EXPLORATION OF THE IMPLEMENTATION OF TRADITIONAL POHNPEIAN COUNTING SYSTEM IN GRADE ONE

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By

Deeleeann Daniel

Dissertation Committee:

A. J. (Sandy) Dawson, Chairperson
Joseph Zilliox
Neil Pateman
Tom Craven
Donald Rubinstein

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Finally, the one person in my life to whom this study is dedicated to, that is for you my Son, Doh- Sao, you have given me strength. I am thankful for the love and joy that I have experienced being your mom. I love you.

ABSTRACT

This dissertation was a qualitative case study that explored teachers' and elders' perceptions of the implementation of traditional Pohnpeian counting system in grade one. The focus of this study was on the teachers' and elders' perceptions on the use of cultural practices and activities in teaching mathematics lessons and the efficacy of using elders' assistance in the development and refinement of the pedagogy for the implementation of the teaching of the Pohnpeian counting systems. The participants included three teachers from two different elementary schools and three elders from two different communities. The teachers' and elders' perceptions were gathered through field notes and observations during the implementation of the lessons and interviews after the implementation of the lessons. According to the teachers and elders, the implementation of culturally-based mathematic lessons is an effective way of strengthening students' understanding of mathematical ideas and preserving the fading cultural practices.

The teachers' and elders' perceptions highlighted the need for more support from school administrators in the use and development of lessons that draw on our own cultural practices to teach mathematics or other subjects. Additionally, the study recommends further research on the use of elders as resources for developing instructional materials.

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CHAPTER ONE

INTRODUCTION

In this chapter I provide an overview of my educational background and experiences as a mathematics teacher that led me to the study of the implementation of a culturally based unit of mathematics designed for grade one students on the island of Pohnpei.

About me and my home island

My name is Deeleeann Daniel. I was born and raised in Pohnpei in the western Pacific. I am the youngest in the family of 3 brothers and 3 sisters. I have a 3 years old son. Pohnpei is one of the four states in the Federated States of Micronesia (FSM). The FSM can be found south of Guam and east of the Philippines. The FSM is made up of four states and many islands. With a land area of approximately 129 square miles,

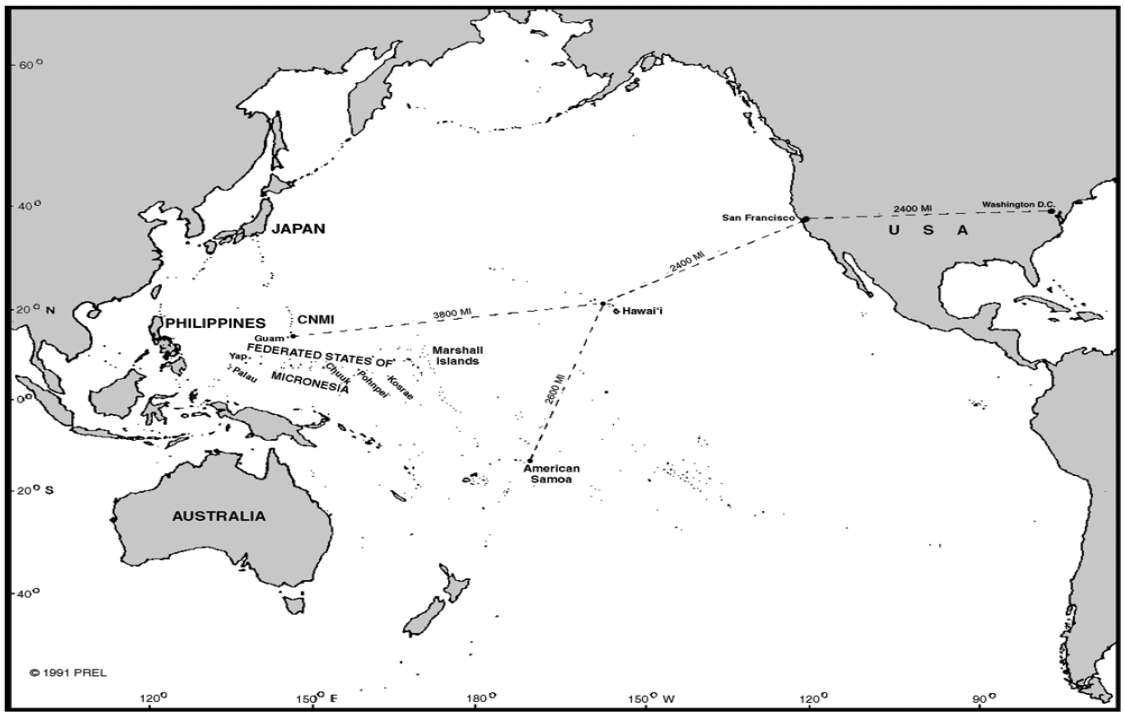

Figure 1: Map of the Pacific Region where Project MACIMISE is situated

Pohnpei is the largest of the islands within the group known as the Eastern Carolines. It is also one of the wettest places on earth with annual recorded rainfall exceeding 300 inches (7,600 mm) each year in certain mountainous locations. The island is comprised of 6 municipalities: Kitti, Madolenihmw, Sokehs, Uh, Nett, and Kolonia and 5 outer islands.

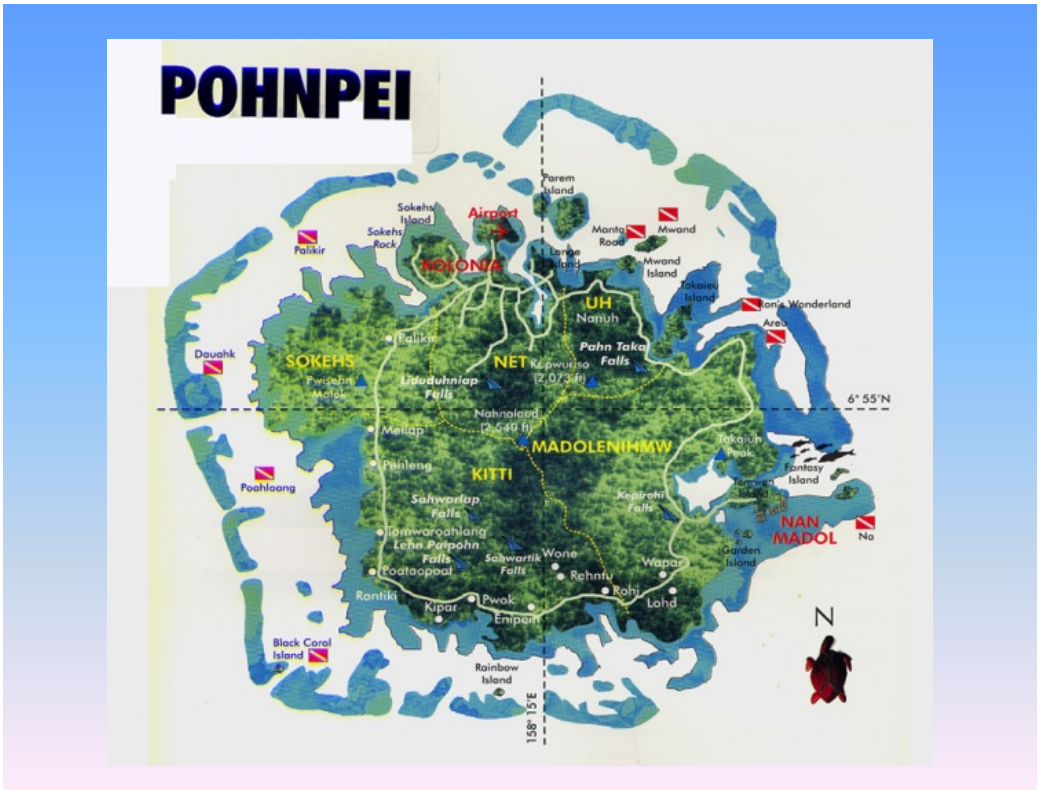

Figure 2: Map of Pohnpei Island

My Educational Journey

My educational journey is a combination of both learning and teaching. Immediately after receiving a Bachelors of Arts in mathematics from the University of Hawai‘i at Hilo in 2004, I started teaching mathematics at the high school level on Pohnpei. Even though I did not have any prior teaching experience, school administrators and the mathematics specialist for Pohnpei thought I was qualified to teach mathematics.

Moreover, this assignment gave me the opportunity to be part of Project MENTOR (Mathematics Education for Novice Teachers: Opportunity for Reflection). It also allowed me to enroll in an online program at the University of Hawai‘i at Mānoa in Curriculum Studies to pursue a Master's degree with an emphasis in mathematics.

A year later, I was asked to transfer to Nanpei Memorial High School to teach geometry and algebra. I taught two geometry classes and three algebra classes. With the help and support of the ongoing activities in the MENTOR project and online courses that helped deepen my understanding of mathematics content, I overcame the challenging experiences common to new teachers.

In 2006, I accepted an offer from the Pohnpei Campus of the Federated States of Micronesia's College of Micronesia (COM/FSM) to be a mathematics instructor. I was more comfortable in accepting the job at the college than I was with the high school job with Pohnpei Department of Education. I assumed that college students would be more mature and their 12 years of learning mathematics would help prepare them before enrolling in college. Seven years later, I am still trying to prove that my assumption about college students is right.

In 2010, another opportunity arose to further my studies in Curriculum Studies at the University of Hawai‘i in a much different setting. This time around, the project combined mathematics and culture. I was accepted as a Doctoral student in conjunction with being part of a National Science Foundation funded project *Mathematics and* Culture *in Micronesia: Integrating Societal Experiences* (MACIMISE). The twenty-two

participants in Project MACIMISE[1] are from the state of Hawai‘i, and nine US-affiliated islands of the Pacific {the Republic of Palau, Guam, the Commonwealth of the Northern Mariana Islands [CNMI], the Federated States of Micronesia [FSM] (which includes Yap, Chuuk, Pohnpei, and Kosrae), the Republic of the Marshall Islands [RMI], American Samoa}. Twelve of the participants work in their local departments/ministries of education, eight are instructors at their local colleges, one is an assistant prosecutor for her State's Justice Department, and one is a State legislator. The latter two were with the local education authority when selected for the Project. All participants are or were enrolled in Doctoral (ten participants), Masters (11 participants) or general education (1 participant) programs in the Department of Curriculum Studies at the University of Hawai‘i-Mānoa. We call ourselves the *Macimisers*.

In the beginning, there was no path, not even a rough trail through the jungle, only unexplored territory surrounded by unchartered Pacific waters. Despite the challenges we were facing, and the obstacles that we knew we'd have to overcome, we nonetheless could envisage our destination, and we had confidence that we'd get there. There were just over thirty of us when we began. As the first leg of the journey neared its end, our numbers gradually dropped. When our leaders indicated we'd reached the first plateau of a journey that began in January 2010, we numbered just twenty-two.

We are the Macimisers

MACIMISE is a National Science Foundation[2] funded project that focuses on the languages and cultural practices of the islands noted above. The islands encompass at

[1] MACIMISE, pronounced as if spelled maximize, stands for **M**athematics **A**nd **C**ulture **I**n **M**icronesia: **I**ntegrating **S**ociety **E**xperiences.

[2]The Project is supported by a National Science Foundation (NSF) grant (0918309). This material in this paper is based on work supported by that grant. The content does not necessarily reflect the views of the NSF or any other agency of the US government. The Project is a collaborative

least ten distinct language groupings that are spread across 1.5 million square miles of the Pacific Ocean yet have a total landmass of less than 1000 square miles.

The first goal of the Project is the development of elementary school mathematics curricula sensitive to local mathematical thought and experience. A necessary prerequisite for the achievement of this first goal is to recapture and honor the mathematics developed and practiced in the various communities. This is the Project's second goal. The recapture of local mathematical thought and its transformation into school curricula requires local experts in the teaching and learning of mathematics who are familiar with the mathematical practices in their own cultures and who in the years ahead will provide leadership in the development of curricula sensitive to local mathematical thought. In order to maximize (MACIMISE) its impact the goals of the Project are to:

- develop and assess local mathematics curriculum units for grades one, four, and seven;
- rediscover/uncover the indigenous mathematics of ten Pacific island language communities; and
- build local capacity by offering advanced degree opportunities to local mathematics educators.

The dynamics of how these goals are to be achieved consists of three phases: (1) to educate the local mathematics educators to be trained collectors of and (2) documenters of the mathematical practices found in their language and culture, and (3) to

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effort between Pacific Resources for Education and Learning (PREL) and the University of Hawai'i-Mānoa (UHM) with PREL as the lead organization.

develop these local mathematical practices into curriculum units that will be implemented and assessed in schools on the noted island communities.

The Project arose from the diligent work of the participants of two previously funded NSF grants (Project DELTA[3] and Project MENTOR[4]), college mathematics instructors and local mathematics teachers who had reached a point in their career development where they were looking for something more, and in particular, mathematical understandings and practices that arose from their own cultural experiences and knowledge.

The Director of Project MACIMISE, Dr. A. J. (Sandy) Dawson, tells the following story of the genesis of MACIMISE.

> *Back in 2000, Jerry became part of Project DELTA almost by accident. He happened to be standing in the College of Micronesia: FSM Yap campus offices one day when I was there seeking a college math person to be part of the year old DELTA Project. Eight years later he had taken part in both the DELTA Project and Project MENTOR. Over a meal on Yap when I was making one final trip across the region as Project MENTOR was wrapping up, Jerry's response to a question about 'what should we do next if money could be found' elicited this thoughtful and heartfelt reply: "For eight years we've studied western mathematics, mainland mathematics, and teaching approaches that are suited to mainland children. Why don't we ever look at Yapese cultural practices and languages, examine them for the embedded mathematical knowledge, and then create lessons and units of work for our children that are based on things they've experienced? Not many Micronesian children have ever experienced snow, but they sure know about fishing in the vast Pacific Ocean." His response was the germ of the idea that eventually blossomed into Project MACIMISE.*

[3] Developing Effective Leadership Team Activities, NSF grant (9819630) 1999-2002.
[4] Mathematics Education for Novice Teachers: Opportunities for Reflection, NSF grant (0138916), 2002-2008.

Jerry's[5] response was the conversation opener for the remainder of a 2008 trip across the region. On each of the islands visited (Palau, CNMI, Guam, the FSM, and the RMI), the reaction was the same: yes, why don't we look at our own cultural practices, our own languages (some of the islands use as many as four or five different dialects)? They said that not only would their children relate more easily to examples and illustrations from things they know, but it would help to preserve some aspects of their cultures and languages that are being lost. One gentleman on Chuuk lamented the fact that at one time there were more than 50 ways of counting, and now there were only 3 and even those were in danger of being lost. Conversations with community elders (persons of knowledge who may or may not be old in terms of age), reinforced the desire that traditional practices not be lost, that the younger generations needed to be introduced to and educated in the ways of living on isolated Pacific islands which enabled survival, protected the land and waters surrounding their islands, and kept the people locally smart as well as world smart. These conversations led to the development of the Project MACIMISE proposal that was submitted to the NSF in January 2009. The proposal was approved and funded with a commencement date of September 1, 2009.

Participants, of which I am one, in MACIMISE saw themselves as full members of the Project MACIMISE research team who were active in several roles within the project: as field researchers and local experts on indigenous mathematics, as experienced classroom teachers who may be implementing or field-testing the culturally-based

[5]Jerry Fagolimul ran for and was successful in a bid to become a Senator in the Yap State Assembly. His 4-year term began in January 2011.

mathematics curriculum units, and as culturally-sensitive evaluators who can assess the outcomes of the project.

The long term outcome envisioned for Project MACIMISE is to maximize the impact on children of the experience of learning mathematics in an environment which draws on the cultural practices of the children's home communities. The Macimisers are seen as the potential educational leaders of tomorrow for the islands of the western Pacific and American Samoa, a group of individuals steeped in the values of both their home cultures and the world vision enunciated in the ethnomathematical philosophy which forms the theoretical foundation of Project MACIMISE.

A number of sources were referred to in order to provide a brief explanation of Ethnomathematics as the foundation of the Project's work. For examples, Magallanes writes that "Employing an ethnomathematics pedagogy provides flexibility and versatility to the mathematical universals based on perspectives derivative of culture and experiences." Ethnomathematics provides a locus from which to engage issues of equity and quality in education. The National Council of Teachers of Mathematics asserts that education should include tasks that are based on a range of ways that diverse students acquire knowledge and develop a coherent framework for mathematical ideas (NCTM, 1991; 2000). According to Gay (2000) and Ladson-Billings (1995), there is unmet theoretical and practical potential in non-traditional methods that are accommodating and responsive to societal structures. For example, the UCLA Center X has documented that "Culture matters when it comes to teaching and learning. Every child enters a classroom with rich cultural knowledge and lived experiences that help them learn each day" (2008, p. 1). D'Ambrosio (2001) explains that an important component of ethnomathematics is

to reaffirm the individuality and identity of students through education. In a research study conducted by Greenfield (1996), he argues that the achievement gap is due in part to "the incompatibility of the traditional Western system of education with values and practices" (p. 923). As such, ethnomathematics allows us to address the needs of diverse groups of students through transformative approaches that draw on the strengths of students' cultural backgrounds (Goetzfridt, 2008). Given the indigenous nature of the islands of the western Pacific the MACIMISE focuses on, using Ethnomathematics, as the foundation for the work seemed highly appropriate and academically defensible.

One phase of project MACIMISE required each of the nine entities involved with the project [the Republic of Palau, the Federated States of Micronesia (including the States of Chuuk, Kosrae, Pohnpei and Yap), Guam, the Commonwealth of the Northern Mariana Islands, the Republic of the Marshall Islands, American Samoa, and Hawai'i] to develop culturally relevant mathematics units for grades one, four, and seven. Once developed, the Project required us to pilot our units in public schools on our island. I chose to pilot my grade one unit on the learning and use of the Pohnpei counting system at a local school close to my home. Designing and implementing the pilot study was an engaging and educational experience for me

In conjunction with the unit development and designing the pilot, I also needed to complete all the requirements for a doctoral degree. Brainstorming and debating with my MACIMISE colleagues (we came to call ourselves the *Macimisers*) for a challenging but manageable dissertation topic, I realized that the exploration of teachers' and elders' perception on culturally-relevant teaching and learning would provide a rich opportunity

for me to learn first hand about the teachers' and elders' experiences with the project and how they felt about the work of Project MACIMISE.

The Study

This is a qualitative research study the focus of which is to gather data about

- teachers' perception regarding the introduction of the traditional Pohnpeian counting systems in grade one, and
- the efficacy of using elders' perceptions and assistance in the development and refinement of the pedagogy for the implementation of the teaching of the Pohnpeian counting systems.

Three teachers were asked to implement the grade one unit (Appendix A) developed dealing with the teaching of the traditional Pohnpeian counting system. Case studies were completed for each of the teachers involved in the teaching of these units. Further, the elders who assisted me with the development of the units were interviewed before and after the implementation of the unit in order to ascertain their perceptions of the approach developed to teach the Pohnpei counting system.

The Pohnpeian Counting System

The people of Pohnpei (formerly known as Ponape) developed their own counting systems. This traditional knowledge included wisdom that Pohnpeians accumulated by observing their environment and structuring their island society. The traditional Pohnpeian counting system of Pohnpei is very interesting. The system starts like the English standard counting system where terms are used to indicate numbers: "one" *ehu*, "two" *riau*, "three" *siluh*, "four" *pahieu*, "five" *limau*, "six" *weneu*, "seven" *isuh*, "eight" *waluh*, "nine" *duwau* and "ten" *eisek*.

Numeral classifiers are used in most Micronesia language and the Pohnpeian language uses at least twenty-nine. The native speakers use different classifiers for different objects to assist them in differentiating objects, which gives them an advantage over speakers with other counting systems. There is one counting system that does not employ classifiers, thus actually there are thirty counting systems. However, within these systems, there are only three ways of saying ten: *eisek*, *ehk* and *ngoul*. Tables 1 below divides the classifiers into three ways of saying ten and includes objects that use the classifiers.

Table 1: Set of classifiers used with *eisek*

Set of classifiers used with *eisek*	
Numeral classifier/word ending	Objects taking each classifier
1. -u	inanimate things, commonly used
2. -pak	occurrence
3. -mwut	objects in heap or pile
4. -lep	halves
5. -pit	strips or strands of hair
6. -el	restricted to leis worn on the head
7. -sop	cut more than a half
8. -mwodol	small round objects
9. -tumw	gusts of wind
10. -dip	slices smaller than half
11. -dun	food tied together
12. -i	bunch of things*
13. -sou	trash or feces

Table 2: Set of classifiers used with *ehk*

Set of classifiers used with *ehk*	
Numeral classifier/word ending	Objects taking each classifier
1. -men	animal and human
2. -pwoat	long objects (trees)
3. -pali	slices
4. -poar	thin objects or pieces (board, strips of tuna)
5. -te	leaves, paper
6. -par	tin roof
7. -ka	sheaf or bundle (wood and sugar cane)
8. -pa	frond
9. -ra	branches of trees
10. -pwuloi	stanzas of a song
11. -sel	sennit
12. -kap	row or lines
13. -pei	coconut husks

Table 3: Set of Classifiers used with *ngoul*

Set of classifiers used with *ngoul*	
Numeral classifier/word ending	Objects taking each classifier
1. -umw	Yams, bananas prepared in an *uhmw* (stone oven)
2. -pwong	night (*nipwong*)
3. -wel	single root plants (bamboo, sugarcane)
4. -kis	small pieces or fragments of things

*Note that this particular class of objects led to some disagreement among interviewees

There are many nouns that occur with more than just a single counting system. Rehg claimed, "many speakers of Pohnpeian language have consequently expressed concern that the rich system of numeral classifiers is in a state of decay and that many counting systems are in danger of being lost" (1981, p.137). A few examples that occur with more than one counting system are provided in Table 4 below.

Table 4: Examples of same noun taking different classifiers

Banana (*uht*)		Breadfruit (*mahi*)	
Two bananas	*uht riau*	One breadfruit	*mahi ehu*
Two banana trees	*uht rioapwoat*	One breadfruit tree	*mahi oapwoat*
Two bunches of bananas	*uht rioumw*	One breadfruit leaf	*mahi ete*
		One bunch of breadfruit tied together	*mahi adun*

Recently, a member of my dissertation committee asked me how 'mahi ehu' tells the listener that we are talking about 1 thing, and that thing is a breadfruit?" My explanation to him was, " that *'mahi'* means breadfruit, the *'eh'* means one, and the 'u' means inanimate things". So, for example, *mahi ete* would literally mean breadfruit one leaf. The *e* represents the numeral prefix for one and the *te* means leaf therefore *ete* means one leaf.

When most people think of mathematics, they think of numbers. But mathematics is much more. It also includes skills such as recognizing patterns, storing information and constructing objects. The mathematical patterns that exist in the counting system will

help any person interested in learning the counting system easily. Each noun is constructed using a numeral prefix followed by a classifier.

Table 5 Examples of common prefixes for 1-9.

Commonly used prefixes	Examples
(One) *a-, e-, o- , oa-*	*ara, ehu, oumw, oapwoat*
(Two) *ria-, rie-, rio-*	*riara, riewel, rioumw*
(Three) *sili-*, or *sil-* if followed by a vowel	*silipak, siluh*
(Four) *pah-*	*pahkis*
(Five) *lim-, limo-, lime-, lima-*	*limpak, limoumw, limewel, limakis*
(Six) *wen-, wene-, weno-* if followed by 'u'	*wenpwuloi,wenepwong,wenoumw*
(Seven) *isi-, is-* if followed by 'u'	*isimen, isuh*
(Eight) *wel-, weli-, wali-, wal-*	*wellep, welisop, walimwut, waluh*
(Nine) *duwa-, duwe-, duwo*	*duwauh. duwewel, duwoumw*

Higher numbers in Pohnpeian

Nowadays few younger Pohnpeians use or know the Pohnpeian terms for numbers higher than 'thousand'. In fact, many are likely to use English number words for both lower and higher numbers, though they are fluent in both languages. The Pohnpeian names for higher numbers are:

kid ‘one thousand’
nen ‘ten thousand’
lopw ‘hundred thousand’
rar ‘million’
sapw ‘hundred million’
lik ‘billion’

The root words or prefixes for ‘two’ to ‘nine’ are combined with the one-syllable words to create their multiples. For example, ‘two thousand’ is *rie-kid*, ‘thirty thousand’ is *sili-nen*. The existence of different one-syllable words for each denomination of ten from ‘thousand’ to ‘billion’ is very intriguing. Unlike the classifiers, these one-syllable words do not have any other meaning. Rehg (1981, p. 140) notes that according to the German linguist Girschner, missionaries introduced the names for higher numbers.

CHAPTER TWO

LITERATURE REVIEW

Indigenous Counting Systems

"Different communities and different cultural groups have developed and used a range of ways of counting and representing numbers" (www.ethnomath.org). The decimal numeral system (also called based ten) is used widely by modern civilizations. Hindu-Arabic, Roman and Chinese numerals are also based on powers of ten (http://en.wikipedia.org/wiki/Decimal accessed 2/3/14) including many Micronesian number systems.

Overtime and at varying places around the world different methods for counting arose. They include the use of objects, the use of hands as a way to represent numbers, counting with body parts, and the use of numeral classifiers, which is existed in most Micronesia languages.

Numeral Classifiers

All Micronesian languages (except for contemporary Marshallese) contain such numeral classifiers, but variation is large with regard to the degree of differentiation. It ranges from a binary system in Kosraean to a system of more than one hundred classifiers in Chuukese (Harrison and Jackson (1984) in Bender and Beller, 2006). These numerals consist of two morphemes. The first morpheme represents the numbers one through nine and the final morphemes are the numeral classifiers.

As noted above, there is more than just a single way to count in Pohnpeian. In fact, there are at least thirty ways. This multiplicity of counting is due to the existence of numeral classifiers. Every concrete noun in Pohnpei belongs to one or more classes.

When we use a numeral with a noun, an appropriate classifier must be employed (Rehg, 1981). Every concrete noun belongs to one or more classes.

Body Part Counting

Body-part counting occurs in many cultures. Many cultural groups make use of parts of the body for numerals and the base structures of body part counting systems are now vary widely (Lancy 1978, Menninger 1970, Zaslavsky 1973). Several Indo-European number words derive from body-part terms, suggesting an underlying body-part counting system: the word 'four' is related to the Proto-European word for 'finger'; 'five' in many Indo-European languages is related to the Proto-Indo-European word for 'hand' (Butterword, 1999). Some cultures possess more elaborate systems, such as the Papua New Guinean Okapsmin, who count on their fingers, facial features, shoulders and arms, which are touched, and named in a conventionalized stable order (Saxe, 1981)

Teaching Children the Counting System

Counting and sharing are two of the most important early number skills. They provide the foundation for mathematical understanding (Muldoon et al. 2007). Fosnot and Dolk (2001) identify counting on as a landmark strategy that children discover from their experiences in the world and in school. Hannuala et al., (2007) identified three early numerical skills that develop during childhood. The first of these skills is subsitizing-based number recognition—the rapid and accurate number recognition of 1–4 objects without counting. The second essential enumeration skill is verbally based object counting. It takes children a long time to reach meaningful object counting skills after they learn their first number words (e.g., Fuson, 1988; Wynn, 1992). This suggests that the skills to precisely enumerate sets of items require practice to develop. The notion of

practice needed for early numerical development leads us to the third skill of interest in this study: spontaneous focusing on numerosity (SFON).

Counting requires action on discrete elements, entailing the logic of one-to-one correspondence (Pepper and Hunting, 1998). Piaget (1952) highlighted the fragility of children's grasp of the relationship between item-to-item correspondence and number in his test of conservation. Counting objects and counting by rote is not the same thing. Being able to rattle off the count sequence comes first, before attaching it to physical objects in one-to-one relationship. Children also need to be adept with extended rote counting, with skip counting, counting by 10s and by 5s, counting from various starting points, as well as counting backwards (although this can be considerably more difficult than the other counting skills). When basic math performance lags significantly, it is important to fully explore these underlying counting skills even for students entering adolescence. Strengthening students' counting skills can be key to strengthening their math performance (Charbonneau & Steiner, 1988; Sharp, 1971).

Elders' role in developing culturally related mathematic lessons

It is important that the curriculum being used in any school be adapted to meet the needs of the students in that community. The extent to which you relate the content in any subject area to the local language and culture tells the students a great deal about the value which you place on their way of life. The participation of people from the local community allows the curriculum to be explored at a local level making studies more relevant to students. Consultation with local elders allows educators to learn more appropriate pedagogy for teaching about cultural issues and to take into account the necessary sensitivities and feelings of one's own culture when developing strategies

appropriate for teaching students. Elders involvement is essential in validation of cultural content.

The collaborative work between educators and elders contributes to preserving cultural dignity and offers the intellectual tools for exercise of citizenships (D'Ambrosio & D'Ambrosio, 2013, Lipka, 2006). It is an ongoing process that benefits all participants in helping to ensure that local practices are effectively incorporated into the curriculum. It involves establishing a respectful relationship within the community, and demonstrating a willingness to share, to learn, and to negotiate.

Working with elders enables educators to become aware of community views and sensitivities. This will involve educators getting to know members of the local community, at the same time making people aware of what is happening in the school. Encouraging elders' involvement in curriculum planning and delivery allows both teachers and students to explore their own culture through the life stories, practices, and experiences of people from their local communities. Such interaction allows students, elders, and teachers to develop mutual knowledge and understanding of their own culture. It can also provide cultural affirmation and pride for the students. Wherever possible, it seems productive to focus on investigation such as this one on local community experiences. It is suggested that concrete local examples have more meaning for students.

Importance of Using Ethnomathematics

"Ethnomathematics encourage us to witness and struggle to understand how mathematics continues to be culturally adapted and used by people around the planet and throughout time" (D'Ambrosio, 2001, p.309). To most educators, culture has its own place. The mathematics in many classrooms is disconnected from our students' reality.

Educators play an important role in the development of students' skills and interest in mathematics. “When teachers do acknowledge a connection, students experience in multicultural mathematical activities that reflect the knowledge and behavior of people from diverse cultural environments and they not only may learn to value the mathematics but, just as important, many develop a greater respect for those who are different from themselves” (D'Ambrosio, 2001, p.308).

For many Pohnpeian students, mathematics is taught in ways that are not connected to their lives and experience. According to Kaomea (2012), many argue that conventional mathematics pedagogy persuades students from historically marginalized communities to consider school mathematics as a subject divorced from their personal and cultural experiences, which makes students perform poorly in mathematics classes and internalize negative images about their knowledge and ability in mathematics.

Prior to European contact, native Pohnpeians had a self-sufficient and self-sustaining civilization. According to Bishop (1988), teaching mathematics is not a matter of learning sufficient mathematics to be able to teach that content to school students. Mathematics teachers are passing on values, habits, and customs as well as knowledge and skills.

Many Pacific Islander are experiencing difficulties in learning mathematics because of their ability to process mathematical ideas. When they are from different cultures, speak languages other than English, the traditional teaching of mathematics is not appropriate. An Ethnomathematics approach is suggested as a possible solution to this situation.

D'Ambrosio (1985) defines 'ethnomathematics' as the mathematics needed by a particular subgroup of the population, be it an occupational group or a cultural group. Ethnomathematics includes curricular relevance, but is much more than building a curriculum around the local interests and culture of the learners. This local focus can become limited to the mathematics the students want to study, which they see related to either their traditional or emerging roles. While it is important not to ignore this local perspective, such an approach can overlook the organization of mathematical ideas and preclude the development of a structured mathematics curriculum. The goal is to provide students with mathematics content and approaches that will enable them to successfully master modern mathematics. An ethnomathematics approach to the curriculum can be a vehicle for achieving such a goal.

"It is too easy to attribute the minority students' difficulties in learning mathematics to any one factor alone. For example, minority students perform very poorly on standardized tests from the third or fourth grade on, while in the early years their performance is closer to average" (Leap, 1988).

Standardized tests, by their very nature, place great importance on language skill. A student who is an inadequate reader and has poor mastery of English language vocabulary is at a serious disadvantage. It is clear that a language deficit will automatically lead to a mathematics deficit. ELL students typically do not receive such pressure because influences outside the school are unable to address the problem. Furthermore, ELL students are not motivated by test taking. They find the questions irrelevant to their interests and, apparently, and do not respond to them seriously. This problem signals the need for questions that students would be willing to treat seriously.

Finally, the ELL students perform poorly on the tests because they do not understand the mathematical processes. Such understanding is usually motivated through the use of manipulatives and visuals. In short, in competing with mainstream students on standardized tests, ELL students are disadvantaged through an interplay of language deficiency, cultural dissonance, and inappropriate instruction.

In addition, the guidelines of the National Council of Teacher of Mathematics (NCTM, 1991) highlighted the importance of building connections between mathematics and students' personal lives and cultures. According to Rosa and Orey (2011), "culturally relevant mathematics curriculum should focus on the role of mathematics in a sociocultural context that involves the idea and concepts associated with ethnomathematics, using an ethnomathematical perspective for solving contextualized problems".

CHAPTER THREE

METHODOLOGY

Case Study Characteristics

As noted earlier, this is a qualitative research study the focus of which is to gather data about

- teachers' perception regarding the implementation of the traditional Pohnpeian counting systems in grade one, and
- the efficacy of using elders' perceptions and assistance in the development and refinement of the pedagogy for the implementation of the teaching of the Pohnpeian counting systems.

It is important to understand teachers' and elders' perception on the implementation of culturally relevant mathematics lessons in early grades. Qualitative research methods are well suited to the study of meaning and complexity of experience (Patton, 2002). Qualitative methods allow a researcher to solicit more detail and describe what happens in a natural setting. Case studies, as one example, allow for an in-depth perspective with a smaller number of participants and can help policy makers understand the intricacies of a given situation. Using qualitative methods allowed me, as the researcher, flexibility in the data collection to gather more relevant information based on findings that emerged over time (Grbich, 2007). Interviewing the participants allowed me to gather their perspectives and probe for further clarification and meaning. This constructivist approach allows knowledge and meaning to emerge, relies on the researcher to elicit meaning in the phenomenon being studies rather than impose one's own belief. As a mathematics teacher and participant in project MACIMISE, I had to set

aside by beliefs to accurately portray those of the participants. Grbich (2007) notes that the researcher's personal experiences allow for multiple realities. Therefore, research bias was continually checked to ensure that proper attention was paid to what is actually occurring rather than what I expected to see. Please see the Concept Map for the study on the next page (Page 23)

A case study must be bound by specific and identifiable criteria (Merriam, 1998; Stake, 2000). Within the bounded system, the researcher's role in a case study is to gather data and make sense of the system being examined. This case study was bound by two criteria: (a) location – Pehleng and Ohmine School; (b) participants- first grade teachers and cultural experts/elders. This methodology allowed me to develop an understanding of the case through perspectives and interaction of the multiple participants.

When conducting a case study, triangulation of sources is necessary to compare and cross check the consistency of information collected at different times and by different methods (Yin, 1994). Additionally it is crucial to cross check and compare across participants from different role groups in the context of the study (Patton 2002). Validation of multiple sources of data adds credibility of the study and ensure that the researcher takes multiple perspectives into account in describing the case. The data collection in this research consisted of semi-structured interviews of three teachers from different schools and three elders from different communities.

Participants

In this study, I used purposeful and convenient sampling to select first grade teachers and elders who portrayed a range of experiences and knowledge of the Pohnpeian culture. The teacher participants are all over the age of 40 and received an

Associate of Arts degree in Elementary Education. And the elder participants are all over the age of 50 and have knowledge of the traditional Pohnpeian counting systems.

Role of the Researcher

The researcher's role in a case study is to gather data and make sense of the system being examined. It was my goal to gain insight on teachers' and elders' experiences and perceptions of the implementation of the traditional Pohnpeian counting system in grade one.

According to Merriam (1998), characteristics of qualitative researcher include: tolerance, sensitive to context of data, and good communication skills. I focused on these skills while conducting interviews. I compared and contrasted participants' experiences in each interview and developed themes across participants and change interview protocols to fit the emergent themes as participants shared their experiences. Additional characteristics that are important to my role as researcher include my interested in promoting awareness of culturally relevant mathematics and elders' involvement in developing culturally relevant lessons.

Data Collection Methods

This research employed a qualitative case study approach, where in methodology is selected to best understand the case (Stake, 2000). I selected the participants from two schools in Pohnpei and two different communities. The participants were purposefully selected based on their experience with the curriculum and knowledge of traditional cultural activities. My interest in Ethnomathematics and teachers' and elders' perceptions on the implementation culturally relevant mathematics in grade one led me to choose a case study approach to answer my research questions.

Studies that use only one data set are susceptible to errors. Triangulation of sources is recommended to compare and cross check the consistency of information collected at different times and by different qualitative methods (Patton, 2002). In order to understand teachers' and elders' perceptions on the implementation of traditional Pohnpeian counting systems in grade one, I triangulated the data collection (Bogdan & Biklen, 2003) by using multiple sources, including interviews, observations and open-ended questions.

Ethical Considerations

Throughout the study, consideration was made in regards to the participants and their confidentiality. All participants were informed on the purpose of the study verbally, and given consent form that outlined the procedures as well as their rights (Appendix B, C). Participants were asked to participate on a voluntary basis and had the right to withdraw from the study at any time, although none did. All data collected were strictly for research purposes and all their information were kept confidential. In reporting of the data, pseudonyms were used to maintain confidentiality of the participants.

Interviews/Observations

Interviews were conducted before and after the implementation of the traditional Pohnpeian counting systems in grade one at the beginning of the school year. I sought to understand teachers' perception on the introduction of culturally relevant units and elders perception on their involvement in designing and creating culturally-based curriculum. Case studies were completed for each of the teachers involved in the teaching of these units and elders involved in developing the culturally-based unit.

In addition to the interviews, observations during the introduction of the culturally-based mathematics lessons were utilized to gather information or gestures that may be vital to the research and are not recorded during the interviews. Interactions between the teacher and the students during the implementation of the unit were of great importance as these interactions were directly related to the research questions. Observations aimed to record non-verbal cues (such as intonations, body languages and pauses) to assist in understanding teachers' and students' reactions during the teaching of culturally-based mathematics. In order to ensure that precise information was collected, audio recording were made of the observations and were transcribed later. Detailed notes were collected during the observations that were shared later with the participants; again relying on member check to determine authenticity and precision of my interpretations.

Data gathering and analytic methods included:

- Observe and participate in the collaboration and reflection process of the introduction and implementation of the unit,
- Analysis of the reflections of the teachers and elders involved with the classroom design and creation of the culturally-based curriculum, and
- Analysis of the reflections of the teachers and elders involved with the implementation of the culturally-based curriculum.

Data Analysis

Data were analyzed as I collected them in order to develop my understanding of teachers' and elders' perceptions of their experiences with culturally relevant mathematics. I developed common themes by coding the interviews and their responses to the open ended questions.

To ensure quality of data collection, I conducted interviews with participants before and after the implementation of the culturally relevant mathematics unit. I recorded, transcribed and coded the interviews after they occurred and looked for themes as I analyzed the interviews. The data gathered from the varied participants increased the validity in the collection and analysis of data (Grbich, 2007). I was able to understand the similarities and differences in the perceptions of the teachers and elders.

Patton (1999) suggests that it is important to seek other ways of organizing the data that may lead to different conclusions. In addition to the interviews, observations and open ended questions were utilized to gather gestures or other ideas that may not be collected during the interviews. Additionally, member checks were an important step in data analysis. It is important to make the finding available to others to receive feedback on their accuracy (Yin, 1998). Participants have access to review transcribed interviews and notes and provide feedback on the analysis of the findings.

Data were collected through interviews with selected teachers from two different elementary schools on the island and elders from two different villages in Kitti. Observations during the implementation and open-ended questions were also taken to acquire more data. And data analysis took place as data is being collected. Multiple participants and data sources such as interviews, observations, and questionnaires are used in the study. Interviews notes were analyzed and then solicit feedbacks and confirmation from participants after data is analyzed.

Pilot Phase of the Study

With the help of elders and project advisors, the unit on the traditional Pohnpeian counting systems was designed from spring 2012 to summer 2012 and then piloted in

October 2012. The pilot process required feedback and comments on the pilot teacher's experiences. So in June 2012, the Project's assessment coordinators conducted interviews with all the teachers involved in piloting the units. From the interviews, teachers showed their support of the implementation of culturally relevant mathematics teaching but they wanted to be more involved in the development of the units. They said they would be more comfortable in teaching something that they helped create rather than teaching something that is just handed to them.

In July 2013, I met with the teachers and elders to revise the unit so that the content would be culturally relevant and appropriate for grade one and addressed the issues that the teachers had during the pilot phase.

One phase of project MACIMISE required each of the nine entities involved with the Project to develop culturally relevant mathematics units for grades one, four, and seven. Once developed, the Project required us to pilot our units in public schools on our island. I chose to pilot my grade one unit at Pehleng Elementary School. The school is one of the six elementary schools in Kitti municipality. I live close to the school and I knew the first grade teacher.

The unit piloted for this study was developed through Project MACIMISE and put through a pilot implementation during October 2012. The pilot process required feedback and comments on the pilot teacher's experiences. Data was gathered from the pilot teacher and sent to the MACIMISE Project evaluators. The evaluators subsequently shared this data with the unit developers.

The Project's assessment coordinators conducted interviews with all the teachers involved in piloting the units. Even though the teachers were very supportive of the

implementation of culturally relevant mathematics teaching, they wanted to be more involved in the development of the units. They said they would be more comfortable in teaching something that they helped create rather than teaching something that is just handed to them.

The teacher that piloted my lessons shared that the unit would more appropriately be taught at the beginning of the school year. She also felt she needed more involvement from the very beginning of the lesson design and implementation. For the testing phase of the implementation process, the experimental teachers would be involved in revising the units.

Testing Phase of the Study

I met with the teachers and elders prior to the implementation of the units during the second and third week of the school year to revise the unit. We focused on the unit and story so that the content would be culturally relevant and appropriate for grade one. I provided a copy of the unit and the story to each of the participants and we discussed and debated on what and what not to keep in the unit. I made notes and revised the unit based on the discussions we had during the two-day meeting. Again, I had to make copies of the revised unit and had them go through it again to ascertain that I had captured their ideas and suggestions as faithfully as I could.

Before the implementation of the unit, I interviewed elders who had major contribution to the development of the culturally-based mathematics lessons. After the implementation, I interviewed teachers and elders separately to collect their perception on the implementation of culturally relevant mathematics lesson for grade one. I recorded and transcribed each interview. Generalizations of all the participants' ideas were made

based on their responses. I made follow up visits to verify some of the responses that were not clear during the interview. I provided the participants with a copy of what I wrote.

The schools, the teachers and the elders

This section describes how the schools, teachers, and elders were selected for involvement with the formal testing phase of the study. It also defines the role of the cultural experts.

The Schools

Pehleng Elementary School is one of the 7 public elementary schools in Kitti municipality. The current population of the school is 310 students and 13 teachers. There are 14 classrooms. I know the teacher from his/her involvement in piloting units with project MACIMISE. The school is walking distance from my house. The students attending the school live in the village where the school is. Parents and teachers know each other. Their first language is Pohnpeian.

Ohmine Elementary School is one of the 2 public elementary schools in town of Kolonia. The current population of the school is 803 students and 37 teachers. There are 34 classrooms. I know the teachers from their involvement in the revision of Pohnpei Mathematics Standards that was undertaken in 2011. The school is close to my workplace.

In the town of Kolonia, there are a large number of non-Pohnpeian speakers. People from the five outer islands of Pohnpei have taken up residence on island in order to obtain employment with the government. Most of their children are attending one of

the two public elementary schools in the town. Therefore, there are different speech communities existing at Ohmine School.

The teachers and the elders

Convenient sampling was used for the study. I worked with the same teachers and elders in the pilot phase of project MACIMISE units for grade one.

The three teachers identified as experimental subjects for this project came from two different public elementary schools. These teachers are all female. They were asked to be part of this project for approximately 6-8 months. The teachers taught the developed lessons as a regular part of their teaching assignment.

The teachers were asked to reflect on the effectiveness of the lesson through a set of interview questions focusing on their perception on culturally relevant mathematics learning and teaching. The interviews were audio recorded. After each interview, I transcribed them and subsequently had the teachers review and analyze what had been transcribed.

The three elder participants were also a convenience sample: these elders were involved in the development and refinement of the said lessons through project MACIMISE. I chose them because I already had built a relationship with them. They were all over the age of 50 and had knowledge of the Pohnpei counting systems. The elders were from two different villages or communities on the island of Pohnpei. The elders assisted in the development of the unit with a focus on making sure that the counting systems were being described correctly in the lessons.

Revising the unit

In mid July 2013, elders and teachers were invited to a session where their assistance would be requested to revise the unit (APPENDIX A), prior to the unit being taught at the beginning of the school year. In this meeting, I shared with them the purpose of the study and their roles as participants. The meeting was very fruitful because we combined teachers who understood students' learning skills or abilities with elders who have knowledge of different cultural practices.

The culturally based unit was comprised of 5 lessons. The goals of the unit were (1) to develop awareness of categorizing numbers and counting pattern,(2) to count from 1-10 using the u, pwoat and te classifiers, and (3) to classify objects and use appropriate counting systems (classifiers) for objects used in building a canoe. Through the unit, students would endure understanding of the indigenous counting systems of Pohnpei and able to classify and identify numbers from 1 to 10. Assessment tools were embedded in the lessons were based on identifying, grouping and using correct classifiers with human, or animate things, elongated items and leafs or sheets of paper.

CHAPTER FOUR

FINDINGS AND RESULTS

Analysis of teachers' interviews and questions

Teacher interviews were semi-structured around the following questions and/or prompts:

- Briefly describe yourself: age, years of teaching lower grades, educational background and why teach lower grades, or others.
- How effective was the unit in teaching mathematics concepts/skills that you teach at this grade level? Describe how the lessons are compared to other lessons that are not culturally relevant. How did the students respond?
- The unit used a story as an opening for each of the lessons. Did you feel it is important to use a story to guide students' learning of mathematics or other subjects?
- Building a canoe is used as a cultural activity in the lesson. How important to our younger generation is it to learn about building a canoe?
- Building a canoe is also used in the lesson because of the different tools or materials necessary for building a canoe applies to the different classifiers stated in our current Pohnpei Mathematics Standards. Do you think it is necessary for this age to learn or know these different counting systems or numeral classifiers?
- Comparing your present and past observation, teaching or learning experiences, were there any differences in how the numeral classifiers are used, taught and learned?

- Classifiers are present in the Pohnpeian Counting systems: do you think it is necessary to implement the different counting systems so students can understand the different counting systems that exist in our language?
- Pattern is one of the four standards of mathematics. Did you realize that there are patterns existing in the Pohnpeian Counting system?
- How did the students react when they saw that the lesson included activities from their own culture or objects from their own environment?
- How did you know if the students mastered the mathematics concepts in the unit?
- How has this unit in mathematics using cultural practices influenced the way you think about using our culture to teach school lessons?
- Is it important to continue to develop lessons that draw on our own cultural practices to teach mathematics or other subjects?

Interviews and observations were collected over several months at two different schools to provide a clear representation of teachers' perception on culturally based mathematics lessons. Interviews were recorded and later transcribed. In order to avoid misinterpretations, I shared all data with the participants to ensure that their ideas were correctly described.

Detailed notes were also taken during observations and interviews to record data that are not reflected in the transcripts from the interviews. It included descriptions of non-verbal responses and events or actions and behaviors of the people involved.

- Briefly describe yourself: age, years of teaching lower grades, educational background and why teach lower grades, or others.

The three teachers are all over the age of 39. They have spent more than 9 years teaching first grade. Even though their first experiences with first grade teaching was not chosen by themselves, but assigned by their school's principals, they loved teaching younger children. They have all completed the third year certificate program of teaching from the College of Micronesia. They were involved in many curriculum development programs for early grades, including both mathematics and reading. One of the three is actively involved in teaching Sunday school with those who are under the age of 4, or children who have not received any form of formal education. Their experiences as mothers for more than 14 years helped a lot in dealing with younger children.

- How effective was the unit in teaching mathematics concepts/skills that you at this grade level? Describe how the lessons are compared to other lessons that are not culturally relevant. How did the students respond?

"The students learned through the use of familiar objects." They were engaged and could relate to different materials used in the unit: the different parts of the canoe and the different names of trees. Aside from being aligned with the curriculum, the idea of culturally-based was useful. "It is good and helpful for the students because it is something that is our own." The students were attentive and very responsive in explaining to those who were not very familiar with the different materials or objects used in the unit. "The students learn more than just mathematics". In the unit, students learned the counting, names of different trees, and names of different parts of the canoe.

- The unit used a story as an opening for each of the lessons. Did you feel it is important to use a story to guide students' learning of mathematics or other subjects?

"Younger children love stories." The idea of story as an opening got their attention and they wanted to learn. It helped a lot because even though the unit was focusing on the counting system, the use of story helped preserve something that used to happen in the homes in the past. These days' parents depend on TV over spending time with the family. "As a grandmother, I only tell stories to my grandchildren when we don't have access to TV. But I often realized that most of the time I tell them stories, I noticed that they are more attentive and often times fell asleep as I was telling them stories."

- Building a canoe is used as a cultural activity in the lesson. How important to our younger generation to learn about building a canoe?

It helped preserve the fading culture or canoe building skills that many people in the past have.

- Building a canoe is also used in the lesson because of the different tools or materials necessary for building a canoe applies to the different classifiers stated in our current Pohnpei Mathematics Standards. Do you think it is necessary for this age to learn or know these different counting systems or numeral classifiers?

"It is also stated in our Pohnpei Studies Standards." It emphasized the implementation of units that would helped support students understanding in classifying things and use appropriate numeral classifiers when counting different objects. Students learned more than the counting systems because from the trees, they learned names of different trees, and they learned the names of different parts of the canoe.

- Comparing your present and past observation, teaching or learning experiences, were there any differences in how the numeral classifiers are used, taught and learned?

Regarding implementation, the unit was aligned with the current mathematics standards. However, the unit was culturally-based therefore there are some differences in how these counting systems are taught in the classrooms. “I see a lot of general counting system use over the use of correct counting systems when counting different object outside the classrooms or when not focusing on the unit.” There was also have a wide range of languages exist in our school; therefore we can say that the general counting was mostly used when counting any object or the counting system of the first language. At Ohmine elementary school, there was more than just one language/dialect due to large number of outer islanders coming in to find work and live on the island: Pohnpeian, Mokilese, Pingilapese, Ngatikese, Nukuoro, and Kapingese.

- Classifiers are present in the Pohnpeian Counting systems; do you think it is necessary to implement the different counting systems so students can understand the different counting systems that exist in our language?

It is part of our mathematics standards so we need to implement as many as possible so students can be aware and learn the Pohnpeian counting system. If one is familiar or can associate different objects with all the different classifiers, then he/she will be able to learn the counting system easily.

- Pattern is one of the four standards of mathematics. Did you realize that there are patterns existing in the Pohnpeian Counting system?

Having more than 9 years of teaching first grade, patterns to them was only focused on for shapes or sizes, and not in terms of number or how it is used in the counting system.

- How did the students react when they saw that the lesson included activities from their own culture or objects from their own environment?

They like the fact that they can contribute in providing the tools necessary for each of the lessons. Some of them have similar objects such as canoe or a particular kind of tree at their house that is used in making a canoe.

- How did you know if the students mastered the mathematics concepts in the unit?

"Assessment tools embedded in the lessons helped in assessing students' understanding of the lessons and how the students react to the lessons." With younger students, learning occurs when they participate, help others and were able to respond to questions.

- How has this unit in mathematics using cultural practices influenced the way you think about using our culture to teach school lessons?

"It is very important to teach culture in the lessons no matter what kind of lesson is to be taught." Teaching and learning can be engaging if it involves our own cultural practices.

- Is it important to continue to develop lessons that draw on our own cultural practices to teach mathematics or other subjects?

The three teachers all agreed with this statement because they felt that cultural-based lessons would save a lot of money since materials and tools are easily accessed or just outside the schools or homes where they can get them for free.

Teachers were supportive of the implementation of culturally-relevant mathematics in grade one. It is aligned with the curriculum and provided opportunity for students to learn more about their culture. Students engaged in different activities such as listening to story, group work and poster work in the lessons and become aware of the connection between mathematics and culture embedded in the lessons. It is very important to teach the culture in our schools no matter what kind of lesson is to be taught. Children relate more easily to examples and illustrations from things they know and it

would help to preserve some aspects of their cultures. All the three teachers agreed with this statement because they felt that cultural-based lessons would save a lot of money since materials and tools are easily accessed or just outside the schools or homes where they can get them for free and students learn more about their own culture.

Analysis of elders' interviews and questions

Elder interviews were semi-structured around the following questions and/or prompts:

- Briefly describe yourself: Age, number of kids, grandchildren and great grandchildren, educational background, community involvement such as schools or any educational related activities.
- In our developed units, we used story as an introduction to lessons; a common practice known to be fading in our cultural practices at home or in the schools. Do you feel it is important to use story as a guide for our younger students since we are working with grade 1?
- The use of canoe as a cultural activity in this lesson: how important it is to our younger generation in their learning process?
- In our lesson, aside from selecting canoe building as the cultural practice is also aligned with our current Pohnpei mathematics standards: *ehu, riau, ete riete,* and *emen riemen, oapwoat rioapwoat*. Do you think it is necessary for this age of this student to learn or know these different classifiers?
- Comparing your experience of usage of the classifiers in past to present, were there any differences? In the classrooms, at homes?

- Regarding the use of classifiers present in the Pohnpeian counting system, are you aware of the importance in understanding the different counting systems that exist in our language?
- Knowing and understanding the different counting systems helps reinforces people's understanding of classifying different objects and using correct classifiers when counting.
- Do you feel that it is necessary to implement the different number systems we have in the Pohnpei School Systems?
- Did you realize that there are mathematical patterns in the counting systems?

Individual interviews were carried out with the three elders after the implementation of Pohnpeian Counting System. The interview questions sought out elders' perceptions on the implementation of Traditional Counting System in Pohnpei for grade one. All interviews were recorded and later transcribed to ensure accuracy. Detailed field notes were taken during observations and interviews to record actions or gestures that have been overlooked during the interviews and observation.

- Briefly describe yourself: Age, number of kids, grandchildren and great grandchildren, educational background, community involvement such as schools or any educational related activities.

All the elders are over the age of 50. They have grand and great grand children who are currently attending elementary school. Of the three elders, one made it to high school but dropped out during 10^{th} grade. The other two didn't made it to high school due to the limited number of secondary schools available when they were growing up, and also because of their parents' choice of wanting them to help at home over sending them to

further their education. All three were actively involved in Parents Teachers Administration (PTA) meetings, and one of them spends most of his/her days at the school because of overseeing a special needs child. Of the three, one was a teacher when the first Early Childhood Education (ECE) program was established in the community. Two of the three spent more than 20 years teaching Sunday school to the youth and younger children in the community. They are also part of many special projects involving teaching Pohnpeian language to children attending one of the two schools in town and part of the "Pohnpei Stories" booklet written in 1990's.

- In our developed units, we used story as an introduction to lessons; a common practice known to be fading in our cultural practices at home or in the schools. Do you feel it is important to use story as a guide for our younger students since we are working with grade one?

To the elders, story was an important part of Pohnpeian Culture. It used to be a source of passing information from one person to another. "I learned the culture and the many different legends of Pohnpei through the many stories told at home and at the schools." It tells what had happened and what is happening amongst those who have gone and those who are living. Many stories told in the schools were used as a way to help remind or give students the opportunity to learn how Pohnpei was created and other things that happened on the island before they were born. At the end of every Pohnpeian story, instead of saying "the end", one would say "*ai soai pwoat rohrohwei*" which literally translates, as "my one story is being transferred or carried away". The statement at the end tells the listener that the story is being passed on to him/her and it is his/her responsibility is to carry or pass it on to the next person or others. To one of the elders,

story time means an opportunity to come as one and work together. To him/her, it means family time. Today television (TV) has replaced parents' time for their children. They turned on the TV while they go out and drink *sakau* (kava) or do other things. "My fourth grade son was asking why they can't have stories in their classroom." To some children story can be used to help them engage and understand the lessons in the classrooms.

- The use of canoe as a cultural activity in this lesson; how important it is to our younger generation in their learning process?

Canoe is very important to the people of Pohnpei. Using it in a lesson will help with preserving the fading use of knowledge that younger children can associate with canoe. It signifies different things that are related or used in counting different objects that are listed in the current mathematics standards, and different names of different trees that are used for making different parts of the canoe. People today have little knowledge of the tools or things that are used in making a canoe so doing this activity in schools can help with the preservation of the lost understanding that people have towards canoe.

- In our lesson, aside from using the selection of canoe building is used to match our current Pohnpei mathematics standards: *ehu, riau, ete riete,* and *emen riemen, oapwoat rioapwoat*. Do you think it is necessary for this age of this student to learn or know these different classifiers?

The elders believed that the use of different classifiers needed to be implemented both at schools and at homes. They contended that the greater use of the different classifiers would help students understand and correctly use the different counting systems that exist in the Pohnpeian language.

- Comparing your experience of usage of the classifiers in past to present, were

there any differences? In the classrooms, at homes?

There were a lot differences between the past and present use of different classifiers both at school and at home. “I can recall times in the past where my parents would use the appropriate classifiers during our daily conversations while nowadays my children, grandchildren would use the general counting for any object they are counting.” To the elders, many parents didn’t realize their role as the first teacher to their own children. Children or student experiences at home can help enhance their understanding of the different counting systems that exist in the Pohnpeian counting system and other things about their own culture. The teachers at schools also play a crucial role in the students’ learning and understanding. The more they are exposed to the different classifiers, the more they would understand. What kids learn or experience at the house is what really changes how much the student can learn or know about different counting systems. We adapt other languages and used in our language that makes the difference in using appropriate language during our daily conversations.

- Regarding the use of classifiers present in the Pohnpeian counting system, are you aware of the importance in understanding the different counting systems that exist in our language?

  Knowing and understanding the different counting systems helps reinforces people’s understanding of classifying different objects and using correct classifiers when counting.

- Do you feel that it is necessary to implement the different number systems we have in the Pohnpei School Systems?

They learn more than just the mathematics in these lessons. “Aside from learning the different counting systems, students will learn names of different trees and names of different parts of the canoe.”

- Did you realize that there are mathematical patterns in the counting systems?

Even though they all answered “no” to this question, they shared that their involvement in the project made them more aware of their own culture. “Nowadays, I often paused and asked myself if there is any mathematics in what I am doing?”

Both teacher and elder participants support the idea of using cultural activities in teaching mathematics lessons. The implementation of traditional Pohnpei counting systems in grade one was an effective instructional example of using cultural practices in teaching. Many teachers and the community were not aware of the mathematics that exit in the culture and teachers’ and elders’ role in revealing and exploring cultural practices for students to understand and value their unique cultures.

Working with elders involves getting to know members of the local community, at the same time making people aware of what is happening in the school. Elders’ involvement in curriculum planning and delivery allows both teachers and students to explore their own culture through the life stories, practices, and experiences of people from their local communities. Such interaction allows students, elders, and teachers to develop mutual knowledge and understanding of their own culture. Wherever possible, it seems productive to focus on investigations such as this one on local community experiences. Experience suggests that concrete local examples have more meaning for students.

Elders were also supportive of the implementation of traditional Pohnpeian counting systems in grade one. Effective instructional example: Students learn more than just counting. They learned about the importance of story and canoe building in their culture. They learn different names of trees and parts of the canoe and the different classifiers for counting different objects. People today have little knowledge of the tools or things that are used in making a canoe so doing this activity in schools can help with the preservation of the lost understanding that people have towards canoe or some of our own cultural practices.

CHAPTER FIVE

CONCLUSIONS

This study aimed to better understand the perspectives of teachers and elders on the implementation of traditional Pohnpeian counting systems in grade one. Implementing the traditional Pohnpeian counting systems in grade one can be effective in strengthening students' understanding of the mathematical ideas and recognize the mathematics that existed in their own cultural practices.

Ethnomathematics contributes to restoring cultural dignity and offers the intellectual tools for the exercise of citizenship. In enhances creativity, reinforces cultural self-respect, and offers a broad view of humanity (D'Ambrosio, 2013). Development of instructional materials should focus on culturally relevant activities which requires collaboration between communities experts/elders and teacher. With their experiences with curriculum, teachers play a vital role in the development of these culturally-relevant lessons. Additionally, consultation with elders is important because of their knowledge and understanding of the cultural local practices.

By examining teachers' perception of the implementation of the traditional Pohnpei counting systems in grade one; I was able to gain insights of the use of culturally relevant curriculum instruction. Many teachers teaching cultural activities only came into play when they were teaching Pohnpei Studies. The units integrate more than just mathematics. Students learned the traditional Pohnpei counting systems. The stories embedded in the unit helped support students' listening skills that all students need to possess at all grade levels, and they learn more about their culture. Additionally, teachers'

knowledge and experiences with the traditional practices portrayed their attitudes towards the implementation of the culturally-based mathematics lessons.

Even though school administrators and teachers have the right to develop and teach curriculum materials for our students, we need to consider the ideas of elders in the development and implementation of culturally relevant materials. Consultation with local elders allows educators to learn more appropriate pedagogy for teaching about cultural issues and to take into account the necessary sensitivities and feelings of one's own culture when developing strategies appropriate for teaching students. Born and raised in town or Kolonia, I was less involved in many cultural activities. Unlike the other 5 municipalities, Kolonia does not have traditional chiefs. I knew little about the culture. The opportunity to work with elders had a great impact on how I feel or react to the culture. At one point in our conversations, we were talking about who can clean the front of the nahs (local house) during gathering in the presence of a Nanmwarki and which side of the nahs to enter during cultural activities. Aside from learning the importance of stories, working in groups in the culture and the counting system, I learned a great deal about the culture. School administrators should encourage the use and development of lessons that draw on our own cultural practices to teach mathematics or other subjects and further research on the use of elders as resources for developing instructional materials.

Recommendations for Future Research

As a result of this study, there are many directions for further examinations of the support for culturally relevant mathematics teaching. This study was focused on two elementary schools. To further understand the effectiveness of using culturally based

mathematics lessons, it is important to introduce more schools to involve them in implementing culturally relevant mathematics lessons to gain insights and a broader perspective on the effectiveness of using familiar stories and local cultural practices in teaching our students. It will be useful to find similarities and differences in the teachers' and elders' reaction to culturally-based mathematics and students' attitudes or achievement towards culturally-based mathematics.

Limitations of the Study

As with most case studies the findings are based on a small sample of subjects whose stories have been based on a limited number of observations and responses. Due to the nature of perceptions, experiences are influenced by many factors outside of the school structures and the support provided, so these must also taken into consideration. Perceptions are likely to change over time and thus with continued research within this area of mathematics, it is possible that the teachers' or educators' perceptions described here will change as well over time.

Furthermore, this study's purpose was to gain insight on elders' perception on their involvement in developing and designing curriculum materials. While interviews and observations were conducted to determine elders' perceptions on culturally-based mathematics teaching, there are limited number of sources were available to support the study. More study should be conducted examining role of cultural experts in developing curriculum materials in the schools more specifically in the Pacific Islands where different islands have their own cultural practices and languages.

APPENDICES

Appendix A: Grade One Unit Plan

Unit Title: Pohnpei 1st Grade Mathematics Unit

Rationale: Understanding the categorizing and pattern in Pohnpeian Counting System is an essential part of everyday life. Different classifications used in the Pohnpei counting system can be learn through the objects used in building a canoe.

<table>
<tr><th colspan="2">Stage 1—Desired Results</th></tr>
<tr><td colspan="2">Goals

a. Develop awareness of categorizing numbers and counting pattern.

b. Count from 1 – 10 using the general Pohnpeian counting system.

c. Classify objects and using appropriate counting systems (classifiers) objects used in building canoe.</td></tr>
<tr><td>Enduring Understandings

Indigenous Counting Systems of Pohnpei</td><td>Essential Questions

Why do students need to learn how to count?</td></tr>
<tr><td>Knowledge

Understand and learn the indigenous counting systems.</td><td>Skills

Classify and identify numbers</td></tr>
<tr><td colspan="2">Common Core Standards addressed</td></tr>
<tr><th colspan="2">Stage 2—Assessment Evidence (attach copies of everything you will use)</th></tr>
<tr><td>Summative Assessment Task

Worksheet activities based on identifying, grouping and using correct classifiers with human or animate things, elongated items and single rooted plants from 1 to 10.</td><td>Other Evidence</td></tr>
</table>

Stage 3—Learning Plan (Titles of your lessons)			
MACIMISE Daily Lesson Plan Title: Use the general Pohnpeian counting from 1 to 10 (using objects). Lesson #: 1			
Stage 1—Today's objectives			
a. Count out a given number of objects up to 10. b. Match objects with given numbers or vise versa.			
Stage 2—Today's formative assessments for learning			
a. Group work and one to one discussions among students. b. Observation of students' work and discussions.			
Stage 3—Today's learning strategies (attach copies of all materials you use)			
Introduction			
Time	Teacher Activities	Student Activities	Materials
2 minutes	Today children we are going to read a story and then we are going to do some activities on counting system. The story sets the stage for what the students will learn.		
Activities (step by step details and organization enough for someone else to follow.)			
Time	Teacher Activities	Student Activities	Materials
3-5 minutes	Read the story called Soupalehdi Invite students to join Soupahledi (you) count in	Listen to the story of Soupalehdi Count from 1(ehu) to 10(eisek) out loud with the	Soupalehdi Story

10-15 minutes 15-20 minutes 5-7 minutes	learning how to count from 1(ehu) to 10(eisek) in Pohnpeian. Divide the students into 3-4 groups for this activity. Provide a bag of shells or pebbles and kaikes to each group. Say the name of each number out loud. Have students repeat after you. Call out different numbers from 1-10 and have students count out the number from the bag. Teacher at front of class identifies a couple of students, holds up 4 objects, and asks the two student how many? Repeat the same process with different students. Review: What did we learn today and why does it matter to us?	teacher. Pick or count out the number of shells, pebbles or kaikes that matches the number. Take turns in counting out the number of objects that the teacher called out. Students at front of class with teacher and say the number of objects that the teacher is holding. Share what they learn during the lesson, and ask questions.	
Conclusion: At the end of the lesson I will see if the students can count from 1 to 10 and if they can associate the number of objects (from 1 to 10) with the appropriate counting word.			
Time	Teacher Activities	Student Activities	Materials

MACIMISE Daily Lesson Plan

Title: Use the general Pohnpeian counting to count 1 to 10 (using sequence) Lesson #: 2

Stage 1—Today's objectives

Count forward beginning at any given number.

Group objects and identify the idea of increasing piles.

Stage 2—Today's formative assessments for learning

a. Group work

b. Observation

c. Students' participation in poster activity.

Stage 3—Today's learning strategies (attach copies of all materials you use)

Introduction

Time	Teacher Activities	Student Activities	Materials
	Today we will continue counting in a different orientation. Counting can be fun if we can identify the different we can start from any number but not just from 1 (ehu). And sometime we can also move backward which is also possible with counting.		

Activities (step by step details and organization enough for someone else to follow.)

Time	Teacher Activities	Student Activities	Materials
5-7	Read the story called Soupalehdi	Listen to the story of	Soupalehdi

minutes 15-20 minutes 15 minutes	Invite students to join Soupahledi (you) count in learning how to count from 1(ehu) to 10(eisek) in Pohnpeian and backward 10(eisek) to 1(ehu). Post a poster on the front and ask students to make sets of numbers 1-10. Then call two students at a time to glue and write the symbols for the number they are working on. Guide students to count from 1 – 10 by pointing to their work. Start at any number and count forward or backward with students. Teacher will be at front of class and asking students to count forward and backward from any number. What happens to our sets if we count forward? Or what happens if we count backwards? Guide them to understand the concept of increasing and decreasing through the set of set they created.	Soupalehdi Count forward and backward: 1(ehu) to 10(eisek) and 10(eisek) to 1(ehu) out loud with the teacher. Make sets of numbers of shells, pebbles or kaikes that matches the number and glue to the poster. Name the numbers that is pointed to by the teacher with the teachers. Students at front of class with teacher and counting forward or backward from any number called by the teacher using the poster. Share their ideas with peer.	Story
Conclusion: At the end of the lesson I will see if the students can count from 1 to 10 using sequence (counting forward or backward counting at any number from 1-10.			
	Teacher Activities	Student Activities	Materials

MACIMISE Daily Lesson Plan

Title: Use "*men*" classification to count 1 -10 person and animals.
Lesson # 3

Stage 1—Today's objectives

Name, identify, and describe the characteristics of things that use "men" classification.

Stage 2—Today's formative assessments for learning

a. Group work – students work in group and explaining their thoughts with their peers.

b. Observation

Stage 3—Today's learning strategies (attach copies of all materials you use)

Introduction

Time	Teacher Activities	Student Activities	Materials
	We've been hearing the story of Soupalehdi for the passed few days and today we will work with Soupalehdi and help him identify some the important things required when building a canoe.		

Activities (step by step details and organization enough for someone else to follow.)

Time	Teacher Activities	Student Activities	Materials
3-5 minutes	Read the story called Soupalehdi	Listen to the story of Soupalehdi	Soupalehdi Story
20-25 minutes	So if you are Soupalehdi who has experts in canoe building. What will you need in order for you to make a canoe? Have students turn to a partner and share their ideas.	Name and describe with a partner the many things that a canoe builder will need. Group what they name in a category and explain why they are in that	

		certain category. and try to group them. Talk to a partner and share ideas to the whole class.	
10-15 minutes	Teach say “our cultural activities are not functional if there is no cooperation between the community members. There has to be people in order to start the activity”. Explain that we are fortunate to have a unique culture that can help us categorize and count different object using different classifiers. And that “men” classification is used for counting men and animals. Invite student to count with Soupalehdi (you) to count from 1 (emen) to 10 (ehk) when counting the ten people that will be helping.	Listen and connect to their own experience. Count along with Soupalehdi (teacher).	
Conclusion: At the end of the lesson I will see if the students can identify and use appropriate classifiers to count from 1-10.			
Time	Teacher Activities	Student Activities	Materials

MACIMISE Daily Lesson Plan

Title: Use “pwoat” classification to count 1-10 elongated things.
Lesson #: 4

Stage 1—Today’s objectives

1. Name, identify, and describe the characteristics of things that uses “pwoat” classification.

Stage 2—Today's formative assessments for learning			
a. Group work – Students' discussions of their ideas. b. Observation			
Stage 3—Today's learning strategies (attach copies of all materials you use)			
Introduction			
Time	Teacher Activities	Student Activities	Materials
	Today we are still continuing our work with Soupalehdi and can somebody tell us what we need in order to build the body of the canoe.	Listen and respond or ask questions.	
Activities (step by step details and organization enough for someone else to follow.)			
Time	Teacher Activities	Student Activities	Materials
3-5 minutes	Read the story called Soupalehdi	Listen to the story of Soupalehdi	Soupalehdi Story
7-10 minutes	We need the tree to have the main part of our canoe. Can somebody tell us what other things aside from canoe that we can use a tree for. Is it important do know how to count elongated objects or trees? Assuming that the students' response is yes, invite them to count 1(oapwoat) to 10(ehk) with you.	Share ideas with the whole class. Count 1(oapwoat) to 10(ehk) out loud with the teacher.	
	Group students into groups of three and identify and name	In their groups, students will name and discuss	

10-15 minutes	other objects aside from three that can also use the same "pwoat" classification.	some of the other objects that can use "pwoat" classification.	
7-10 minutes	Have them share their learning in the past two days. What are the new words we learn? Is it important to learn them?	Recall and share their learning experience with the whole class.	
Conclusion: At the end of the lesson I will see if the students can identify and use appropriate classifiers to count from 1-10.			
Time	Teacher Activities	Student Activities	Materials

MACIMISE Daily Lesson Plan

Title: Use “te' classification to count 1-10 leafs or sheets.

Lesson #: 5

Stage 1—Today’s objectives

Name, identify, and describe the characteristics of things that use “te” classification.

Stage 2—Today’s formative assessments for learning

a. Group work

b. Observation – Students' responses.

Stage 3—Today’s learning strategies (attach copies of all materials you use)

Introduction

Time	Teacher Activities	Student Activities	Materials
	We've learned a lot about our counting systems with Soupalehdi in the past few days. There are several objects we need to identify and able to count them using the correct classifiers. Today we count the leaves of the trees that are used in making the canoe.		

Activities (step by step details and organization enough for someone else to follow.)

Time	Teacher Activities	Student Activities	Materials
5 minutes	Teacher will share the fact that we are fortunate to have more than just a single way to count objects. Allow student time to ponder	Listen	

5 minutes 15-20 minutes	and identify some of the nouns that uses “te” classifier. Group students and ask the following questions: What can we say about leafs? Can we categorize them based on a certain character? Teacher might said “our language benefits a lot from the other languages like English because we have different classifiers that help us understand what we are counting rather than mentioning the name after each number we say. For example, riemen we already know that two animals or two people”. Explain that leafs and papers used the “te” classification. Invite students to count 1(ete) to 10(ehk) with you. Have student summarize their learning experience in the past three days in a complete sentence.	Share what they learn or heard people used to make string from. Work in groups: Name, group and identify some of the characteristics that each group of leafs or papers have. Listen and ask question Discuss and share ideas. Count 1(ete) to 10(ehk) loudly with the teacher. Respond using a complete sentence.	
Conclusion: At the end of the lesson I will see if the students can identify and use appropriate classifiers to count from 1-10.			
Time	Teacher Activities	Student Activities	Materials

Appendix B Consent Form for Elders

University of Hawai'i

Exploration of the Implementation of

Traditional Pohnpeian Counting Systems in Grade One.

My name is Deeleeann Daniel. I am a doctoral student at the University of Hawai'i at Manoa (UH), in the School of Education, Curriculum Studies. I am interested in learning more about the implementation of culturally-based mathematics teaching and learning. The purpose of my research project is to explore elders' perceptions on the introduction of culturally-based mathematics in the early grades. I am asking you to participate in this project because you know more about the culture.

Activities and Time Commitment: If you participate in this project, I will ask you to help review and refine the developed culturally-based mathematics lessons to be implemented in the early grades. I will also want to meet with you for an interview at a location and time convenient for you. The interview will take 45 – 60 minutes. Interview questions will focus on your perceptions on the culturally-based mathematics learning and teaching. Only you and I will be present during the interview. I will audio-record the interview so that I can later transcribe the interview and analyze the responses. You will be one of about 3 elders whom I will interview for this study.

Benefits and Risks: There will be no direct benefit to you for participating in my research project. I hope, however, that the results of this project will help me and the mathematics education community learns more about culturally-based mathematics learning and teaching for the benefit of future students. I believe there is little or no risk to you in participating in this research project. However, if you become uncomfortable of the implementation or answering any of the interview questions or discussing topics with me during the interview, we can skip the question, or stop the interview, or withdraw from the project altogether.

Privacy and Confidentiality: During this research project, I will keep all data in a secure location. Only my University of Hawaii advisor and I will have access to the data, although legally authorized agencies, including the UH Human Studies Program, can review research records. After I transcribe the interviews, I will erase/destroy the audio-recordings. When I type and report the results of my research project, I will not use your name or any other personally identifying information. Rather I will use pseudonyms (fake names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law. If you would like a summary of the findings from my final report, please contact me at the number listed near the end of this consent form.

Voluntary Participation: Your participation in this project is completely voluntary. You may stop participating at any time without any penalty or loss.

If you have any questions about this research project, please call me at (691) 320-3161 or email me at deeleeann@comfsm.fm. If you have any questions regarding your rights as a research participant, please contact the UH Human Studies Program, by phone at (808) 956-5007, or uhirb@hawaii.edu.

If you agree to participate in this project, please sign and date this signature page and return it to me.

Deeleeann Daniel, Principal Investigator

Signature(s) for Consent:

I have read and understand the information provided to me about participating in the research project, *Exploration of the Implementation of Traditional Pohnpeian Counting Systems in Grade One*.

My signature below indicates that I agree to participate in this research project.

Printed name: _____

Signature: _____

Date: _____

You will be given a copy of this consent form for your records.

Appendix C Consent Form for Teachers

University of Hawai'i

Exploration of the Implementation of Traditional Pohnpeian Counting Systems in Grade One.

My name is Deeleeann Daniel. I am a doctoral student at the University of Hawai'i at Manoa (UH), in the School of Education, Curriculum Studies. I am interested in learning more about mathematics teaching and learning. The purpose of my research project is to explore teachers' perceptions on the introduction of culturally-based mathematics in the early grades. I am asking you to participate in this project because you teach mathematics in early grades.

Activities and Time Commitment: If you participate in this project, I will ask you to help with the implementation of a culturally-based mathematics lessons and meet with you for an interview at a location and time convenient for you. The interview will take 30 – 45 minutes. Interview questions will focus on your perceptions on the culturally-based mathematics learning and teaching. Only you and I will be present during the interview. I will audio-record the interview so that I can later transcribe the interview and analyze the responses. You will be one of about 4 teachers whom I will interview for this study.

Benefits and Risks: There will be no direct benefit to you for participating in my research project. I hope, however, that the results of this project will help me and the mathematics education community learns more about culturally-based mathematics learning and teaching for the benefit of future students. I believe there is little or no risk to you in participating in this research project. However, if you become uncomfortable of the implementation or answering any of the interview questions or discussing topics with me during the interview, we can skip the question, or stop the interview, or withdraw from the project altogether.

Privacy and Confidentiality: During this research project, I will keep all data in a secure location. Only my University of Hawaii advisor and I will have access to the data, although legally authorized agencies, including the UH Human Studies Program, can review research records. After I transcribe the interviews, I will erase/destroy the audio-recordings. When I type and report the results of my research project, I will not use your name or any other personally identifying information. Rather I will use pseudonyms (fake names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law. If you would like a summary of the findings from my final report, please contact me at the number listed near the end of this consent form.

Voluntary Participation: Your participation in this project is completely voluntary. You may stop participating at any time without any penalty or loss.

If you have any questions about this research project, please call me at (691) 320-3161 or email me at deeleeann@comfsm.fm. If you have any questions regarding your rights as a research participant, please contact the UH Human Studies Program, by phone at (808) 956-5007, or uhirb@hawaii.edu.

If you agree to participate in this project, please sign and date this signature page and return it to:

Deeleeann Daniel, Principal Investigator

Signature(s) for Consent:

I have read and understand the information provided to me about participating in the research project, *Exploration of the Implementation of Traditional Pohnpeian Counting Systems in Grade One*.

My signature below indicates that I agree to participate in this research project.

Printed name: _____

Signature: _____

Date: _____

You will be given a copy of this consent form for your records.

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