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Mathematical Explorations and the Chamorro Game of Chonka

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Project MACIMISE

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> **chonka**. Type of game played by two persons only. The players have a wood tray with several cups carved into the top of the tray. Each player has a handful of marbles or small shells which he places in the cup successively. *Chonka* also names the equipment used in the game. Also ***chonga.*** (Topping, et al., 1975 p.43)

Mathematical games can foster mathematical communication as students explain and justify their moves to one another. In addition, games can motivate students and engage them in thinking about and applying concepts and skills (National Council of Teachers of Mathematics, website accessed April 16, 2010). According to Bishop (1991), mathematics games involves six universal activities (actions, counting, measuring, explaining, playing, designing, and locating) that are independent of culture (as cited by Niecikowski, n.d.). If all people have a culture, and ethnomathematics is the way that people utilize mathematics to solve problems that arise in their lives, then culturally-based lessons help children gain a deeper understanding of the mathematics in that lesson because it is immersed in a familiar context. Culturally-based lessons that are rooted in other cultures also have a place in a typical classroom because they help children see the value of culture in the classroom (McGlone, 2008). Hildebrandt (1998) states that games provide social and mathematical development, and through repeated play, students share and develop mathematical calculation strategies (as cited by Niecikowski, n.d.). This paper explores the ways in which the Chamorro game of Chonka lends itself to mathematical explorations.

The game of Chonka, as it is known on Guam, is known over a wide area of the world from Africa to the Philippines. For example, Cordero (1967) stated that European explorers [recounted] that the Philippine variant [*sungka*] is one of similar games played on boards (and even in holes dug in the ground) over extensive areas of the world, from the Middle East, Africa, and India, to Southeast Asia [and that the variations occur in the number of holes on the board and what contents of the holes hold] (Cordero, 1967, p.44). Comments found on the "Elliott

Avedon Virtual Museum of Games" website further Cordero's claims by saying "[I]n Ceylon it is called *chanca*, and at Johore, Straits Settlements, *chondkak*. The arrangement of the board in both cases is the same as in the Philippine game" (Elliott Avedon Virtual Museum of Games, 2010). One of the more interesting facets about this world-wide game is related to its name. Cordero (1967) suggests that the names of the games and the regions that these versions come from provide insight into origins:

> from Africa, *adjito* (Dahomey), *aware* (Ivory Coast), *bau* (Kilamanjaro), *mancal* (Ethiopia), Cairo, Syria, and Arabia), *ouri* (Senegal) and *tami* (Gold Coast). From the East Indies: *wa-wee* (descendent of Negro slaves in Martinique and the Barbados). From Southeast Asia: *chonkak* (Malaya); *dakon* (Java), *jungka* (Sumatra). The Phillipine names, - *sunka*, *chongka*, *tsungka*, etc. are related to the Southeast Asian names and undoubtedly have been transmitted to us by our Malayan ancestors." (p.44).

In other words, this game can be considered both a product of local culture as well as something that appears to have been shared by multiple cultures. Bringing this game into the Micronesian context, Fritz (2001) provides one of the earliest descriptions of the Chamorro version, *Chonka*. where the objective of the game centers on strategically moving the stones of shells around the board.

> Chonka is a game played with a wooden board with two rows of seven depressions in which, at the start of the game, seven small stones or shells are placed. At the ends of the board are banks of each player. The first one takes the contents of each of his seven small heaps and from right to left, lays one shell each into consecutive compartments, then in his bank, and into the compartments of the opponent. If he ends up in one of the latter, he takes those contents and continues to distribute in the same way, without, however, putting anything into the bank of the opponent. If he finishes up in one of his own compartments, which happens to be empty, he may place the contents of the opponent in his own bank but may not continue to play. It is important to get as many shells as possible into one's bank. Finally, there are only a few shells left in the compartments and the game may last for a long time" (Fritz 2001, p. 45)

Fritz' early description hints at the mathematics and strategy involved in the traditional game.

While it is unknown if the Chonka board was used for computation in the past, the game now seems to be played merely for enjoyment as a way of cultural preservation. As it is played

today, the winner aims to take all the shells from the opponent. It is mainly a sedentary game, often first taught to children by their grandparents and played during the "down time" after lunch and before siesta time, when it is too hot to play outside. These types of interactions are in line with a statement by Shaelling (1998) that playing games is a vital human activity since they build community and make enhancing skills, intellect, and problem-solving fun (cited in Niecikowski, n.d.).

The Game

Since the Philippine version is identical to the Chamorro game of Chonka, references to "Sungka" are interchanged with the word "Chonka". The following game rules are taken from a web page posted by Benjamin McMahan (retrieved April 14, 2010), and are supplemented with inserts from Tesoro's *Rules of Sungka* (n.d.).

How to Play the Game

Chonka is a two-player game where the players take turns picking up shells from the board and distributing them. The goal is to put as many shells in your home base as possible. You take turns until no more shells are available and that concludes a round. You start a new round with an obvious bias determined by how well you did in the previous round. The game ends when one player cannot even play a round.

The Initial Board

1 Chonka board, alternatives: some way to separate 16 piles of shells from each other.

98 small (cowrie) shells, alternatives: beans, beads, rocks, anything you can easily fit 10 of in your hand.

The board consists of two rows of 7 ***holes***, with two additional holes at either end. These two additional holes are the ***homes*** of the respective players. The hole to your left is your home. The game starts with ***7 shells*** in each of the 14 holes in the middle.

Your Home	7	7	7	7	7	7	7	Player 2's Home
	7	7	7	7	7	7	7	
	Your Side							

Starting the Very First Round

To start the very first round, both players start simultaneously. A common house rule is that when making a choice of which hole to start with, as soon as you touch the shells/hole you must start with that hole. Most players usually start with the last hole on their side. Since the players begin simultaneously, each will drop his seventh shell into a hole at approximately the same time. However, the manner (and speed) in which each player continues—indeed whether he continues at all—depends on where he dropped the last shell. So:

(1) IF HE HAPPENS TO DROP THE LAST SHELL INTO HIS OWN STOREHOUSE (HOME):

the player is free to continue immediately scooping all the shells from any one of his own houses (cups) and distributing them around the board, working as before, one shell to each hole, beginning with the first clockwise hole from the newly emptied hole, but

always skipping his opponent's storehouse (home).

(2) IF HE HAPPENS TO DROP THE LAST SHELL INTO ANY HOUSE (CUP) IN WHICH THERE ARE ALREADY ANY SHELLS:

the player scoops up whatever shells are in that hole, including the shell he just dropped, and continues around the board, dropping one shell at a time as before.

(3) IF HE HAPPENS TO DROP THE LAST SHELL INTO ONE OF HIS OWN HOUSES (CUPS) THAT IS EMPTY:

one of two things happens:

(a) If his opponent's hole directly opposite contains any shells, then the player may confiscate the shell he just dropped and all of the shells in the opponent's directly-opposite hole. The player puts the handful of confiscated shells in his own storehouse. He is now "dead". He stops playing until it is his turn again.

Your Home	2	3	0	0	5 Capture these	2	6	Player 2's Home
	3	7	1	0	0 Land here	5	4	
	Your Side							

(b) If the hole directly opposite is empty, then the player is "dead". After dropping the last shell, he stops playing until it his turn again.

(4) IF HE HAPPENS TO DROP THE LAST SHELL INTO AN EMPTY HOLE (CUP) BELONGING TO HIS OPPONENT:

In this case he is "dead" and stops playing until it is his turn again. The distribution process continues, with players taking alternate turns, until one of the players has no

shells on his side. The other player continues to go until none of his shells can fall on the other side – in other words until all shells are disposed of in the storehouse. This merely ends the first round. The last player to have any shells on his side is considered to be the "winner" but only for the privilege of going first in the next round. (Tesoro, n.d.)

Playing the Next Round

First you reinitialize the board. To do this start taking shells from your home and placing them into the holes on your side, placing 7 in each hole. As soon as you do not have enough to fill a hole, leave the remaining shells in your home. The board may look something like this:

<table>
<tr><td rowspan="2">Your Home 6</td><td>7</td><td>7</td><td>7</td><td>7</td><td>7</td><td>7</td><td>7</td><td rowspan="2">Player 2's Home 1</td></tr>
<tr><td>7</td><td>7</td><td>7</td><td>7</td><td>7</td><td>7</td><td>X Dead hole/burned</td></tr>
<tr><td></td><td colspan="7">Your Side</td><td></td></tr>
</table>

You did not have enough to fill out the last spot on your side. That hole is now ***burned*** and cannot be used during the entire round. That means you and your opponent cannot put shells in the burned holes as you distribute the shells. The person who was not the last to play in the last round gets to start the new round (which is very beneficial and one of the bigger benefits of not having a hole that is burned on your side).

Playing a Full Game

You keep playing rounds until one entire side of a board has been burned, or for some reason a player concedes defeat. At that point the game is over and the person with a remaining side wins.

Chonka as a Way of Enhancing Mathematical Foundations: Strategy

The National Council of Teachers of Mathematics emphasizes that "the tasks and activities that teachers select are mechanisms for drawing students into the important mathematics that composes the curriculum. Worthwhile mathematical tasks are those that do not separate mathematical thinking from mathematical concepts or skills, that capture students' curiosity, and that invite students to speculate and to pursue their hunches" (NCTM web page accessed April 28, 2010). As a vehicle for teaching mathematics, playing Chonka stimulates competition and development of strategy, such as that expressed by Maria Perez in her interview about the game: "I like[d] to select a friend that's a little bit dumb. Then I beat them… If they're smart, maybe I won't play them. It's a good game, but you need some tricks there" (Santo Tomas, 2004, p.18).

In video interviews with manamko at the Mangilao Community Center on April 15, 2010 and in the days following with students at George Washington High School, participants played rounds of the game of Chonka while sharing their strategies related to winning the game. Participants were asked, "Do you have a particular strategy to ensure that you will win the game?" While playing chonka, different strategies could be seen, with four main strategic plays emerging: ensuring continuation of play, ensuring long play, confiscating the most shells, and finally, speed of play:

Ensuring Continuation of Play: It is obvious that the sharp player will make a quick mental count of the shells in his own holes before selecting the hole he will scoop out for launching a play. If, for example, it is his turn to go and he has one shell in the house just before his storehouse, he can simply scoop out that one shell and drop it in the next hole, which is his own storehouse (Tesoro, n.d.). Chamorro players carefully consider which pot to select. Araceli (age 77) states that "I always pick the shells that end up in my house." Teresa (age 15) explains "I guess I usually go for the one that's next to my spot (home)." Kananimalia (age 15) points out the relationship between the right number of shells and the length of her turn in her comment, "I pick the smallest number of shells to get me to my house so I can go again." Their actions ensure the continuation of the turn and the option of selecting a hole/cup that gives the greatest benefit (Tesoro, n.d.)

Long Play (applied at the start of a game): Most veteran players choose to open by scooping the seven shells out of their hole on the far right, thus dropping their last shell in their own storehouse. Real old veterans, of course, pre-reckon their opening beyond this: some players have memorized sequences of selecting holes in many typical situations assuring them of long plays that accumulate many shells in the storehouse before the player "dies" (Tesoro, n.d.).

> "I choose a cup if I think it will make me get to another one and then I can keep on playing." (Josepha, age 77)
>
> "I pick the shells that will land in my house and then I get to go again." (Francis, age 15)
>
> "I pick the one with the most shells so I can last longer." (Kaylani, age 14)
>
> "I learned from my parents that you have to go for the fullest pile and then you get to play for a long time." (Claret, age 14)
>
> "I like to pick the fullest pile and then play until 'dead'. If you don't want to get 'dead', I sometimes add to my hole to make it more full." (Virginia, age 64)
>
> "I like to pick the holes that have the most shells and I go more times around." (Barbara,

age 60)

> "I pick the small pile of shells to see if I can land in a big pile of shells so that I can go around the board longer." (Brandon, age 14)

> "I learned from my grandma to pick the cup with the most shells or the one that will get me to the most because you keep going on and you won't lose your life." (Joyce, age 16)

> "I pick the hole with the most shells because I get more turns." (Fabien, age 14)

> "I get the hole with the most shells because that's how to make my turn last longer." (Lily, age 15)

> "I choose the hole with the most shells so that I can keep on going." (Kellie, age 14)

> "I learned from my older sister and I like to pick the one with the most shells because it gets me the farthest and gets me more times to put shells in my house." (Reedajane, age 15)

These players made the connection that the length of play increased their chances of winning and so would choose the holes that would increase that probability.

Confiscating the Most Shells: The best conclusion of play, of course, is to land in an empty hole on one's own side, with the opponent's hole directly opposite loaded with shells. The player can then confiscate the load in the hole as well as the one shell he dropped on his own side (Tesoro, n.d.). This same strategy is common among Chamorro players:

> "If I can count and see that I'm going to end up where I can eat a lot of shells, I'll land there and just end my turn." (Juana, age 65)

> "I like to land across the biggest pile." (Ashlynn, age 14)

> "I just try to empty my side of the board, because if I land on it and there are a lot of shells on the other side, that is how you win." (Dana, age 14)

> "I choose the hole with shells that will get me around the board at least twice. I try to have empty holes on my side and build up the other side so that when I land on my empty side, I 'eat' the other persons shells" (Janiece, age 15)

> "I pick the least number of shells and wait until the cups build up and then I see if I can land on a space opposite the fullest cup." (Anita, age 15)

> "My auntie showed me how to play and she said to go around until I see if a can land in the empty space with a lot on the other side." (Kimberly, age 15)

In these examples, the manamko and the teens either count or estimate the number of shells in any given cup as a way to plan out their moves. In other words, they see counting and/or estimation is an effective strategy to capturing their opponent's shells.

Speed of Play: Other players simply have strategies not based on the choice of a pile to start with.

> "You must be fast in order to take over your opponent." (Aranceli, age 77)
>
> "I just play fast and I play to win." (Anne, age 67)
>
> "I play slow and take my time and to be careful." (Matilde, age 86)

There are specific advantages to the player's speed of play. A fast pace provides players with an advantage over their opponent. In contrast, a slow course of action allows more time to be methodical or to mull over options.

More enjoyment seems to occur if one wins in the first round and loses in the next, as is the case for beginners. In the case of experts, however, with the second game in play, it is just a matter of who makes the first move. The way Chonka is played indicates that it involves substantial arithmetical calculations by both players although the main object is to gain more shells than your opponent (Osmena, 1967).

As mentioned earlier, worthwhile mathematical tasks do not separate mathematical thinking from mathematical concepts. By that token, it is not uncommon for these worthwhile explorations to also address more than one mathematical concept or process. This is the case for chonka playing. In addition to encouraging the players to develop calculation strategies, it can also reinforce fundamental mathematical concepts such number sense. In setting up the Chonka board at the beginning of the rounds, the players must count out the correct number of shells for

each hole. As a method of teaching mathematics to children, they can be encouraged to count out loud as they set up the game board for play and as they drop shells into each of the wells (holes). In this way, number sense is developed and through repetition, polished.

The chonka board provides the opportunity to demonstrate in a concrete and meaningful way the complexities of the Chamorro counting systems. The ancient Chamorros used a decimal system for counting. They used two sets of numbers. One set was for counting things that were alive. The other set was used when counting inanimate objects. An adapted version of information from Beatty (1968) and Cunningham (1992) is compiled below.

NUMBERS		Modern Chamorro Numbers (Similar to Spanish)
For living things	For objects	For Nonliving Objects
1 - *maisa*	1 - *hachiyai*	1 - unu
2 - *hugua*	2 - *huguiyai*	2 - dos
3 - *tato*	3 - *totguiyai*	3 - tres
4 - *fatfat*	4 - *fatfatai*	4 - kuatro
5 - *lalima*	5 - *limiyai*	5 - sinko
6 - *guagunum*	6 - *commiyai*	6 - sais
7 - *fafiti*	7 - *fitguiyai*	7 - siete
8 - *gua gualu*	8 - *guaguiyai*	8 - ocho
9 - *sasigua*	9 - *siguiyai*	9 - nuebi
10 - *maonot*	10 - *manutai*	10 - dies
11 - *maonot nagai maisa*	11 - *manutai nagai hachiyai*	11 - onse
12 - *maonot nagai hugua*	12 - *manutai nagai huguiyai*	12 - dosse
20 - *hugua na fulu*	20 - *huguiyai na fulu*	20 - bente
21 - *hugua na fulu nagai maisa*	21 - *huguiyai na fulu nagai hachiyai*	21 - bente i unu
30 - *tato na fulu*	30 - *totquiyai na fulu*	30 - trenta
40 - *fatfat na fulu*	40 - *fatfatai na fulu*	40 - kuarenta
100 - *gatos*	100 - *gatus*	100 - siento
200 - *hugua na gatos*	200 - *huguiyai na gatos*	200 - dos siento
1000 - *chalan*	1000 - *chalan*	1000 - mit
2000 - *hugua na chalan*	2000 - *huguiyai na chalan*	2000 - dos mit
10,000 - *maonot na chalan*	10,000 - *manutai na chalan*	10,000 - dies mit

H. Constenoble (1936, 1974) found that the ancient Chamorro numbers were similar to those of other Pacific Island peoples, especially those in the southern Philippines.

> In a strip covering three fifths of the circumference of the earth, from the island of Madagascar on the coast of Africa to Easter Island near South America; from

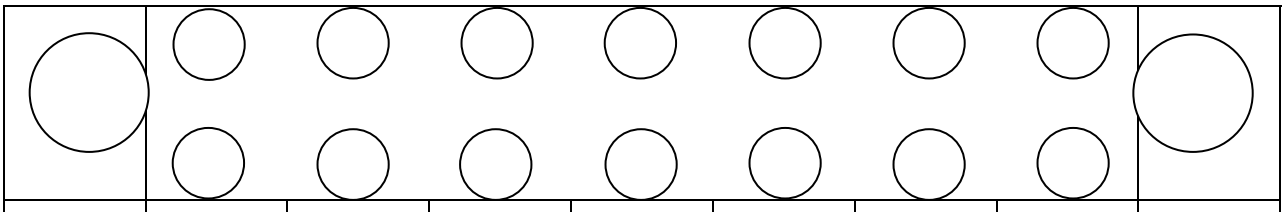
> Madagascar and New Zealand in the South, skirting New Guinea, up to Formosa, the Marianas and Hawaiian Islands in the North, are found a great number of islands, and all its inhabitants speak languages that are related to each other. To this great family of languages has been given the name 'Austronesian', which means 'pertaining to the South-Eastern Islands'. South-East, that is, in relation to the continent of Asia. Of this comprehensive family Chamorro is a member" (Constenoble, 1936, p.303, 319).

Nearly every Austronesian language uses "*lima*," "hand" for the number five and the word for numeral is often related to terms meaning "finger" (Manansala, 1995).

Number Similarities in Pacific Island Languages							
	Mariana Is.	Philippines		Indonesia		Melanesia	Polynesia
No.	Chamorro	Iloko	Pampango	Napu	Batak	Fiji	Samoa
1	*maisa*	*maisa*	*isa*	*isa*	*sada*	*dua*	*sa*
2	*hugua*	*dua*	*adua*	*dua*	*dua*	*rua*	*lua*
3	*tulo*	*tallo*	*atlu*	*talu*	*telu*	*tolu*	*tolu*
4	*fatfat*	*uppat*	*apat*	*iba*	*empat*	*va*	*fa*
5	*lima*	*lima*	*lima*	*lima*	*lima*	*lima*	*lima*
6	*gunum*	*innem*	*anam*	*ini*	*enem*	*ono*	*ono*
7	*fito*	*pito*	*pitu*	*pitu*	*pitu*	*vitu*	*fitu*
8	*gualo*	*walo*	*walu*	*walu*	*waluh*	*walu*	*walu*
9	*sigua*	*siam*	*siam*	*hio*	*siwah*	*thiwa*	*iwa*
10	*fulu*	*pulo*	*pulu*	*pulo*	*puluh*	*vulu*	*fulu*
100	*gatos*	*gasot*	*dinalan*	*atu*	*ratus*	*drau*	*lau*

As an extension to the development of number sense, Manansala suggests that several uses of the Chonka (Sungka) board for mathematical calculations, when extended, can lend themselves easily to computation with regard to currency.

The wells can stand for abstract values in powers of tens as seen below:



	1,000,000	*100,000*	*10,000*	*1,000*	*100*	*10*	*1*	*fractions*

Diagram I

In Diagram II, the board shows a simple addition problem of five numbers being added: 233, 464, 1200, 1301, and 55,206. The place value will be arranged from left to right in the modern Western system. At the extreme right, next to the large well is the place for the 1's with the other places increasing by multiples of 10 towards the left. Along the bottom row, the counter places the number of cowries, shells, or whatever device is used for each number given above in the proper place. Thus, for the number 233, three cowries are placed in the 1's well, three in the 10's well to its left, and two in the 100's well. This is done for all five numbers with the total number of cowries in each well shown.

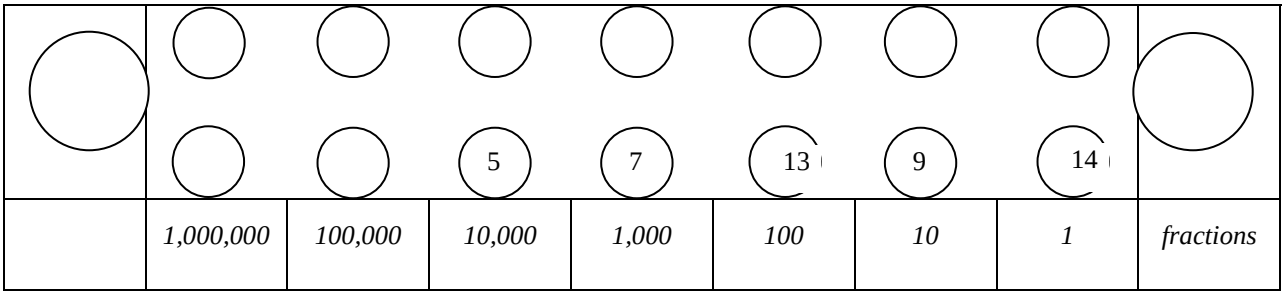
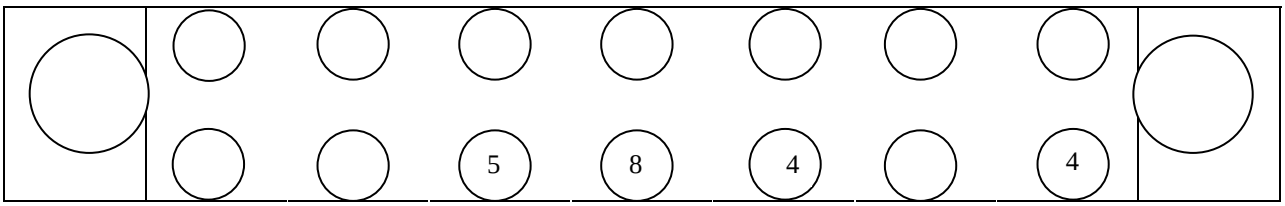


Diagram II

In Diagram III, the next step is illustrated. The counter counts 10's from each well and places one cowrie for each ten cowries removed from a well in the well immediately to its left. In the first row of 1's, there are 14 cowries, so one cowrie is placed in the 10's place to its left. The remainder 4 cowries is left in its original well, and the rest are placed in one of the large wells which both hold cowries for use in the calculations.



	1,000,000	*100,000*	*10,000*	*1,000*	*100*	*10*	*1*	*fractions*

Diagram III

The same is done for the 10's well using any additional cowries contributing from the 1's well, and so on for each well containing cowries. The final results are shown above and the number read from left to right is 58,404, which is correct. Subtraction can be illustrated similarly—the number to be subtracted from is placed in the upper row with the subtrahend placed in the lower row.

Simple multiplications can be solved and eventually memorized for use in larger problems. For example, 5 × 8 may be calculated by placing five cowries in eight wells, with the total number of cowries counted indicating 40. Diagram IV shows a multiplication problem: 21,000 × 17.

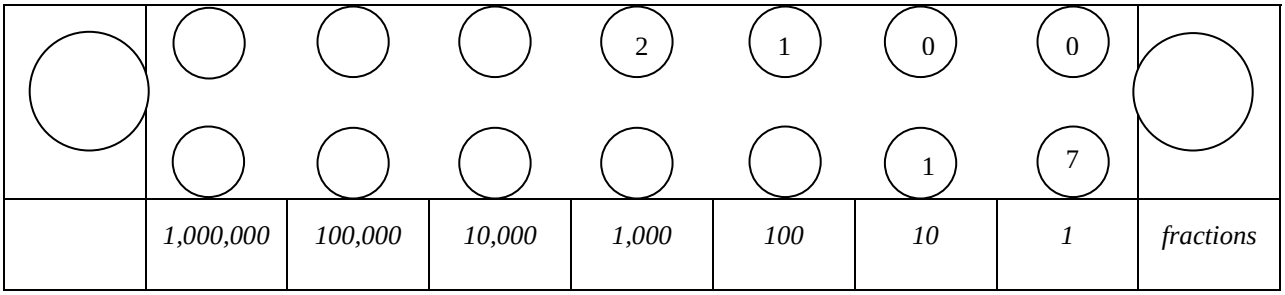


Diagram IV

The higher number is placed in the upper row, and the lower one at the bottom. The process is from the left to right for multiplication. The two in the 1000's row is multiplied by the one in the 10's row of the lower row, 2 × 10 = 20. Any quantity of 10 adds one cowrie to the well to the left of the row in question, so we place two cowries in the 10,000's row. Next, we multiply the seven in the 1's row with the two in the 1,000's row, 2 × 7 = 14. From this product, we expunge 10 and place one cowrie in the 10,000's row and leave the remainder of four cowries in the 1,000's row. If the result is under 10 we leave the whole amount in the place being

multiplied. After completing these calculations for each well we read the result shown on the top row.

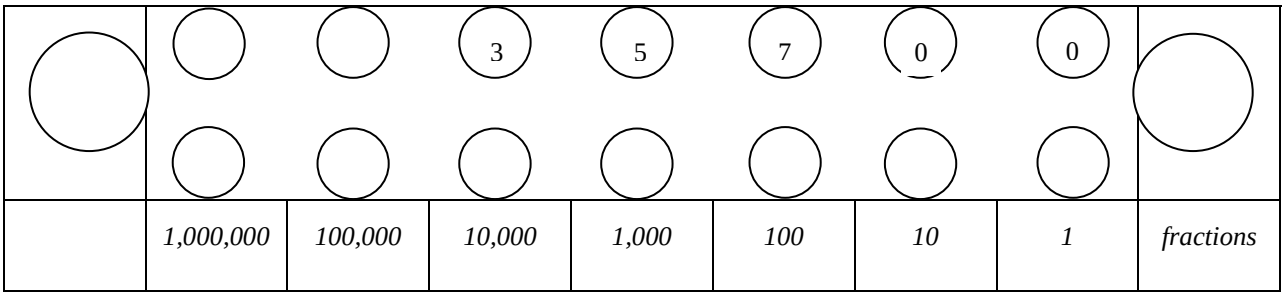


Diagram V

For division problems, the numbers are placed at the extreme left of the board, placing the quotient of two cowries on the ground in line with the lower well, with any remainder placed in the first two wells. Manansala also shares examples of using the board for exploring ideas of permutations, combinations, and progressions concerning cube roots. "The possibility of solving algebraic equations with the use of the sunkahan (chonka board) is not too remote to consider" (Osmena, 1967, p. ?)).

With regard to mathematical explorations, Manansala assumes a pattern of a step progression and how the Chonka board is used to represent it.

Let us assume a progression by two's with the first four steps shown:

$1 = 1 \times 2 = 2$

$2 = (1 \times 2) + (2 \times 2) = 6$

$3 = (1 \times 2) + (2 \times 2) + (3 \times 2) = 12$

$4 = (1 \times 2) + (2 \times 2) + (3 \times 2) + (4 \times 2) = 20$

On the Chonka Board, if two cowries are placed in each well for each progression, up to the 4^{th} step, ten of the wells will have two cowries each. The equation for this type of pattern is:

$n^2 + n$

where n = the number of the step. So, at the 8^{th} step,

$8^2 + 8 = 72$ and $8 \times 2 = 16$

$7 \times 2 = 14$

$6 \times 2 = 12$

$5 \times 2 = 10$

$4 \times 2 = 8$

$3 \times 2 = 6$

$2 \times 2 = 4$

$1 \times 2 = 2$

Total 72

Manansala also suggests observing the progression taken by the factors of 2^2 or 4. In this pattern the progression doubles at each step, where the pattern is also related to square roots:

Number	**Square Root**
$1 \times 4 = 4$	2
$4 \times 4 = 16$	4
$16 \times 4 = 64$	8
$64 \times 4 = 256$	16
$256 \times 4 = 1024$	32
$1024 \times 4 = 4096$	64

A number of other explorations can be considered, which can lead children of all ages to become successful with mathematics that demands higher levels of reasoning, such as generalizing, problem solving, and justification (National Council of Teachers of Mathematics, 2009, p. 52). What this means is that mathematics educators, in examining the fundamental expectations about what children can learn, must strive to create learning environments which

are engaging and filled with rich mathematics. Little research has been conducted to examine the role of culturally-based mathematics lessons in the general classroom and the impact that those lessons have on children. A question to consider may be that if playing games is considered one of six culturally universal mathematics activities, how might the other activities (actions, counting, measuring, explaining, designing, and locating) be contextually developed as effective curriculum tools to enhance the learning and understanding of mathematics? Areas for further research consideration may include investigations of cultural models and the implementation process connected to those investigations.

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