi*.

Figure 10: Inclined plane to place tasa (Cunningham, 1992, p. 52)

The third method appears more a matter of brute strength. The workers would lift up the *tasa* using their own strength. Dr. Cunningham sketched how four poles were tied together. One pair of parallel poles was laid across another pair of parallel poles making a box in the center. The poles were secured with rope at each corner of the box. The *tasa* was either built on top of the box or placed on top of the box. The workers then lifted the *tasa* and placed it on top of the *haligi*. The poles and workers had to be pretty strong to lift something that weighed in tons. Many good questions and discussions can be developed comparing the different methods and having students choose and defend their favorite method.

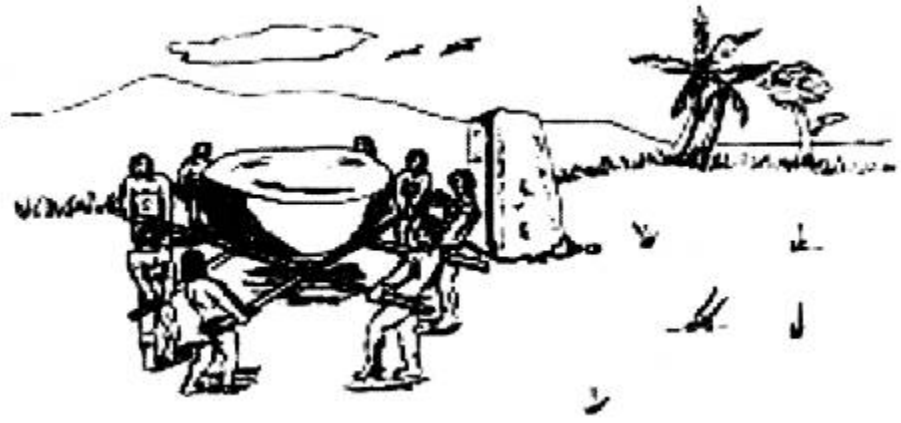

Figure 11: Lifting to place *tasa* (Cunningham, 1992, p. 52)

We will now focus on the latte sites on Guam and then expand to the other islands later. Latte sites on Guam were built in areas that had the resources needed to build a latte structure. Different authors have suggested different numbers of sets of latte sites on Guam, ranging from fifty to two hundred fifty. Many sites were near the ocean where the two main resources needed to build the latte, namely limestone and brain coral were found in the coral reef or near the shores. Latte sites that were inland were near rivers or areas with water resources. The number of sets has decreased because of natural disasters, destruction during the war, and clearing of sites in order for modern developments to be built.

Victoriano April's "Latte Quarries of the Marianas Islands" describes quarries on Guam, Rota, Tinian and Saipan. Although his paper was written primarily to investigate the techniques and methods used to quarry latte, it includes a brief history of the four islands. His paper also includes pictures of the more popular sites on the four islands, background information on each, illustrations of the way latte sites were set up and measurements of individual posts of each latte structure. A description is also given for each of the capstone features that he measured and reported on. The chart below shows the measurements of one site in the Urunao Quarry on Guam. The charts, maps and illustrations included in his book can be used to develop math questions for many of the Guam Department of Education Content Standards.

Urunao Quarry, Guam: Measurements

Feature No.	Type of Feature	Diameter in meters	Depth in meters	Length in meters	Width in meters
1	Shaft	14.40	.26		
2	Capstone depression	7.29	.26		
3	Capstone depression	7.20	.12		
4	Capstone depression	17.80	.18		
5	Capstone depression	2.40	.19		
6	Capstone depression	1.08	.24	.72	
7	Capstone depression	4.40	.24	.72	
8	Capstone depression	2.40	.29		
9	Capstone depression	1.80	.30		

Figure 12: Urunao capstone measurements (April, 2004, p. 150)

The pictures below show the latte site in Urunao and the Angel Santos Latte Park in Hagåtña, Guam. The lattes in the Park were taken from Mepo, a latte site near Fena Lake, which is on a military base. The lattes from Mepo are considered one of the bigger lattes on Guam.

Figure 13: Angel Santos Latte Park (courtesy of Judy Flores, Guampedia)

Figure 14: Urunao Beach 2010 (personal photograph)

Urunao is the only site where I have seen latte in their original location and entirety. The site housed four latte structures which may have been for a clan or large family. Many of the latte sites on Guam are in remote areas or with difficult access because they are inside military bases or on private, no-trespassing sites.

The site that I visited in Urunao has the ocean shore on one side and a huge cliff behind it. Three of the latte relics have ten posts. These three structures were built with the long side of the latte houses parallel to the beach. The fourth building is an eight-post latte structure. This was the only building that was built with the long side perpendicular to the ocean shore.

Mr. Lizama emphasized the importance of the prevailing winds in relation to where latte houses were built. Although the latte houses near the beach were parallel to the beach, the builders still had to make sure the front sides were oriented perpendicular to the direction of the prevailing winds. This supported his belief of why the floors were lashed to the *tasa* in pairs. If the prevailing winds were strong, the manner in which the wooden floor was lashed to the *tasa*

ensured that the winds could not lift the entire structure off the ground or displace it. I wonder what typhoon strength could lift or displace such a structure. Wind charts, wind directions, Guam's weather and how the weather may have affected the building of latte structures is another unit that could be developed. Even Mr. Lizama's conjectures regarding the placement of latte structures according to prevailing winds could be tested.

Dr. Cunningham took a group of ninth graders to Rota to weigh the latte monuments, *haligi* and *tasa*. The students, with help from their teachers, devised a plan to determine the weight of the latte. Dr. Cunningham explained in his paper how students used formulas for the weight, density, and volume of a sample. Following is a brief summary of Dr. Cunningham's paper and the work of the students.

Students planned to use the calculations for the volume of the hemispherical *tasa*. They gathered the measuring instruments they planned to use and headed to Rota where the tallest latte was, even though it was fallen. Students had to figure out what measurements to use since the *haligi* was not a perfect geometric shape. The *tasa* fortunately closely resembled the hemispherical shape that they were expecting.

Figure 15: AsNieves Quarry, Rota

One team was assigned to each of the sixteen stones at the AsNieves latte site in Rota. Using a map and compass, each team had to find the stone they were assigned, measure it, and calculate its volume. A seventeenth team was assigned to determine the density of the bedrock which each team would use to calculate the weight of their latte. Dr. Cunningham's paper includes some of the work students completed. The students' work shows their calculations of the density, weight, and volume of the *haligi* and the capstone.

A table shows that the shortest diameter of the seven capstones was 115 inches and the lowest weight was 30,269 pounds or approximately 15.1 tons. The longest diameter for the capstone was 130 inches and the heaviest weight was 43,726 pounds or 21.9 tons.

The table also shows the measurements for the shaft or *haligi*. The shortest width was 10 inches, the shortest thickness was 64 inches (not the same shaft as the shortest width), and the shortest length was 196 inches. The lowest weight was 14,288 inches or 7.1 tons which belonged to the 10 inch length shaft. The longest width was 66 inches, longest thickness 104 inches (again not the same shaft as the longest width), and the longest length was 206 inches. The heaviest weight was 68,860 pounds which was 34.4 tons.

The table also includes the average height and weight of the capstone and shaft, separate as well as combined. The largest capstone and shaft were also included, separate as well as combined. The students' work provides information for future students of the latte monuments. I haven't come across a similar project done on Guam. I believe accessibility is one reason. Another may be the lack of interest by teachers which in turn affects the students. I think it would be exciting to do this project on the largest sites in Guam, Tinian, Rota and Saipan. Comparisons could probably also be made with present-day calculations and the calculations of the students in 1977.

The students used measuring tape and modern-day instruments to make the calculations. Dr. Cunningham mentioned many things that can be used for measurement. In the students' calculations they found out that the heights of the *haligi* were not all the same. If this is so, then how did the Chamorros make the height of the latte posts all at equal height or even level? The workers back then did not have modern-day tools.

Table 1: Statistical Summary of the Size and Weight of the As Nieves *Latte*

CAPSTONES

Capstone	Diameter in inches	Weight in pounds	Weight in tons
1	130	43,726	21.9
2	120	34,392	17.2
3	128	41,739	20.9
4	115	30,269	15.1
5	115	30,269	15.1
6	128	41,739	20.9
7	123	37,036	18.5

SHAFTS

Shafts	Length in inches	Width in inches	Height in inches	Weight in pounds	Weight in tons
1	35	94	204	51,008	25.5
2	10	74	200	14,288	7.1
3	42	82	210	54,966	27.5
4	50	84	196	62,563	31.3
5	52	88	198	68,860	34.4
6	41	104	204	66,109	33.1
7	66	64	200	64,205	32.1
8	50	64	196	47,667	23.8
9	26.5	82	206	34,020	17.0

AVERAGE

	Standing Ht. in feet	Weight in kilograms	Weight in pounds	Weight in tons
Capstone	5.1	16,829	37,024	18.5
Shaft	16.8	23,419	51,521	25.8
Combined Shaft & Capstone	21.9	40,248	88,545	44.3

LARGEST

Capstone	5.4	19,876	43,726	21.9
Shaft	17.5	31,300	68,860	34.4
Combined Shaft & Capstone	22.9	51,176	112,586	56.3

Figure 16: Ninth grade results (Cunningham, 1977, p. 7)

One of the historians conjectured that the even height was made up by the *tasa*. Mr. Garrido mentioned how the *tasa* was used to make sure the height of all posts were the same. The following is my guess about how the Chamorros leveled all the latte posts. The first *haligi* was placed in a hole, and the *tasa* placed on top would set the height for the rest of the latte posts. The other *haligi* of different heights were placed in their holes. Then each had to be measured to determine what was needed to match the height of the first latte post. The workers would then cut out a shape and then scrape it to the correct dimension to match the first *haligi*. Students can use problem-solving skills to determine how builders would compensate if there was a slope under the latte structure or other issues that may arise when latte structures were being built.

The distance between posts was also equal. There were always two rows of whatever number of posts. "Most frequently, there are two parallel rows of crude .5 to 1 meter-high coral rocks, buried in the ground, usually five in each row. They are 1 to 1.5 meters away from each other and 3 meters away from the opposite side. The measurements of a house ruin in Halum Anite on Rota were as follows:

> Row distance 3.75 meters with each row possessing six pillars (*haligi*).
> Distance from pillar center to pillar center is 3.9 meters.
> In cross section the pillars measure .95 meter by .65 meter.
> Height of pillar is 1.70 meters.
> Capital (tasa) diameter is 1.86 meters and height 1.35 meters.

The large latte house ruins on Tinian have been traditionally known as the ruins of the House of Taga. This ruin consists of two rows of six pillars.

> Row intervals are 4.22 meters.
> Pillar intervals are 3.6 meters.
> Cross section of the pillars on the bottom measure 1.45 meters by 1.1 meters and on the top 1.2 meters by .85 meter.
> Capital diameter is 2.45 meters and capital height is 1.66 meters.
> The height of the columns is 4.1 meters.

With the capital in place atop the shaft the height is 5.76 meters. (Fritz, 1989).

Recently a senior student at St. John's Academy presented his thesis on "The Latte of the Marianas". He quoted many of the writers that I quoted in this paper, especially Dr. Cunningham. He did an experiment to study the physics behind the design of the latte structure. With modifications, his study can be done by students in earlier grades. The interviews and papers that I have read on the latte lead me to visualize the possible integration of the subjects of Chamorro Language and Culture, Science and Mathematics by ambitious educators.

The mysterious nature of the latte is in itself a playground for the imagination. Questions abound with latte technology. What other technologies were needed to facilitate the latte? How many ways can the challenges be solved? Are there better methods? These are just some of the questions that may arise in the study of finding math in latte.

Bibliography

Anonymous, Latte of Meppo-Guam (photo), *Guam Recorder,* Volume II; February 1926, p. 334

Anonymous, "Coral tombstones of Guam" (photos included), *Guam Recorder,* Volume III; Sept. 1926, p.164-168

Anonymous, "Important discovery", *Guam Recorder,* Volume III; October 1926, p. 204

Anonymous, "Sea rovers of the long past", *Guam Recorder,* part V. Volume IV; August, 1927, p. 126-29

Anonymous, "Latte – ancient monuments on the island of Rota (photo)", Volume IV; August 1927, p. 126

Anonymous, Brief notes on some ruins or monuments of the Marianas Islands. Volume IX; January 1933, p. 172-173

Anonymous, Newly discovered lattes (photo included), *Guam Recorder,* Volume XV; July 1938, p.15, 30

Anonymous, Latte at the site of the ancient town of Nisihan, Guam (photo), *Guam Recorder,* Volume XV; February 1939, p 17.

Anonymous, Ruins of ancient monuments – Island of Rota (photo). *Guam Recorder,* Volume XVII; November 1940, p. 320

Anonymous, Lattes found on the Island of Tinian (photo), Guam Recorder, Volume XVIII; April 19421, p. 7

Anonymous, Lattes found in Nisihan, Guam (photo), *Guam Recorder,* Volume XVIII; April 1941, p. 9

Anonymous, Latte found at Mepo, Guam (photo), *Guam Recorder,* Volume XVIII; April 1941, p. 36

Anonymous, The Bishop Museum field work; collections from Guam; part 1. Volume 1, March 1924, p.5

April, Victoriano, "Latte Quarries of the Mariana Islands", Latte: Occasional Paprs in Anthropology and Historical reservations, No.2, Guam Historic Resources Division, Dept. of Parks and Recreation, April 2004

Bellwood, Peter, The Prehistory of Micronesia, Man's Conquest of the Pacific, Oxford University Press, New York, 1979, p 282 – 285

Bryan, Jr., E.H., Notes on the ancient culture of Guam; the latte sites (photos included), *Guam Recorder,* Volume XIV; June 1937, p. 6-9

Cunningham, Lawrence J., Weighing the Largest Latte Stones. Saipan, CNMI: Occasional Historical Papers Series, 2004, Print.

Cunningham, Lawrence J., Ancient Chamorro Society. Honolulu, HI: Bess, 1992, Chapter 5 Shelter, p. 47-56

Davis, Esther Payne, *The Strange Latte Stones of Guam,* World Explorer, 1:23, Spring/ Summer 1992, p. 65-68

Donlon, A., "The Latte - what are they?", *Guam Recorder,* Volume XVIII; April 1941, p.7-9, 36-37

Fritz, George. The Chamorro: A History and Ethnography of the Marianas. Trans. Elfriede Craddock. Ed. Scott Russell. 2nd ed. Saipan: Division of Historic Preservation, 1989. Print. (reference found in printout given by Dr. Lawrence Cunningham)

Gill, L.T., Ancient stone ruins surpassing stonehence found on Pacific Island. ", Volume 1; February 1925, p. 4, 12

Gill, L.T., The coral tombstones of the Marianas.", Volume II; February 1926, p. 334-37

Guillemard, F.H.H., Australasia Volume II Malaysia in the Pacific archipelagoes, Volume V; March 1929, p. 256-257

Harlan, S.R., Miemo River Valley and entrance to Hidden River, *Guam Recorder,* Volume XVI; July 1939, p. 139-140, 165

Hornbostel, H.G., The House of Taga." *Guam Recorder,* Volume 1; January, 1925, p.3

Hornbostel, H.G., "Quarrying with fire and water.", Guam Recorder, Volume III; April, 1926, p. 21

Morgan, William N., "The Mariana Islands", Prehistoric Architecture in Micronesia, University of Texas Press, 1989, Chapter 5, p116-154

Plaza, Felicia, "The Lattes of the Marianas", *Guam Recorder*, Volume 3; March 1973, p. 6-9

Rainbird, Paul, "The Mariana Islands", The Archaeology of Micronesia, Cambridge University Press, 2004, p. 101-133

Reinman, Fred, "Guam Prehistory." *Guam Recorder*, n.s., 1, (1973) p10-14

Interviews:

Artero, Franklin, male, Urunao, owner of the Urunao site I visited

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