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# What is MACIMISE?

A. J. Sandy Dawson

Abstract. Mathematics and Culture in Micronesia: Integrating Societal Experiences (MACIMISE) was a collaborative research and development project led by Pacific Resources for Education and Learning (PREL) and the University of Hawai'i at Mānoa. It was funded by the U.S. National Science Foundation (Grant No. 0918309). Founded on ethnomathematics research, the project aimed to improve mathematics teaching and learning for first-, fourth-, and seventh-grade elementary school students in ten Pacific island groups. The project team included 21 master's and doctoral students from the region who developed and field-tested culturally and linguistically sustaining grade-level curriculum units in mathematics topics such as numbers and counting, division of whole numbers and fractions, and geometry. Project leaders and advisors provided feedback as graduate students developed and piloted lessons. Associated research focused on the indigenous mathematics learning experiences embedded within the respective island communities. The late Dr. Sandy Dawson (PREL, University of Hawai'i) and Dr. Thomas Craven (University of Hawai'i) were the original Principal Investigators of MACIMISE. Dr. Donald Rubinstein (PREL; University of Guam) took over for Sandy Dawson in November 2014. This article, taken from reporting on the project by Sandy Dawson, gives background and framing for the articles in this special issue.

## 1. Introduction

Pacific Resources for Education and Learning (PREL) received funding from the U.S. National Science Foundation (NSF) in 2009 to implement Project MACIMISE – Mathematics and Culture in Micronesia: Integrating Societal Experiences (pronounced as "maximize"). The project was a collaborative effort between PREL and the College of Education, University of Hawai'i at Mānoa (UHM). The author, Dr. A. J. (Sandy) Dawson was Director of the Project for PREL, with Dr. Tom Craven and Dr. Donald Rubinstein as Associate Directors. During the project, Drs. Dawson and Craven were professors (in Mathematics Education and Mathematics, respectively) at the University of Hawai'i; Dr. Rubinstein was a professor (Anthropology) at the University of Guam.

The 21 graduate program participants in Project MACIMISE were from ten island groups in the United States Affiliated Pacific Islands (USAPI) in the northern Pacific from Hawai'i west to the Republic of the Marshall Islands (RMI) and across the Federated States of Micronesia (FSM)—which includes the states of Kosrae, Pohnpei, Chuuk and Yap—to the territory of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), farther west to the Republic of Palau, and south of the equator to American Samoa. The region encompasses a population of approximately 1.7 million people living on 110 islands spread across 4.9 million square miles of the Pacific Ocean yet having a total landmass of less than 1000 square miles (see

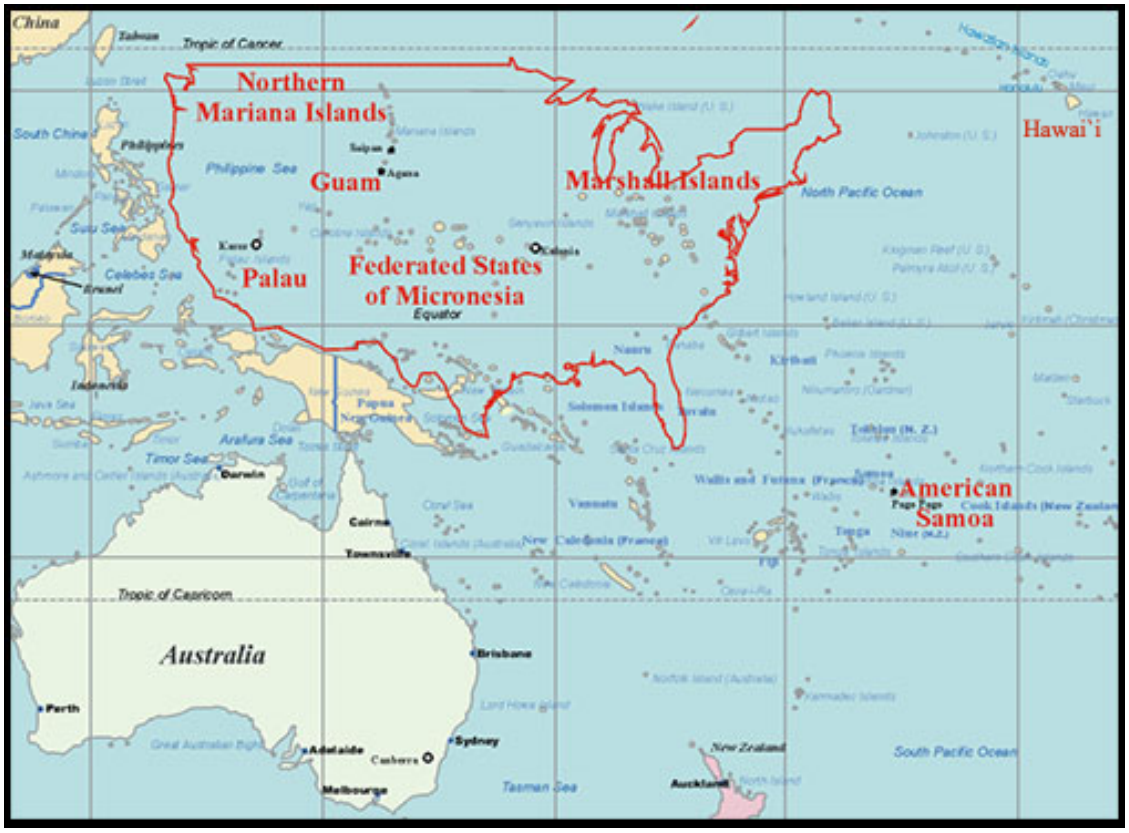


**Figure 1.** Map of the Pacific Region for the MACIMISE project.

Figure 1 for a sense of the size and distribution of islands of the area). In addition to being geographically isolated, the region is characterized by: high cultural and linguistic diversity, varying sociopolitical, class, and cultural structures, and generally limited economic resources.

Twelve of the participants worked in their local departments/ministries of education, eight worked for local colleges, one worked for the State's Justice department, and one was also a State legislator. The latter two were with the local education authority when selected for the project. All participants were enrolled in doctoral (10 participants) or masters (11 participants) programs in the Department of Curriculum Studies at UHM. They call themselves the Macimisers.

Building on the work accomplished in two previous NSF-funded projects, Project DELTA (Developing Effective Leadership Team Activities) and Project MENTOR (Mathematical Experiences for New Teachers: Opportunity for Reflection), the MACIMISE Project's primary goal was the development of elementary school mathematics curricula sensitive to and sustaining of local mathematical thought and experience. A necessary prerequisite for the achievement of this goal was to recapture and honor the mathematics developed and practiced in Pacific Island communities. 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 culturally sustaining curricula.

In particular, the goals of the project were:

- Develop and assess local mathematics curriculum units for grades 1, 4, and 7.
- Rediscover/uncover the indigenous mathematics of participants' Pacific Island language communities (Palauan, Yapese, Chamorro, Chuukese, Pohnpeian, Kosraean, Marshallese, Hawaiian, and Samoan).
- Build local capacity by offering advanced degree opportunities to local mathematics educators.

The dynamics of how these goals were to be achieved consisted of three phases:

- Educate the local mathematics educators to be trained collectors of the mathematical practices found in their language and culture.
- Support the local mathematics educators to be trained documenters of the mathematical practices found in their language and culture.
- Develop the local mathematical practices into curriculum units that were implemented and assessed in schools on the respective island communities.

## 2. Scaling Across

Scaling across means "releasing knowledge, practices, and resources, and allowing them to circulate freely so that others may adapt them to their local community" (Wheatley & Frieze, 2011, p. 32). This concept seems particularly appropriate to describe what took place in Project MACIMISE. Scaling across is distinct from the idea of "scaling up" that dominates many western educational reforms. According to Wheatley and Frieze scaling up "creates a monoculture that relies on replication, standardization, promotion, and compliance" (p. 35). Scaling up is the opposite of what the Macimisers wished to accomplish. They were interested in preserving and promoting cultural practices and knowledge that were in danger of being lost. The aim of Macimisers' work was not at all that of designing one approach, or one interpretation, or one body of knowledge to encompass the vibrant cultures found in each of their ten jurisdictions.

> But respect for the invisible forces of place—to which we could add its social and cultural heritage—is hardly conventional wisdom when it comes to taking things to scale (p. 35)

Scaling up does not fit well with the ways of working, respect for the wisdom of their elders, and the power found in their cultural practices that enabled Macimisers to thrive on their remote Pacific islands. The conventional wisdom of Micronesian cultures is not the conventional wisdom of western education systems. This is not to imply that the practices found on one island are not similar to those found on other islands. There are some at least superficial similarities in language, in methods of building canoes and houses, forms of dance, and other indigenous activities. But there is not the standardization and replication that western educational reform movements seek. Attempting to identify "best practices" is not the Holy Grail for these Pacific island nation/states that it is for many western educators. As Wheatley and Frieze note:

> Exchanging best practices often doesn't work. What does work is when teams from one organization travel to another and, through that experience, see

> themselves more clearly, strengthen their relationships, and renew their creativity. (p. 35)

In the case of Project MACIMISE, the "organizations" that traveled were the Macimisers themselves. As indicated previously, the Macimisers were from a variety of professional and home groups. During the project, Macimisers came together at least once per year, rotating the meetings among the islands (July 2010 on Saipan in the CNMI, July 2011 on Pohnpei, July 2012 on Palau, July 2013 on Saipan, May 2014 in Hawai'i, and July 2015 in the Marshall Islands). A significant aspect of each meeting was the time given over to cultural sharing. This gave participants an opportunity to experience and learn about other cultural practices, to build strong inter-personal relationships bound together by a common interest in mathematics education, and to devote their considerable expertise and creativity to the development of teaching and learning situations based on their local children's experiences and practices.

Macimisers took the ideas they encountered during regional meetings and learnt from them. They carried these learnings back to their home islands and developed them in their own unique ways. Unlike scaling up, scaling across "invites communities to learn from one another and solve their own problems in their own particular way" (Wheatly & Frieze, 2011, p. 36). Moreover, Wheatly and Frieze's term "trans-local" describes what happened when Macimisers carried an idea from one place back to let it loose in their home environment, often fostering its growth into something quite different.

## 3. Where to Begin

Working with peoples from ten different language groups, and ten unique cultural settings spread over 1.5 million square miles of the Pacific Ocean, presents many challenges. Where to begin was certainly a question that faced the project staff. Because of the Macimisers' varied backgrounds, their first university course would deal with anthropological research strategies, preferably taught by an anthropologist who knew the Pacific region, and who had experienced some of the island cultures that were part of the project. A professor at the University of Guam filled that requirement, and was recruited to offer the first course. This was the start, and the professor followed that everywhere by sharing with the Macimisers materials and experiences he had from his work on Yap and Chuuk. Based on his own experiences, he was well aware of the fact that "each place is an interdependent web of relationships, which is why you can start anywhere ... and follow it everywhere" (Wheatley & Frieze, pp. 91–93). So, he started with the weaving patterns found in materials produced by the peoples on the island of Fais in the state of Yap.

The course was taught via an internet-based, synchronous interactive digital conference environment (Blackboard Collaborate). The software included tools for breakout rooms for smaller group conversation, whiteboard, graphical annotation, application sharing, and screen sharing. The moderator could record a synchronous class session for others to watch later. The whiteboard supported the uploading of presentations for viewing during the classes and consultation meetings. During the first summer institute (July 2010) each Macimiser was given a computer. The decision to equip the computers with an open source computer operating system was with a view that the computers should not be too expensive to keep up-to-date since many of the Macimisers live in subsistence cultures. Wheatley and Frieze (2011) shared what Desmond Tutu said about *Ubuntu*:

> [It] means [peoples who are] generous, hospitable, friendly, caring, and compassionate. They share what they have. It also means my humanity is caught up, is inextricably bound up, in theirs. We belong in a bundle of life. We say, "A person is a person through other people." It is not "I think therefore I am." It says rather "I am human because I belong." I participate, I share (p. 82)

In fact, the Linux operating system on the computers provided to the Macimisers was named Ubuntu. During the first summer institute (July 2010) the Macimisers bonded together and quickly displayed that generous, hospitable, friendly, caring and compassionate spirit so characteristic of Pacific island peoples, the Ubuntu of "an invitation to each other and every one of us to recognize that we are inextricably bound up together in a bundle of life" (Wheatley & Frieze, 2011, p. 95).

Part of each day during every one of the summer institutes was given over to cultural sharing, a time when the group of Macimisers from a particular language group presented an aspect of their culture to their colleagues. This sharing sometimes took the form of a chant, a song, or a dance that was taught and usually enthusiastically engaged in by fellow Macimisers; or the sharing described certain cultural ceremonies performed at, for example, weddings, funerals, or first birthday celebrations. Often gifts were presented: lava-lavas from the American Samoans, latte stones from the Chamorro group, leis from Yap, black pepper from Pohnpei, and so on. Prior to the launch of the project, many of the Macimisers had never had the opportunity to interact or visit with other Pacific islanders. Knowledge of each other's practices and beliefs was minimal so it was with the Ubuntu spirit that the cultural sharing aspect of regional meetings was initiated.

Through ten days of intense work together in the summer of 2010, the Macimisers bonded and began to provide support for each other academically, physically, and spiritually. Macimisers were given the technology for unlimited internet access through their local telecommunications providers. Facebook became a daily venue for the sharing of successes, challenges, and frustrations experienced by group members.

During the fall and spring terms of UHM, all Macimisers were enrolled in graduate courses that met synchronously online once per week. This was a challenge logistically, since Macimisers resided in six different time zones spread across the Pacific Ocean west of Hawai'i. Moreover, four of those time zones were on the opposite side of the International Date Line. To accommodate all the time differences a timetable was developed that allowed the class sessions to be synchronous (e.g., see Table 1).

**Table 1.** Timetable for all Macimisers and instructors to be in simultaneous communication.

| *Countries:* | *Hawai'i* | *American Samoa* | *Marshall Islands* | *Kosrae, Pohnpei* | *Chuuk, Guam, CMNI, Yap* | *Palau* |
|---|---|---|---|---|---|---|
| **Day** | Wednesday | Wednesday | Thursday | Thursday | Thursday | Thursday |
| **Time** | 10:00 PM | 9:00 PM | 8:00 PM | 7:00 PM | 6:00 PM | 5:00 PM |

After the first few meetings of the very first class the schedule worked smoothly. It did mean, of course, that for Macimisers on Hawai'i, the two and half hour meeting took place from 10:00 pm Wednesday to 12:30 am Thursday! Since all the Macimisers were fully employed and could only

attend class after their working day was over, the earliest a class could begin was 5:00 PM Palau time. All the Macimisers adjusted to this in order to accommodate their MACIMISE colleagues. This too was the Ubuntu spirit expressing itself in the workings of the project. So the Project started somewhere, and in the intervening five years the Macimisers lead it everywhere.

Along with the Macimisers, the Project's Advisory Board as well as UHM course instructors and a few accompanying persons participated in each institute. The Project's Advisory Board was composed of eight members, seven of whom were present in Palau: Beatriz D'Ambrosio, Bill Barton, Betsy Brenner, Shandy Hauk, Jerry Lipka, Arthur Powell, and Katherine Ratliffe; Ubi D'Ambrosio was unable to make the long trip to Palau. The picture in Figure 2 shows the assembled MACIMISE group at the summer institute on Palau, July 2012.

**Figure 2.** Macimisers, advisory board members, instructors and friends, Palau, July 2012

## 4. From Intervention to Friendship

The history of Micronesia is replete with examples of programs and projects being introduced by outside people who claim to be able to contribute to providing a solution for whatever challenge brought them to the islands. No longer do Pacific islanders necessarily welcome such intrusions.

When visiting the islands for the first time many years ago, one educational leader said to me, "you have a new program, and three years from now you will pack up and head back to the States, and what will be left to show from your program?" He was clearly skeptical, no doubt based on previous experiences, of the long-term benefits of the program being proposed. Such interventions are short-term strategies for current challenges, but it is clear that Pacific islanders realize that any longer-term impact requires the active engagement over time of significant people. Wheatley and Frieze (2011) describe the relationship between the short-term interventionist programs, and the philosophical underpinnings of an outside educator's vision:

> This empty-vessel paradigm of learning is one of the foundations of interventionist mind-set. It posits that the trainer is full, the trainee is empty, and it is only a matter . . . of pouring knowledge from one into the other. (p. 172)

They go on to argue:

> The empty-vessel paradigm of learning is fundamentally founded on the inequality between the professional and the amateur, the expert and the ignoramus, the so-called developed and underdeveloped. (p. 177)

The genesis of the MACIMISE Project came from the Pacific islanders themselves, and arose because of the intimate connections that project staff had developed with the islanders over the previous ten years of working across the Pacific region. One of the Macimisers became part of a previous NSF-funded project, DELTA (Grant No. 9819630), almost by accident. He happened to be standing in the College of Micronesia: Yap campus offices one day when I was there seeking a college mathematics 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 (NSF Grant No. 0138916). Over a meal on Yap when I was making one final trip across the region as Project MENTOR was wrapping up, his 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 lagoons. (J. Fagolimul, personal communication).

In hindsight, it is clear that Project DELTA was interventionist. It met and fulfilled a short-term need that was to assist Pacific islanders in developing their capabilities to provide in-service education to their local teachers. Project MENTOR worked with these newly empowered in-service providers as they moved into the schools to teach colleagues who were new to the teaching of mathematics. The suggestion noted above offered by the Yapese mentor arose because of the relationship that had developed between that one mentor and me. "Perfect friendship is a relationship between equals who offer good will to one another" (Wheatley & Frieze, 2011, p. 182). Because such a relationship existed between the mentor and myself, he pointed out the weakness with Projects DELTA and MENTOR and offered an alternate goal for the fledgling project MACIMISE.

The Yapese mentor's response to my query was the conversation opener for the remainder of that 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 knew, but also such an approach would help to preserve aspects of their cultures and languages that were 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 be introduced to and educated in the ways of living on isolated Pacific islands which enable

survival, protect the land and waters surrounding their islands, and keep the people locally smart as well as world smart. MACIMISE was not an interventionist project. It was a project conceived of by Pacific islanders to serve the perceived needs of Pacific islanders. It supported Pacific islanders to engage in examination of their own practices, to recover indigenous knowledge on the verge of being lost, and to re-frame the mathematical attributes of that knowledge into locally developed classroom experiences and investigations. MACIMISE was an exemplar of "what becomes possible [when] we work together on what we care most about, freed from overbearing control, curious about one another's talents and knowledge, discovering the wisdom and wealth revealed when we turn to one another" (Wheatley & Frieze, 2011, p. 219). The Macimisers were fully engaged in bringing to life the possibility of locally developed curriculum units for mathematics that were based on local cultural practices.

During the MACIMISE summer institutes, each day concluded with circle where Macimisers would share stories about the events of the day, or respond to some questions brought forward from the participants. Circling facilitates the transference of responsibility from a leader to the participants. Leaders are supposed to have the answers. Wheatley and Frieze state, "When we believe this, we willingly give away our power. We wait for leaders to direct us, assuming they know what they are doing." But in circle, as the talking piece travels around, every voice is heard, "even those that for reasons of age or gender or politics have been silenced" (p. 103) The talking stick is a powerful tool. Initially, a sacred eagle feather (presented to the author by an indigenous band in northern Canada) was used but it deteriorated over time and was replaced by a hand-carved Haida Gwaii talking stick. The use of the stick changed the conversation, changed the participant's focus, and though resisted initially by some who were not used to its use, had a powerful impact on the group.

The project presented the Macimisers with multiple opportunities: opportunities to interact with other Pacific islanders, opportunities to interact with international experts from the field of ethno-mathematics (e.g., Ubi D'Ambrosio and other members of the Project's Advisory Board), opportunities to share with colleagues on their home islands, and opportunities to learn from a broad range of people in a variety of environments including but not limited to community elders. Furthermore, as one Macimiser said, "there is a giving of respect to those who went before—elders, researchers, and scholars—and gaining respect for and confidence in the work we are doing."

The vision of the Project to maximize the potential of Pacific islanders to become educational leaders on their home islands, and to further the growth and understanding of indigenous based mathematics curriculum as found in the cultural practices of their island nations has been realized. The papers in this volume are a sampling from the larger collection of Macimise lessons, papers, and dissertations available at `https://macimise.prel.org` (see Figure 3, next page, for a snapshot of the page as of July 2018).

As this paper is prepared, the use of the new materials across the ten island language groups is well underway, sustained by the Macimisers who continue identifying starting points and follow them everywhere. Macimisers forged friendships that grow in depth and richness with each interchange that occurs, whether face-to-face or via the internet, and when they come to sit together in a hospitable space for a circle when next they meet, they will ask each other powerful questions, allow their collective intelligence to emerge, harvest the learning that occurs, and move forward to wise action.

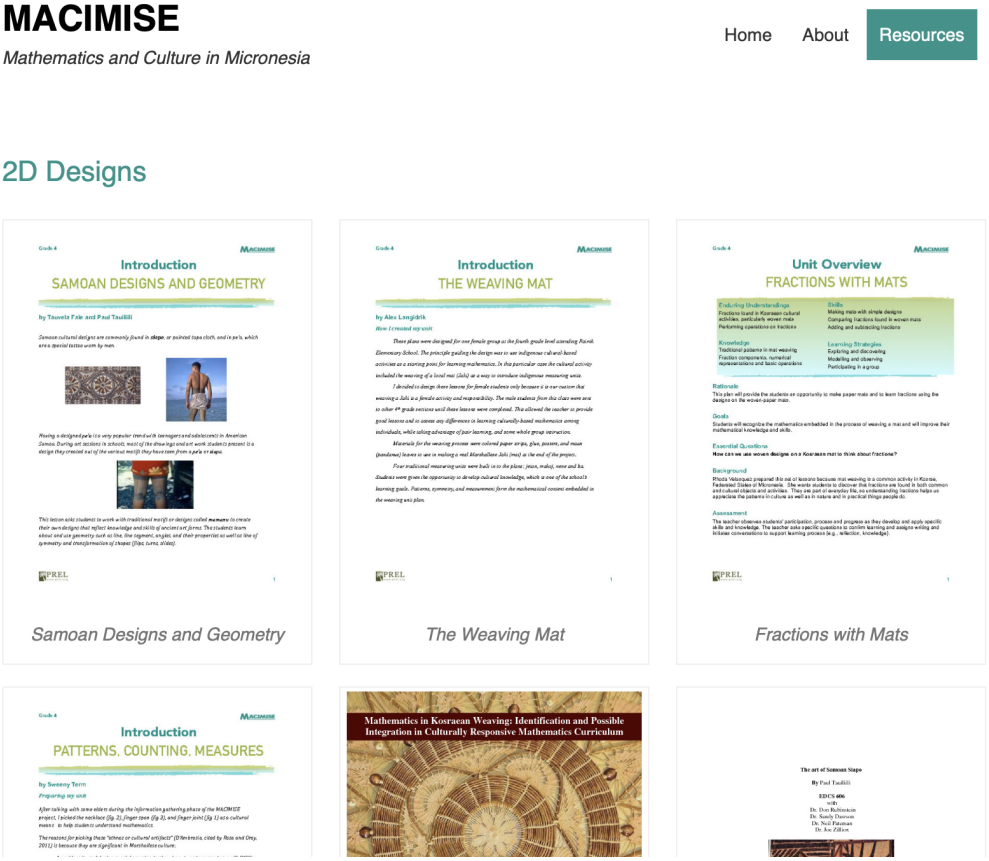


**Figure 3.** Snapshot of the MACIMISE lessons and research products website.

## 5. Coda

The author of this note, Sandy Dawson, became ill and died in 2015, in the last year of the MACIMISE project. Sandy began his career in education in 1963. He taught at elementary and secondary schools in Canada, was active in the Canadian Mathematics Education Study Group as well as both the international and North American organizations for the Psychology of Mathematics Education (PME). Over the years, he worked at the university level in Canada, Portugal, Sri Lanka, and Hawai‘i. He shared this life with his wife, Sandra, his co-traveler to mathematics education conferences world-wide and mother to their three children, and found joy with their many grandchildren.

A dedicated communicator across professional contexts, Sandy authored more than 50 papers, edited dozens more, co-wrote two books, edited a set of conference proceedings, and was the guest editor for two publications. He made over 70 presentations around the world, including conferences in Israel, South Africa, Spain, Portugal, France, the United Kingdom and North America. He produced two film series, one on mathematics education, and one on Logo. He led over $6.8 million in research and implementation grants, primarily from the U.S. National Science Foundation, for Project DELTA, Project MENTOR, and the MACIMISE project.

The PME book he co-authored with Jaworski and Wood looked at teacher education in mathematics from an international perspective (Dawson, Jaworski, & Wood, 1999). That work was informed by, and informed, the ways Sandy was instrumental in the development and delivery of post-baccalaureate diploma programs in mathematics education. Ultimately, Sandy's work in teacher education focused on "the subordination of teaching to learning" (Kieren, 2015, p. 14). Finally, in reflecting on what he had learned from Sandy, Ubi D'Ambrosio voiced many of the ideas shared by Macimisers, advisors, and project faculty during the last circle of the project:

> History tells us that the evolution of basic mathematics, which is the basis for school mathematics, reflects changes of culture, including language, and social, political, economic, ideological and religious factors. The same is true for the evolution of ethnomathematics. The complexity of situations and problems, which determine the generation of traditional ethnomathematics, changes and, as a consequence, the solutions proposed must also change. Ethnomathematics is as dynamic as much as academic math- ematics and every other system of knowledge. We have to recognize that new methods and new facts will be absorbed and incorporated by ethnomathematics. As long as an abundance of new facts, phenomena, situations and problems require ethnomathematical solutions, ethnomathematics will be alive. A lack of evolution of ethnomathematics foreshadows the extinction or the cessation of its development. The cultural dynamics of encounters show that ethnomathematics, which is holistic, transdisciplinarian and transcultural, benefits from academic mathematics. We need to modernize the rich resource and cultural heritage of both ethnomathematics and academic mathematics and to put them in their proper places in today's world. (D'Ambrosio, 2015, p 16)

## Acknowledgments

Dr. Sandy Dawson and three of the MACIMISE doctoral students (Bea Camacho, Tauvela Fale, and Dora Miura) presented an earlier version of this paper during a Round Table discussion at the 2012 Annual meeting of the American Education Research Association held in Vancouver, Canada. This material was based upon work supported by the National Science Foundation under Grant No. 0918309.

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# One Last Circle

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Abstract. This article provides insights and thoughts on next steps that arose from research on a multi-year NSF-funded project, Mathematics and Culture In Micronesia: Integrating Societal Experiences (MACIMISE). The ideas come from my dissertation study, which tracked the difficulties, challenges, struggles, and successes of Project MACIMISE participants. Students in the MACIMISE graduate program were from ten participating Pacific islands and island groups (Hawai'i, Pohnpei, the Republic of the Marshall Islands, American Samoa, Kosrae, Chuuk, Guam, Saipan, Yap, and Palau). Informed by participant reports on new understandings about how their island cultures mathematized their world, a sense of urgency about documenting what is left of their cultures' indigenous knowledge before it disappears, and the conflicts and violations they negotiated while trying to embed indigenous mathematical knowledge and practices within primarily Western-modeled educational settings, I report here on my exploration of the concept of ethnomathematics, particularly on its nature and utility.

## 1. Introduction

**1.1. Project MACIMISE.** Mathematics and Culture in Micronesia: Integrating Societal Experiences (MACIMISE) was a collaborative project by Pacific Resources for Education and Learning and the University of Hawai'i at Mānoa, funded by the National Science Foundation (NSF). One of the primary goals of MACIMISE was to equip Pacific Island teachers with the knowledge and skills to apply ethnomathematics in their classrooms, with the overall aim of improving student achievement in mathematics. The inspiration for the project occurred almost by accident. In 2000, the principal investigator for MACIMISE, Dr. A. J. "Sandy" Dawson was in Yap for the final phase of an NSF-funded education project called MENTOR. Over a meal with one of the participants, who was a Yapese native, the question arose: What future projects might be done if funding could be acquired?

> This was his thoughtful and heartfelt reply: "For eight years we've studied Western mathematics, mainland [United States] 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." (Dawson, 2013, p. 45)

Thus began the MACIMISE journey, which extended well beyond Yap to include "Macimisers" from other island groups across the Pacific. The first project of its kind ever attempted, its aims were threefold: First, to examine local cultural practices and work with elders or other experts to rediscover and/or uncover indigenous mathematics in each of ten participating Pacific islands and island groups: Hawai'i, Pohnpei, the Republic of the Marshall Islands, American Samoa, Kosrae, Chuuk, Guam, Saipan, Yap and Palau; second, to use knowledge gained from this to design, implement and assess mathematics curricular units for grades one, four and seven; and third, to build local capacity by offering advanced degree opportunities to participants. Twenty-one people, myself included, participated in Project MACIMISE, which ended a year ago. My dissertation study (Aiona, 2014) explored and documented the journeys of 18 MACIMISE participants using data collected between 2010 and 2014 in an attempt to address four questions: First, what happens when participants in Project MACIMISE study traditional and local practices to uncover indigenous mathematical ways of knowing; second, what happens when they attempt to create and implement mathematics curricula based on these practices; third, what are the similarities and differences when the participants share about their experiences; and fourth, how can we use these discoveries to inform future projects similar to MACIMISE? Here, after sharing some context about the program, I offer some of the ideas answering the fourth question.

**1.2. Doctoral Program Context.** University of Hawai'i at Mānoa (UHM) and University of Guam (UOG) faculty taught synchronized online courses in spring, summer and fall semesters using the Blackboard *Collaborate* platform to bring together people from such disparate island groups (and time zones). In addition to the online coursework, the entire group met each summer, along with UHM, UOG faculty and various consultants and advisors from universities across the U.S., in one of the participating island groups – Saipan in 2010, Pohnpei in 2011, Palau in 2012 and in Hawai'i in 2013 – to hold classes, attend and present at regional conferences, and experience the culture of the host island. As part of their program work, each MACIMISE participant created, piloted, and examined the implementation of an ethnomathematically informed mathematics lesson for grade one, four, or seven.

Most people who live in or are familiar with Pacific island cultures would likely agree that Pacific Islanders have unique ways of thinking about, perceiving and interacting with the world, and in particular with their local environments. The design and form of project MACIMISE itself evolved in response to the participants' experiences, cultures and contingencies.

## 2. Perspective

My research is ethnographic because I "seek to describe culture or parts of culture from the point of view of cultural insiders" (Hatch, 2002, p. 21). In this research, there are layers upon layers of cultural groups: parents, teachers, colonized, colonizing, children, students, indigenous, Western, ethnomathematicians, mathematicians, and so on. Wilson (2008) describes that essential to an indigenous research paradigm are relationships – with people, with the environment and land, with the cosmos. Like Wilson, my intention is that by seeing relationships "unfold in the text, you would also form a relationship with me. The relationship we form is an elemental component of an oral tradition and is generally missing from written text" (p. 126). And so here is where I must begin to allow you in. To allow you to know me a bit so that you might be able to understand, in context, what I share. It is inevitably seen through and interpreted through my many lenses. To start, "an important component of mathematics education today," wrote D'Ambrosio (2001), "should be to reaffirm, and in some instances restore, the cultural dignity of children" (p. 308). My own mathematics education was anything but culturally dignified.

**2.1. Who I Am.** I was born on Maui and raised on O‘ahu, and like many Hawai‘i children, I am hapa: my father is Hawaiian and I look like him: dark brown skin, hair and eyes and Polynesian features. My mother is a Caucasian (or “haole” as we say in Hawai‘i) and blond haired. My mother left my father when I was three years old. I grew up as the only dark-skinned person in my mother’s haole family. To my peers, I was neither haole nor Hawaiian – I didn’t feel I belonged anywhere. Wherever I went, I felt an outsider. I attended public school on the Windward side of O‘ahu (Kailua, Kāne‘ohe), where I was offered a Western-style education that seemed impervious to the place in which it existed. I didn’t learn ‘ōlelo Hawai‘i (the Hawaiian language), nor was I introduced to Hawaiian spirituality, culture or mathematical knowledge in anything other than a cursory way (for example, learning to count to ten in Hawaiian – an irony, since it’s reported that Hawaiians counted by fours and its multiples).

Neither did I learn anything of my indigenous heritage. As a K-12 student, I was taught a Westernized Hawaiian studies curriculum that both obliquely and directly denigrated Hawaiian history and culture. I was too young to understand the post-colonial dynamics underlying these attitudes toward native people. I did not understand why locals were thought of as stupid and why speaking Pidgin was discouraged. I felt inferior to my white family. I grew to be ashamed of my dark skin, wishing I were white like the rest of my family. I remember being about eight years old, seeing a gecko (local lizard) that had died in a swimming pool. He had turned from brown to white, and I asked my grandmother “If I stay in the pool long enough, do I get to turn white?”

I had recently turned 19 when my grandmother looked at me with sadness and said, “Sweetie, I’m so sorry that you’ll never go to college.” It’s understandable why she’d say that. I’d come from a family devastated by divorce, addiction and abuse, and no one had ever been to college before. We were desperately poor and college seemed an impossible, unaffordable dream. But the next day I took the bus to Windward Community College, applied for a Pell Grant and enrolled a couple of days into the spring semester. Twenty-some years later, I’m not only the first college graduate from my family, but have a PhD.

While attending college, I worked in the visitor industry, first as a sales representative for a tour company, then as a front desk clerk in a Waikiki hotel. It was part of the Western paradigm, where brown-skinned local people, or immigrants from places like the Philippines, worked low-paying jobs servicing a tourist industry catering to more wealthy foreigners. But I was always searching. I transferred from community college to UHM, where at the end of the one required Hawaiian Studies class, the instructor, a native Hawaiian, pulled me aside. He praised the quality of my writing and asked what I planned to do. I told him I was pursuing a bachelor’s in mathematics (I later switched to elementary education). He encouraged me to continue, saying that Hawaiians were underrepresented in advanced careers. I never forgot that moment; I was proud, a feeling I rarely had before.

It has been only in the last decade that I’ve reconnected with a bit with my Hawaiian side. I’ve begun studying Hawaiian language. I’ve educated myself about Hawai‘i’s troubled postcolonial history, during which Polynesian ways of thinking – which have much to offer a Western civilization in dire need of revitalization – nearly died. I owe my renewing sense of identity to those who came before me and fought to keep the culture alive. It is my wish to participate, in some small way, in returning these ancient ways of knowing to Hawai‘i’s children, to maintain the cultural dignity essential to a healthy, sustainable and peaceful future for the people of this ’aina (land) and all of the Pacific.

I believe the reason Hawai‘i’s children, particularly native Hawaiians, as well as children across the Pacific consistently underperform in mathematics is not because they are any less capable

than their Mainland counterparts; it's because the curriculum they're being offered isn't meaningful. In addition, they live lives full of stories like mine, some a little less difficult and some much, much more. All, to different degrees, with indigenous values that are often in direct conflict with the dominant consumer, capitalist, competitive, exploitive, unsustainable growth model.

The Pacific is a region where indigenous people survive. It can be a place where cultural dignity thrives and is passed on to its children. And if I do nothing else, I want to be an example for my four-year old daughter, to show her that we, Hawaiians, Polynesians, the indigenous, have something to say.

**2.2. Some Resulting Biases.** To summarize, some lenses I look through when interpreting my data are: me as a Western colonizer, me as a colonized Native Hawaiian, me as a poverty stricken child, me as a child of addicts and abusive parents, me as a survivor, me as an empathetic mother of all children, me as a seeker of knowledge, me as a worker in the hotel industry, me as a consumer, me as hating being a consumer, me as appreciating the opportunities available in my mostly Western society, me as being limited by my mostly Western society, me as a struggling mathematics student, me as a mathematics teacher, just to name a few. I acknowledge and am keenly aware of my multiple biases. This report is limited by what I am able to perceive. It is also limited by what other participants perceived and were willing and able (we have different first languages) to share with me. However, despite the biases, my dissertation research and the piece from it presented here are extremely valuable for several reasons. The dissertation attempts to tell the story of what happens when Pacific islanders explore aspects of their cultures that have often previously been unexplored by them and others. It tells what happens when indigenous people attempt to resurrect and revive their culture. And it describes challenges and triumphs when they try to position their home cultures in formal academic environments so that their local students might show improved mathematical success. In this study, I define success as something not limited to better test scores but that which includes greater motivation and self-efficacy in mathematics.

## 3. Methods

In addition to the Western research strategies of survey and focus group, participants shared ideas when we were in "circle" and when we did "talking-story," two indigenous strategies of inquiry. Though not new for Indigenous people, these are only recently being accepted as a research technique similar to focus group discussions (Wilson, 2008, p. 41). In our circles, people sat facing each other in chairs arranged in a large circle and a talking stick was passed from one participant to the next. The stick was passed around at least twice. Whoever held the stick had an uninterrupted turn to share feelings and ideas or address specific prompts or questions. A participant could choose to pass the stick if they were not ready or decided that they had nothing (more) to share. This permitted a freedom of expression that allowed speakers to discover what they meant to say through the process of listening, reflecting and speaking. "Circling facilitates the transference of responsibility from a leader to the participants. ...Working within circle engenders an environment of 'hosting' rather than one led by 'heroes' " (Dawson, 2015, p. 269). Circles were held at least twice every time we met face-to-face in the summers, sometimes daily, and most online classes began with a short circle where each person "checked in" and gave a personal update.

A more informal research strategy, called "talking-story" in Hawai'i, happens when a pair or small group of people sit for a conversation. Hanohano (2001) describes the purpose of

talking-story as "to mentally, emotionally, and spiritually reach across...to try to understand the other person's perspective...we speak to understand, not to be understood" (p. 88). There might or might not be a particular topic; topics tend to arise in an unpredictable fashion. It is difficult, even if a topic is intended, to predict whether the topic will be directly (or even indirectly) addressed. Talking-story can be circuitous, discursive, nonlinear, even full of seeming non-sequitur. This form of communication might fluster a Western researcher accustomed to linear question-and-answer dialog. Indeed, I was flustered when interviewing one Native Hawaiian elder. During the interview, I remember thinking that the conversation was going nowhere and that it had gone terribly. It wasn't until later, when I reviewed the audio recording, that I realized what I had missed. I was amazed at what I learned when I wasn't listening for what I thought I wanted to hear.

## 4. Welcome to Our Circle

Here I offer quotes illustrative of some takeaway messages from participating in MACIMISE, presenting them as they might have arisen through talking-story in circle while passing the talking stick. Though they did not arise in a single session or in the given order, my constructed talking-story brings together the many threads of participant experience. Then, in the final section I provide a brief summary of what others have written regarding ethnomathematics and synthesize their words with my experience in MACIMISE to express my own personal relationship with the term. The result is my own definition of ethnomathematics.

Each section loosely represents a theme, although I am somewhat uncomfortable presenting it in that fashion because what I am really attempting to do here is to engage you in our circle, "leading" as little as possible, in hopes that you will imagine yourself with us, adding your thoughts and reflections as you interact with what we shared. The seven themes are:

**Learning from Our Elders:** In general, we gained many new understandings, knowledge and skills and as a result formed new beliefs and values. Part of this was because of working with elders and experts in our communities.

**Learning About Our Cultures:** Many of us thought that we knew a lot about our cultures. However, through engaging in MACIMISE tasks, many of us discovered that we didn't know as much as we thought we did. Some of us realized how little we actually participated in our cultures because of outside influences and the daily duties required to participate in modern life.

**A New Sense of Urgency:** As we reflected on the loss of our culture and cultural practices, a new sense of urgency to relearn, revive and research about local and indigenous practices was discovered. We worried about the survival of our cultures, our survival on our islands as well as our participation in global society. There was a new sense of pride accompanying the belief we did have mathematics in our traditions. Mathematics was now being perceived as something other than just a foreign invention that was brought from elsewhere and packaged in textbooks. And many of us thought that through including cultural activities and practices in school settings, by working with children, cultural preservation could be accomplished.

**Learning and Culture are Intertwined:** Many of us began to see education and teaching very differently. We began to think that one problem was the belief that mathematics was something that was brought to us from others, never thinking that we had mathematics in our own culture. After learning that our cultures thought and

behaved mathematically, we started to develop new goals and aspirations for our futures and new visions of what education could look like in our classrooms and in our communities.

**We Have a New Sense of Purpose:** Many of us are more confident in our roles as teachers and teacher leaders. We thought about how we could do things differently in our classroom because we had experienced the many positive results of implementing cultural activities in classrooms.

**We Learned Together; We are More Grounded as Individuals:** The newly acquired feeling of belonging and a newfound appreciation of being a part of something important that was going to help bring about positive change was common for us. Our coming together and dialoguing allowed us to engage in new consciousnesses. In the beginning, I was struggling with what ethnomathematics was and how my island was mostly westernized. Through struggling together, we each reached understandings grounded in other appreciations.

**It's Important to Preserve Our Cultural Identities:** We appreciated the circles and of us, as Pacific Islanders coming together, alongside the instructors and consultants. We had new beliefs and concerns regarding how personal and cultural identity are important for children's self-esteem and motivation. And there was a belief that increased mathematical achievement could be achieved when cultural identities were brought to the forefront in educational settings.

**Learning from Our Elders**

Visiting with elders and experts, it forced me to reflect on how much I know about my own culture. I considered myself as well educated, but when I entered these traditional cultural activities, I had a lot of first time (aha!) experiences and encountered knowledge about the culture that I did not know before.'

I agree. By meeting and learning with elders, I learned not only about conducting research, but I also now see the beauty and complexity of my culture, which I would not see otherwise.

The stories [the elders told] were so lovely, and yet it's sad because so many of the practices no longer exist today. Some knowledge holders don't share their skills to anyone but only to close relatives or people in the family. I was fortunate to work with very thoughtful people who were happy to share their knowledge for the purpose of educating our children now and in the future.

Once, when meeting with a group of elders, just one or two elders in the group gave most of the responses as if they were speaking for all the elders in the group. One elder would never disagree or contradict another elder because of a fear of revealing their shortfalls...

I had no idea how complex the mathematical ideas could be until I met with the practitioner. The work was so detailed, so structured, so innate. I had a hard time fathoming what he was trying to share with me. How it was even possible. And yet he was so comfortable with it. It felt a bit "out of this world." I guess I can only describe the experience as spiritual.

I am most honored that I was able to conduct research about my own culture. I realized that I am one of very few people who've done work to document the Kosraean values and knowledge that we have.

**Learning About Our Cultures**

I thought I was aware of everything in my culture... but it is only in my mind. I'm so busy with my everyday life. I don't practice what I was raised with... I don't participate in customs because of my work.

I've realized that in my island, everybody always talks about cultural preservation, but it's just lip service. Nobody is doing anything about it. Everybody says over and over, preserve and conserve [the local culture], but we're losing a lot and I don't think we'll ever be able to catch up or make up those losses.

Being involved in the MACMISE program has opened my eyes to many things. First, it has allowed me to see the genius in not only the Chuukese culture, but also Micronesian cultures.

I've realized how much we are missing in our culture, how much we have lost and how much there is to preserve and maintain while those who are knowledgeable can still provide their knowledge and skills.

**A New Sense of Urgency**

I experienced something a little different. I have learned that our cultural traditions are still very much intact compared to others in the Pacific region. With the passing of our master ocean navigator Mau, Nainoa [the Hawaiian navigator who learned from that master] has gotten the knowledge and skill... It's an inspiration to us in our islands. The knowledge is still there, but not to the extent that Nainoa has learned and experienced.

Our ancestors survived living on these islands for so many years. They were adaptive and resilient to changes. Some people might think they were primitive but I think they were very highly intelligent; they were able to survive by making use of what few resources they had in their surroundings. They consistently showed their intelligence through all the complicated activities in our past up to the present moment.

I believe that my findings will be useful resources to preserve and promote the valued cultural practices in Kosrae for today's learners as well as in the future.

To continue our survival, we need to expose our own children to our own cultural practices and skills and at the same time utilize the mathematics embedded in them to teach our children the needed mathematical concepts in the global arena.

There is a sense of urgency that we have to do it now. It's a sad case, but you can't be sad all the time and do nothing. The urgency is there.

Many indigenous cultures of the world have lost a majority if not all of the bodies of knowledge due to colonization and the pressures of western influence. I believe that our island cultures integrated with our curriculum is one way to help preserve our cultures.

**Learning and Culture are Intertwined**

I was part of the generation of assimilation. They pushed hard for us to learn English. [Others in this program] are really rooted . . . [it] has been humbling. When studying in Hawai‘i and the mainland United States, I thought it was important to learn from outsiders. As a result in being a part of MACIMISE I realized that early education is where we need to focus our efforts and

resources . . . at an early age, in the classroom, you hardly find culturally empowering and validating materials. [Teachers] don't understand the relationship between self-esteem, culture and learning. Through this experience and journey, I've discovered and reflected on it.

I now see education and teaching of mathematics as inseparable from life and culture. Evaluation and analysis of traditional activities such as fishing techniques, making of fishing tools, constructions of houses, food preparations, navigations, etc., presented me with a greater realization of how the traditional people interact within their culture mathematically. Most, if not all the traditional activities contain elements of mathematics. Although we are not symbolically mathematicians, we are linguistically mathematicians.

I have discovered through MACIMISE that math can be Chuukese. I discovered that math curriculum could be experienced, meaningful, practical, and fun.

[Being in MACIMISE] leads to my belief now that our culture has mathematics. Some of our cultural practices are so rich in mathematical ideas and concepts. To insert the mathematics reached in our activities and practices into our curriculum, I am sure will help our students learn better because they can relate the mathematics to their prior knowledge.

Before, I thought there was something wrong with the students. Now I believe that many students perform poorly in mathematics because they cannot relate what they are learning in the classroom to daily activities in their social environment or vice versa. Some have even developed a misconception that the academic content knowledge that they learn in school has no relation to their cultural activities.

My perceptions have changed tremendously. I now believe that teaching means having the ability and willingness to accept the differences that exist among people in this world due to different worldviews that are influenced by different cultures and lifestyles. In addition, I have also learned to believe that teaching is a shared and mutual communication process that empowers both the teacher and the student. It empowers teachers by providing them the opportunity to acquire personal and professional competence in dealing with human diversity issues brought forth by students, and students by allowing them to explore their own self-efficacies and their social environments to identify factors that contribute to success in learning mathematics. Hence, the courses that I have completed in the MACIMISE project have enhanced my knowledge base on what teaching is all about. They have given me the opportunity to explore many things that I was either ignorant of or did not know existed . . . I can say with confidence that I am much more aware of the factors in my students' social environments that impact their learning.

I now have a desire to bring cultural practices into the classrooms for children's awareness as well as raising their interest and bring[ing] attention to these endangered practices that I believe are very important to the long-term survival of people living on these small islands.

There needs to be better understandings in education, to create meaningful ways that teachers can teach mathematics that both develop students' math understanding as well as instill pride and knowledge in their culture . . . having students exposed to the facts that world recognized bodies of knowledge like mathematics exist in their indigenous cultures and practices make the experience of learning more meaningful.

Prior to being a part of MACIMISE, I did not see any connections between culture and mathematics. I thought everything I was trying to get was knowledge that was not dealing with our culture because that's what we use in the classroom.

Even as college instructor, my belief of what mathematics was changed. I have a new focus to change what I've been doing . . . not just knowing the formulas and procedures, but to learn the real mathematics.

**We Have a New Sense of Purpose**

I now have the confidence to help guide my teachers toward looking at the curriculum and get the best out of it and to improve their teaching techniques and methods. The curriculum courses helped me see differentiated teaching and learning styles and methodologies. I learned more approaches that I already pass on to my teachers I am sure are already helping some of them improve their teaching which eventually will help improve students' learning outcomes.

I hope to increase my chances of influencing the way teachers on these small islands approach teaching [and to use the newly developed] insights into differentiated teaching styles and methodologies in their own educational careers.

I have a new sense of empowerment and purpose. We can inspire others to do something before it is too late.

At first when in the program, my goal was to get a degree . . . we don't have many chances to get higher degrees. However, after engaging in all of the experiences, I discovered that MACIMISE helped to teach the cultural stuff, but [also helped] develop my ideas about how I teach in the classroom. I could feel and see that I want changes in my students. I want my students to learn. Comparing to the ways I taught before, I think that's a very good development for me.

With the revelations we have, we will go and try to make the people realize that there is also math in the culture . . . make them aware that we can do the cultural math like we can do the modern math. It's an obligation we are having to change our personal teaching strategies.

I've come to realize that maybe I should not depend so much on the textbooks . . . There are many things all around us all the time that we can use as a way of teaching math [and] I can see differences between then and now. Then the students were kind of bored, and every time I gave them a test, they always forgot. . . . Now, it is working. I can see improvement in the things I am looking for.

Before, I was thinking that culture is important, but I wasn't thinking about it in a classroom situation. As a result of this program . . . we can teach math through cultural practices. The teacher I was working with, she is just like me, doesn't realize that using the cultural practices [could be used] as a basis of teaching the math concepts. When she tried the lessons . . . she realized that it's gong to work and it's more interesting to the students.

I worked with teachers and had the teachers write about their experience while using cultural activities in the mathematics class. One hundred percent of them would like to do it in their classrooms . . . This program made it happen . . . We always thought about math as something we get in school and in textbooks, never anywhere else.

When we piloted our lessons, students and teachers showed more interest, motivation and higher participation when the cultural-based lessons were being conducted. Students really liked the activities. [The teacher's] strategy had been doing [the same] routine [instruction]. So when this new thing goes into the classroom, they [the kids] were really excited. I videotaped the lessons and in the videos, the kids were really engaged. And it was exciting for me too.

I work with both college students and children. After I explained what we were doing, some [college students] were interested and some were just looking at me [seeming like they were thinking] can we move on to the next learning outcome please? . . . But elementary students got really excited."

I teach mathematics for teachers. Before, the students would drop or not come to class. However, because the activities were culturally based and they were doing hands-on activities, there is perfect attendance. At the end of the semester, they are still there.

I think the best approach is to go into the schools. There's a lot to improve in our curriculum . . . It's important to start out with what we have, especially in our culture, to bring in the cultural practice and start there when teaching. That's what I think changed. [My] doubts have been resolved. I'm really eager . . . I want to get into the classroom and try things out like this, and find out if it will work . . . I really believe it can.

**We Learned Together; We are More Grounded as Individuals**

Having a circle . . . ties us together professionally and spiritually . . . this program makes me realize that we are doing math without realizing that we are doing math.

Circle time with others gives time to think and reflect, to step back and look at it, [the significance and impact] from afar.

The most memorable and meaningful [part of MACIMISE was] the privilege and opportunity to participate . . . We come together. We sit in a circle and we share. We empty what we brought from our different islands. We go back and reveal and empty and we share [when we] go back [home]. Then we come back together. We come to know each other and really become a family.

I think what stands out most in this program is the instructors and the students, participants, are connected together. It makes me feel like I belong somewhere. I share something that I feel is missing from my culture, knowing that the other islanders have the same issues. It does not make me feel so alone and that I am different from everybody else.

As an individual I am more grounded in my own culture, and more appreciative of everyone's culture . . . We have a shared vision. [We] are part of the group and stronger as an individual. So there is a comfort level. I have a greater appreciation for what I'm learning, my growth, because of their knowledge.

The most meaningful part of the program has been the cultural sharing [because] I've learned so much from everybody . . . I'm already thinking of other things I can do that involve weaving, that involve fishing, navigating and it doesn't seem that I can't do it . . . It's tangible now. I can really touch it. I can see it . . . That process is there. Whereever it takes us. But, I know where I'm heading because of this.

**It's Important to Preserve Our Cultural Identities**

The cultural awareness and importance of including it in the curriculum for the school children is really, really important.

One needs to know ones' own culture . . . to have identity . . . before they can go out and learn about other things. [They] need that foundation.

Once you lose [your foundation], it's gone and you're no longer what you were. You can look around for want you want to be and never find it. You can never be somebody else. You can always be yourself.

I never knew who I was. I never felt a real identity. And as a result, I have always struggled with self-confidence and the ability to truly relate to and trust others.

Being in this project taught me that I need to understand my own culture to be able to reach out to other cultures.

At home, they [the children] already learn many things. What they learn in the classroom is totally different than what they learn at home.

Part of it is breaking down those barriers that have been set up. They're artificial and they don't need to be there.

This project has elevated my knowledge and concerns for our islands. My goal is for children to be educated. I wasn't sure. Are we going to educate them to be American and make a lot of money and all that? You can make all the money you want and never be satisfied. We need to teach them so that they will be somebody. And that somebody is within the culture and tradition of who you are.

## 5. What is Ethnomathematics? To Me?

Gerdes wrote that ethnomathematics was "a relatively new field of interest, that lies at the confluence of mathematics and cultural anthropology" (1997, p. 332). Gerdes (2001) went on to say, "It may be described as the study of mathematical ideas and activities as embedded in their cultural context" (p. 2). These are just two of many descriptions of ethnomathematics from various sources. Like many, they are—often by their authors' own admission—insufficient: vague or subjective, too general or too narrow, with too many undefined terms.

This is because, in part, the field of ethnomathematics is still in the process of discovering itself. Questions remain about its usefulness. Arguments endure about whether there even is such a thing as ethnomathematics. Mathematics, so the thinking goes, is absolute, universal, pure and therefore acultural. This view does not, however, obviate the possibility that different cultures have different ways of thinking mathematically, and the field of ethnomathematics may usefully consider what those differences are and how they might be understood and used.

According to do Carmo Domite and Pais (2009):

> Ethnomathematics does not restrict its research to the mathematical knowledge of culturally distinct people, or people or their daily activities. The focus could be academic mathematics, though a social, historical, political and economical analysis of how mathematics has become what it is today. As mentioned by Greer (2006), it is part of ethnomathematical research to understand the historical development of mathematics as a scientific discipline, the understanding of that development as the intersection between knowledge from different cultures, and the way the validation of what is considered to be true mathematical knowledge is less related to issues of rationality, than with the social and political contexts. (p. 1473-1474)

For me, a simple, functional definition is the most helpful: Ethnomathematics is the effort to reconnect mathematics to what matters. "What matters?" is the essential question, and its answer is culturally specific. What matters to a fisherman in Palau is likely to be different than what matters to a day trader in Manhattan. What matters to a teacher in a Hawaiian-language immersion school is likely to be different than what matters to a teacher in an English-language school. What matters to a teacher is likely different than what matters to a student, and so on. Ethnomathematics is the mathematical thought and practice of a culture; it is the mathematics underlying the daily activities that define a culture. As such, the mathematics found in a culture reflects that culture's heritage and worldview – the mathematics that matter to that culture, their Ethnomathematics.

Implicit in my definition is the converse: That there could be a mathematics that does not matter to a culture, or to individuals within that culture. This idea might be anathema to a proponent of pure mathematics, but it's part of the daily experience of almost every student for whom formal academic mathematics is a requirement. A mathematics teacher commonly hears, "Why should I learn this? When am I ever going to use it?" Each is a difficult question to answer honestly. Perhaps in a culture where any cheap cell phone can be a calculator, there is no good practical reason for someone to be able to perform the standard algorithm for long division. Ethnomathematically speaking, we could say that learning the standard algorithm for long division is not culturally relevant. This makes learning the operation, in the eyes of the learner, pointless. Similarly, the kind of mathematics taught to indigenous people living on remote Pacific islands might not be particularly useful, or in the worst-case scenario might directly conflict with a given culture's way of thinking about the world. By the same token, for a culture where cheap cell phones are not readily and widely available, a different sort of mathematics might matter. The ethnomathematician is uniquely equipped to recognize these points of disjunction and possibly also to remedy them by developing culturally relevant mathematics education tools; that is, to reconnect mathematics to what matters.

D'Ambrosio (2001) distinguished ethnomathematics – the mathematics which is practiced among identifiable cultural groups – in contrast to the academic mathematics commonly taught in schools. The International Study Group of Ethnomathematics defines ethnomathematics "as a research field, that reflects the consciousness of the existence of many mathematics, particular in a way to certain (sub)cultures" (Gerdes, 2001, p. 4). To help provide some clarity regarding the many mathematics that exist, I will use the term Mathematics (with a capital M) when discussing formal academic mathematics. Ethnomathematics (with a capital E) indicates the mathematics that matters to a particular culture and ethnomathematics (lower case e) refers to the field of ethnomathematics in general. Therefore, Mathematics is part of Ethnomathematics because it is the mathematics practiced by a given culture within an academic mathematics environment. These distinctions, although sometimes blurry, are important when considering mathematics that matters. A person interested in Mathematics might have different concerns from a person who's turning a bowl – for that person, Ethnomathematics might be more useful.

How might we reconnect mathematics to what matters? Could we define the particular culture or community to be considered? Then could we could observe them, and most beneficially, participate in their lives? By learning about what is important to them and what they think will be important in their past, present and future, could we then try to determine the Ethnomathematics they have and the Mathematics they might need to achieve their goals? These are important questions to ask when considering what mathematics and ethnomathematics should be taught in schools with indigenous populations in the Pacific. Should it be Mathematics or Ethnomathematics? Or a combination thereof?

One important goal that falls within the scope of ethnomathematics that is almost never a consideration in Mathematics is not mathematical at all: the restoration of cultural pride and an appreciation of a culture's mathematical intelligence. This goal is certainly true for the indigenous peoples of the Pacific, who have for more than two hundred years suffered the effects of colonization by larger powers and whose cultures have been suppressed, absorbed, and/or replaced.

When Mathematics is applied within a relevant cultural framework, it can ignite passion in its practitioners, even help to revive a culture. In the 1970s, after two centuries of suppression, Hawaiian culture experienced a resurgence. Renewed interest in native language, art, hula, medicine and spirituality flourished. One spark for this Hawaiian Renaissance came in 1976, when a replica of an ancient Hawaiian voyaging canoe, Hōkūleʻa, sailed from Maui to Tahiti using only natural elements – the stars, winds and currents, birds – proving that the early Polynesians were not just aimless castaways who got lucky in discovering the Hawaiian Islands but rather a culture with unparalleled voyaging and wayfinding knowledge. In 2007 Hōkūleʻa sailed to Japan. Plans to circumnavigate the globe are being made. Stellar navigation, which requires sophisticated mathematical understanding is not just a useful example of applied mathematics. Pacific voyaging is an example of how science, mathematics and community are integrated in a meaningful way to accomplish incredible feats of imagination and engineering; such mathematical knowledge makes the difference, literally, between life and death. Correct calculation leads to a pristine paradise; miscalculation leads to being lost at sea.

The Hawaiian people, arguably among the most accomplished voyagers in the Pacific, had lost the art of stellar navigation. Only a few people in the Pacific still held this knowledge, one of them being a Micronesian named Mau Piailug. Mau agreed to come to Hawaiʻi to teach the lost art to a new generation of voyagers, including Nainoa Thompson, the navigator who piloted Hōkūleʻa to Tahiti, where the canoe was received with joy and tears from the Hawaiians' distant Polynesian cousins. Probably at no other time in modern history has the sharing of Ethnomathematical knowledge meant so much to so many. Mau shared not just the indigenous methods of measuring azimuth and declination; he shared generations of stored cultural knowledge, knowledge that was integral to the ancestral story of the Polynesians. Mathematics that mattered.

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# Ms. R. and Ms B. and the Coconut Unit Lesson

Dora Miura

Abstract. This short research-to-practice paper gives details about two first-grade teachers and their students using a locally-written and locally-set story about measurement as the center of a lesson. The report chronicles the journeys of the teachers in one elementary school in the Commonwealth of the Northern Mariana Islands (CNMI). Both teachers participated in a series of collaboration sessions led by the author. These sessions first introduced the teachers to the idea of ethnomathematics and the potential of adopting culturally-relevant approaches, and later provided support during implementation. The two teachers reported that the focused collaboration sessions and the implementation process effectively changed their teaching, their attitudes and knowledge of mathematics, and their understanding of curriculum. The paper recommends that others adopt a similar focused collaboration approach as a form of professional development for those who are interested in different approaches to teaching mathematics and developing curriculum.

## 1. Background

The Commonwealth of the Northern Mariana Islands, (CNMI) is comprised of 16 islands in the middle of the Pacific Ocean located east of Japan. The official languages of these islands are Chamorro and Carolinian with English as the official business language. Schools are taught in English. The islands are politically connected with the United States of America. In fact, the CNMI Public School System (PSS) follows the same federal mandates as schools in the U.S.

Many of the locals still speak the language and practice the culture of their great-grandparents. However, it is important to note that many aspects of island life have changed as a result of westernization and technology.

Research in ethnomathematics over the past several decades has been generated in many parts of the world. Such work emphasizes the use of culturally relevant and problem-solving rich mathematics. Until my dissertation work, there was no systematic research in the Commonwealth of the Northern Mariana Islands linking local Chamorro culture and mathematics teaching and learning. This paper presents some of that work. It is focused on two first grade teachers in the CNMI and their journey, as they collaborated to implement a problem-solving rich, ethnomathematics lesson using western and local units of measurement (e.g., diameter of a coconut).

**1.1. Problem-Solving Rich Mathematics Curriculum.** Problem-solving rich mathematical experiences exist in classrooms filled with students discussing their mathematical ideas, justifying their thoughts, and using a variety of manipulatives to illustrate ideas (Buschman, 2003; Hiebert, 1999). These classrooms rely on teachers noticing and supporting student discourse to gauge the progress of the learning and to decide on future lessons (Bray, Dixon, & Martinez, 2006). Lesson plans in such classrooms not only delineate the daily activities of the students but also include the questions that must be asked and anticipated in order to understand and push student thinking (Heng & Sudarshan, 2013; Nebesniak, 2013; Wallace, 2007).

Teachers in a problem-solving rich mathematics classroom observe the dynamics of the classroom and converse with the students. Often, as students become better problem-solvers, teachers step back and allow students to explore without interference, unless absolutely necessary (O'Donnell, 2006). After a period of exploration and student discourse, the teacher may call the class back together for group discussion. This is after teachers identify different types of thinking that were observed and ask those students or pairs to present their findings to the class for whole class discussion (Bray et al., 2006). Through these discussions, teachers can gain further insight into their students' thinking, which can assist them in decisions on how to segue into the next lesson. These discussions usually call attention to any difficulties students encounter (Sanders, 2009).

Rich discussions also provide opportunities to engage in the Common Core's eight mathematical practices (Council of Chief State School Officers [CCSSO], 2010, pp. 6-8). The Common Core standards are practiced in the CNMI.

**1.2. Culturally-Relevant Mathematics.** Ethnomathematics refers to the relationship between culture and mathematics (Barton, 1996; D'Ambrosio, 2001). Dr. Julie Kaomea frames ethnomathematics within the past, present, and future of the Hawaiian people (Kaomea, 2011). For this paper, it can include any aspect of the past, present, future, or a combination of any of those elements. An ethnomathematics curriculum cannot be limited to the past because some of the children, especially the children not native to the islands of the CNMI, may feel alienated and disjointed from the lessons. By connecting the past to the present and possibly to the future, all students can benefit from an ethnomathematics curriculum. Whenever a heterogeneous society exists, care must be taken to allow for entry points for every student. By linking the past to the present, all students can understand the context of the lesson and gain an appreciation for an indigenous culture.

Culture incorporates a people's beliefs, traditions, values, customs, and ways of life. This must be taught, it is not something one is born with (Wolcott, 1982). Dr. Katherine Aguon, a scholar from the island of Guam, notes that the purpose of education is to perpetuate the culture of the people and the place. She argues that in any society, the culture of the indigenous people must be perpetuated in schools. On the CNMI island of Saipan, that would be the Chamorro and Carolinian cultures (KUAM News Extra, 2011). The CNMI also is home to a large number of foreign contract laborers who are Filipino, Korean, and Japanese, and their children. The influx of these foreign contract laborers resulted from huge labor demands in the 1980s. In addition to the indigenous population and the contract labor population, some Americans from the United States call the CNMI home. Consequently, the culture in the CNMI is a mix of these various cultures. Those in the present and the cultures of the past have influenced the Chamorro and

Carolinian people as a result of the different occupying countries during the course of the history of the Marianas.

I am of Chamorro descent. My family is Ada, Atalig, Sablan, Taimanao, Diaz, Cabrera, Manglona, Camacho, San Nicolas, Tudela, Pangelinan, Reyes, and Borja. I understand that although I am considered indigenous on the islands, my blood that flows within my veins is a mixture of various genetic influences starting with my Chamorro ancestors, then during the Spanish occupation, my great- (maybe 3 or 4 "greats" ago) grandfather was a Spanish priest who, along with my great- ($\times 3$ or $\times 4$) grandmother, the maid of the chancery, gave life to the next person in my lineage who was no longer a pure Chamorro (Ancestry.com, 2012; Borja, 2012). This is the history of many people on our islands. However, we consider ourselves Chamorro.

Dr. Katherine Aguon (2011) explains that the concept of Chamorro culture is rooted in *inafa'maolek* or making good. She identifies six concepts in the language that embody the culture:

(1) *respetu* (respect),
(2) *manginge* (paying respect to elders),
(3) *mamahlao* (having shame),
(4) *chenchule* (social debt),
(5) *che'lu* (siblings), and
(6) *ptgon* (children).

These concepts in the Chamorro culture revolve around a community that is not limited to the nuclear family but extends to aunts, uncles, cousins, godparents, and grandparents. Mathematics that focuses on the individual and individual efforts may be an impediment to meaningful learning in the classroom. A culturally-relevant, problem-solving rich mathematics curriculum infuses the culture of the place with problem-solving rich mathematics (Bucknall, 1995). Its intent is to make education more meaningful for students (Agbo, 2001). Through a culturally-relevant curriculum, students can more easily create mathematical meaning via experiences that are real to them (Lipka et al., 2005).

Culturally-relevant curricula, in the context of the Chamorro culture, incorporates the six concepts delineated by Dr. Aguon through either a common, regularly practiced Chamorro cultural activity or a historical Chamorro activity. For example, a regularly practiced Chamorro cultural activity centers on the preparation of food for a fiesta. Chamorros and non-Chamorros of the islands can associate with the different foods and the efforts necessary for the preparation for the fiesta. An example of a historical activity includes the building of a latte-stone. These activities are examples from which the context of a problem-solving rich mathematical lesson can be derived.

Bucknall (1995) defined a successful indigenous class to include components of culturally-relevant mathematics and a challenging mathematical problem. As did researchers after her, such as Hiebert (1999), Buschman (2003), and Wallace (2007), she defined a problem-solving rich mathematical curriculum to include lessons that challenge the students to communicate, problem solve, reason and make sense of the problem, make connections, and use representations to engage in the mathematics. It was my intention to frame the thought-provoking aspect of mathematics within the context of the Chamorro culture.

In order for a curriculum to be successfully implemented, teachers must be fully vested in it. One valuable way this vesting can happen is when teachers are involved in the planning, implementing, and revising of the curriculum unit (Lipka et al., 2005; Willoughby, 2010).

## 2. Procedures and Data Gathering

Participation in the research began in May and continued through the following February. Teacher participation included monthly meetings of about an hour and their in-class implementations. The whole group of teachers consisted of four people: two who taught grade 1 at the same school and two who taught grade 4 at different schools. For this article, the focus is on the two first grade teachers. The activities in the lessons they implemented came from a series of collaboration sessions between the researcher (me) and the teachers. I initially created the unit through project MACIMISE (Mathematics and Culture in Micronesia: Integrating Societal Experiences) where it underwent a multitude of revisions by peers and professionals in the field of education. The final product from MACIMISE was used as the starting point for my work with the teachers in this project.

The results reported here emerged from study of video and/or audio recordings of pre-implementation, implementation, and collaboration sessions, field notes of direct observations of implementation of lessons, written self-reflections by the teacher participants in the study, background information provided by the teachers, and an interview after the final collaboration session using two sets of questions from a second, related, study that tracked the progress of teachers across many different islands and cultures as they implemented culturally relevant lessons.

## 3. Case Studies

**3.1. Teachers.** Heidi and Tara, pseudonyms of the first grade teachers, implemented their lessons concurrently (same days and same time period). Consequently, I only observed Heidi on a daily basis. My telling of Tara's story is a result of watching video recordings of her class, talking with her about her reflections during our collaboration sessions, and reading her written reflections. Heidi and Tara work at the same school so I observed both classes when both Tara and Heidi brought their students outdoors for day 2 of the lesson. Prior to the implementation of the first grade lessons, we met twice to confirm their plans for using the lessons for the unit and two more times with the entire group (not including the initial informational meeting).

3.1.1. *Heidi.* Heidi is a Chamorro who was born and raised on the island of Saipan. She highly values her culture and believes that in a lot of ways, it defines who she is. She wears jewelry that symbolizes our culture and teaches her children to speak the Chamorro language. In her home and in her presence (even outside of her home), she requires her children speak to her in Chamorro. Her husband is a local jewelry maker known for beautiful pieces of Chamorro jewelry. Whenever I have seen Heidi in the context of the research or before and after, outside of the research, we have spoken to each other in our native tongue and continue to do so unless we cannot find the words to express ourselves or are in the presence of individuals who don't speak the language. Heidi has been teaching for 13 years at the same school. She knew she wanted to become a teacher since the age of 8. She loves teaching. She believes that every child can learn

and each has their special way of learning. Heidi also believes that the onus is on the teacher to unlock the child's best way of learning so that they can be successful. She values patience, consistency, and persistence in herself as a teacher. She realizes that teaching and learning are processes and that perfection can never be achieved. She values mistakes as learning tools.

3.1.2. *Tara.* Tara has lived and taught in the CNMI for 23 years. She is a Caucasian from the state of Washington. She considers the CNMI her home because this is where she has made a home with her husband and her two boys. When she was a senior in high school, Tara decided that she wanted to become a teacher. She enjoys teaching. Like Heidi, she believes that every child can learn. She believes that it is her responsibility to think of different strategies of teaching to enhance learning. For Tara, learning never stops and people are always learning new things. She values professional development that can help her become a better teacher, which would in turn impact her students' learning. She has noted that she is a "drill and kill worksheet type of person in terms of math: I teach, then allow them to practice" (Interview notes).

**3.2. Teaching Approaches.** During the October session with the entire group, the teachers were given an opportunity to reflect on their mathematics teaching and share what they were doing in their classes at the moment to help their kids make sense of problems and persevere in solving math problems. Heidi responded with, "I did something different this year with the way I taught place-value. I went with the way Common Core explained it." She "flipped" the way she normally taught place value with her first graders: instead of telling kids where the places were they did an activity, "Bundles of 10." She instructed her students to count sticks and bundle them with 10 sticks per bundle. She reflected that some of her students had a difficult time counting despite the fact that they counted every day. During the Bundles of 10 activity, Heidi noticed her students "arguing." They were justifying to each other their ideas about what to do with extra sticks outside of their bundles of 10.

Through my interactions with Tara and through our discussions, it emerged that Tara's disposition towards mathematics and mathematics curriculum was different from Heidi's. Tara did not exude the mathematics confidence of Heidi. However, she shared Heidi's desire for self-improvement. At each session, Heidi usually asked the questions that others were hesitant to ask. Her questions were always welcomed by others and sparked further discussion. She offered constructive criticism whenever necessary, which caused me to further analyze the lessons and their intent. Tara was not as eager to try new approaches to mathematics. As a member of the study and as a teacher with a desire to improve, Tara was willing to try the mathematics strategies and approaches new to her but gave up when the content became difficult for her. She wanted and felt she needed much guidance. If the guidance was not offered to her, she typically sat back and waited for someone in the team to offer her assistance. With the assistance, she once again attempted to do the mathematics. During these times, she would remind the group that mathematics was not her thing but she was willing to try.

After our initial meetings of planning and doing some mathematics, we met again in October to reflect on mathematics in the classroom. Tara reflected on how, for the sake of time, she seldom used discovery learning. She typically tells and shows her students how to do things. Tara said the mathematical practice of letting the kids discover (versus telling them the answer) was a struggle for her. From as early as August, she was cognizant of this issue. She mentioned having to constantly remind herself to ask the students questions to help their thinking along versus jumping in and correcting them. She talked about time constraints. She wasn't comfortable

giving students the whole afternoon to experience tasks aimed at improving conceptual understanding. She was making an effort to improve at this. Tara said that her students don't have the language necessary to explain their thinking. As a result, she said, she listens to them and helps them with constructing their thoughts using academic language and has them repeat it.

The team of Heidi and Tara openly communicated with one another, freely asking questions, and not hesitating to ask for assistance from the others. Since they teach all subjects in 1st grade (with the exception of the Chamorro and Carolinian Language and Heritage Studies – CCLHS – class), they have come up with a system to help them plan their lessons to satisfy the requirements of their administration. In this system, Heidi is responsible for the plans for the mathematics lessons. As a result, Tara typically asks Heidi what they are doing the next week and they discuss the lesson before it is implemented. In this study, the planning was initially done by me.

**3.3. The Focal Lesson.** I had envisioned a curriculum unit that would fuse the western thoughts of mathematics with the ideas of our culture, the Chamorro culture. The story is about a boy, Jose, who needs to find his height because he needs to get a suit sewn for a school dance. It is set in the Marianas post World War II. The story incorporates the Chamorro culture and language as Jose ventures out into the village to find his height. Throughout the story, it is evident that the narrator is on an island where the culture and the language are not primarily western or English.

This lesson was brought to Heidi and Tara for their review and input. In June, the first month of collaboration, Heidi and Tara sat down and began talking about their upcoming school year and the new Common Core mandates thrust upon them by Central Office. Although I told them I would not be observing them until the following school year, Heidi decided to try out the lesson ideas with what she remembered from our meetings. I do not have data on these lessons except for whatever she revealed during our planning sessions. Because Heidi created her own version of this lesson, one that mimicked the part of a lesson when the students go out and measure their teammates, it gave Heidi a sense of confidence with the lesson. When asked, Tara indicated that she may have done a portion of the lesson, too, in the previous school year, but she couldn't recall.

The lesson was planned to be 5 days in length. The first day began with a story. The remaining 4 days focused on getting students to understand how to measure using non-standard units and then finally understand that measurement is a function of the unit used. After executing the lesson, we learned that the story was too long for first grade students to listen to in one sitting and recommended to break the story into a 2-day telling emerged. The length of each activity took longer than expected and teachers felt compelled to use other times in the day, throughout the day to implement the lessons. In the end, the teachers found value in creating an intense introduction to measurement because the students understood the targeted concept. Discussion on how and when to incorporate future measurement activities ensued at the conclusion of the project. The full lesson is available on the MACIMISE website: `http://macimise.prel.org`.

**3.4. First Grade Implementation of Unit.** Prior to reading the story, the teachers asked students, "How tall are you?" The responses the students provided revealed that students had a poor understanding of measurement units. Some students believed they were 8 feet tall. Heidi was surprised with the student understanding of measurement because she had shared a story of

a giant squid earlier in the year and the students had discussed and measured what 9 feet looked like. After checking her students' prior knowledge, Heidi previewed the story, "Jose's Many Heights" written by me, and read the story with many cultural pit-stops (points in the story where she stopped to talk about the Chamorro culture). Tara read the story without making any cultural pit-stops like Heidi. She felt that there was no need to elaborate during the cultural instances in the story because the students should already be aware of the culture since they lived in Saipan.

After school, for the five days of lesson use we met to reflect on the implementation of the lesson, discuss suggestions for future lessons, and to plan for the next day. The unit began with the story and segued into student experiences in measuring. Students began with measuring their heights, like the boy in the story, using one of the units in the story, coconuts. The subsequent days included students measuring their hands or feet or other objects in the class with different units of measurement. Each measuring day ended with class discussion on what had occurred, challenges, successes, and questions from the teacher in an effort to understand the level of student understanding. For example, at the end of Day 2 when the students measured their heights, the teacher asked the students to report their heights as a number of coconuts tall. Then she asked if that height would be the same number if counted in another unit in the story, bugs, instead.

## 4. Discussion

Through our sessions together, I found our conversations not only revolved around the mathematics but also on the teaching of the mathematics. My findings revealed the kinds of impact collaboration had on implementing something new that was not initiated by the teachers themselves: improved questioning techniques used by teachers, better understanding of the use of manipulatives in a lesson, enduring understandings gained by students, cultural connections, and confidence building. The teachers judged that the implementation of the unit was successful. To varying degrees both teachers in this study grew professionally through the use of the culturally-relevant, problem solving lessons and with the opportunity to collaborate with one another and with me.

The process I had the teachers experience through my project used the structures for effective teacher professional development in mathematics and science already identified in the literature (Blank & de las Alas, 2009): teachers from the same school collaborated before the implementation of the unit to understand how the unit would be implemented, then during the implementation of the unit they collaborated daily after each implementation session in class to discuss their successes and challenges, and finally, at the end of the implementation of the unit, the teachers reflected on the effectiveness of the lessons as a unit and discussed points for improvement for future use. What is noteworthy is that this approach proved equally effective when the professional development was for a paired attention to both culture and mathematics in learning to use, implement, and revise a lesson.

The contrast between Heidi's and Tara's implementations - and subsequent noting of the richer learning by Heidi's students - indicates that opportunities for cultural pit-stops must be infused into the lessons and must be taken up and used by teachers. This provides further support for Wolcott's (1982) notion that culture must be taught and suggests that it must also be explicit in the lesson. A shared problem-solving approach to mathematics lends itself to the Chamorro

culture because the nature of the culture is community oriented. By infusing aspects of the culture into the lessons and framing the lessons in a community setting, the subtle relationship between the culture and the mathematics can be strengthened.

## 5. Conclusion

The goal of this study was to understand what happens when teachers collaborate to implement a mathematics unit designed to be culturally relevant and problem-solving rich. I believed that the teachers involved in the project would be positively affected and that they would gain some degree of acceptance of the new unit and the unit would be successfully implemented.

The relationship between culture and mathematics is nuanced. In the grade 1 case presented here, culture framed the context of the lessons but the culture may never have been referred to again after the first day when the story was read. Note that only the teacher who strongly identified with the Chamorro culture, Heidi, felt compelled to highlight the cultural components of the story. Tara, who had lived on the island for many years and called it her home, felt no such compulsion because she assumed that since her students were from the place, no elaboration was necessary. This implies that if more blatant cultural pit-stops are desired then the lesson must be written explicitly to address assumptions that might be made (e.g., as in Tara's case). I had expected that as teachers in an indigenous context (the Pacific island of Saipan), the teachers would understand and live the ideals of respect, reciprocity, and responsibility. While I was not mistaken, this assumption did not translate into the details of the lesson. For future research projects that include culture embedded in the lessons, the plans must be explicit for teachers as to where the cultural pit-stops could occur and provide scaffolds for teachers about how to manage them.

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# Pohnpeian Traditional Feast House – *Nahsen Pohnpei*

Tendy Liwy

Abstract. This short report gives information about a cultural context for teaching grade 4 mathematics concepts in measurement. The lesson is based on information from knowledgable elders and the everyday experiences of Pohnpeians.

## 1. Introduction

There are three main types of houses in Pohnpei, *wen uhm* (cook houses), *imelap* (main houses) and the *nahs* (feast houses). The nahs serves as the motherhouse of all the other houses within a family. The nahs or feast house plays an important role in the traditions and culture of Pohnpei. This is the place where people gather, feast and celebrate.

There are hundreds, maybe thousands of nahs in Pohnpei, but only one that has been built entirely from traditional materials. Most now are built of durable imported materials that withstand strong winds and storms (e.g., concrete). Today only the remnants of a traditional nahs is visible (Figure 1). The old and beautiful nahs built from local materials are attractive, including to tourists. However, to maintain that specific type of nahs is hard work and time consuming.

Figure 1. What is left of the only traditional nahs made of local materials.

Unique to Pohnpei, a nahs is a simple structure with a complex set of meanings. Little more than a U-shaped platform with a rear wall and pitched roof, this carport-sized construction constantly reminds those who use it of their status in the village. In fact, in some ways the family nahs is the property of the village chief, or Nahnmwarki, with some parts remaining off-limits even to its owners. The nahs is a casual, breezy place that's generally detached from the walled-in main house. The dirt or stone floor is where families and friends sit, talk, work, eat and play. The raised platforms at either side are used for the preparation of food. The entire front section, raised or ground-level is open to everyone. But that's not true of the raised rear section. While the back platform is usually untouched, during feasts its cultural importance is revealed. The stage is reserved for the highest titled person present – which is often not the owners. Even during regular, non-feasting days, when there are no titled people present, the owners of a nahs are not permitted to enter it from the two rear doorways. (Largo Edwin, 2010).

FIGURE 2. Feast in a nahs constructed of imported materials (concrete, steel).

People in the old days used special tools and instruments to build their nahs. One of the units of measurement they used is *ngahp*, the measure by two outstretched arms. Another unit is *tipw*, the measure from the elbow to the tip of the longest finger. When building a big house, a rope is used to measure long distances and the rope is already marked with knots indicating each ngahp. From my own understanding, an average size man is usually the person whose ngahp is used. There is another measure usually used that was introduced by the Japanese, *suh*, the hand span. When constructing the roof the shape is determined by the *keimw*, the angle.

Sometimes, if asked how big a nahs is, people will not give the dimension of the nahs but rather the number of *dinak*. Dinak is the area of one section of a thatched roof, from the eave to the peak, one ngahp in width. The sizes of the koupahleng can be from a few dinaks up to 50 dinaks.

There are at least 333 pieces of lumber that make up a standard feast house, the nahs called *koupahleng*. The number 333 is from the number of soldiers that accompanied Isokelekel, who became the first Nahnmarki (chief) of Pohnpei. The warriors all brought lumber to build the koupahleng for the Nahnmarki. All came and brought their contributions. As a visitor, at the front area of the nahs where you enter, once you are past the front timbers anything you bring you cannot take back.

FIGURE 3. A house made up of two dinaks

The position of the nahs also plays an important role in the prosperity or the livelihood of the nahs and its owners. The closest position to the sea is the point where the nahs should face. (Rodrigo Mauricio, Interview April 13, 2010).

## 2. Geometry and Measurement Lesson

Students often struggle to learn about things that are unfamiliar to them and strange to their culture. I designed a learning unit about nahs to encourage students to learn academically as well as to recapture and honor the mathematics seen throughout their everyday living experiences. The lesson is available along with others on similar topics at the MACIMISE website (`http://macimise.prel.org/3d-structures/`).

Most elementary schools in Pohnpei erect a nahs in the school vicinity. Much mathematics is involved in building it and in all the cultural activities, ceremonies and funerals held in the nahs. This creates a world of mathematics for a Pohnpeian student living an ordinary life, which gives good purpose for learning mathematics. For this unit, local elders shared their knowledge about how people from the past built a nahs with traditional tools to measure and make it squared.

On Pohnpei, a 4th grade teacher, Mr. D and his 30 students used the lesson to learn about geometrical shapes and measuring. The research literature suggests that inquiry-based mathematics can be a powerful learning method, but an open question exists about what it might mean to define "inquiry-based" in a culturally-authentic way. The lesson is based on noticing and counting geometrical shapes that exist in the Pohnpeian feast house and on differentiating which counting unit to use and its significance. Also, the lesson has students explore and talk about the differences between the measures based on their own bodies and the cultural standard of an average size adult man. The goals of the lesson rely on students doing comparing and contrasting of ideas in Pohnpeian and English, describing different patterns and counting objects in both systems (the Pohnpeian system counts classes of objects differently). The final activity in the lesson has students build a scale model of a koupahleng and link English-language notions of measure, proportion, and scale to the Pohnpeian-based nahs structure and methods.

## 3. Resource

See the MACIMISE website for the Grade 4 Lesson:
`https://macimise.prel.org/wp-content/uploads/2015/06/Measuring-and-Modeling-the-Nahs-traditional-feast-house-in-Pohnpei.-Grade-4.-Liwy.pdf`.

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# Lessons from *The Little Crooked House*

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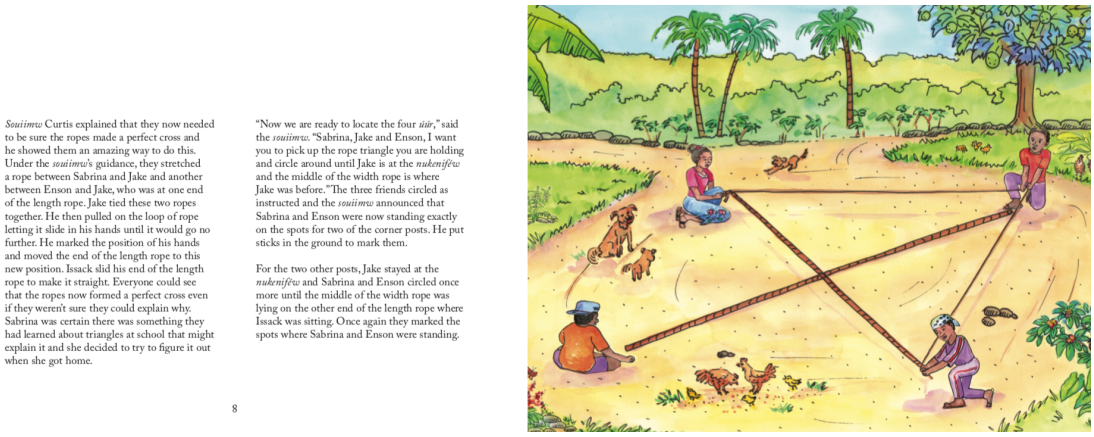
Abstract. This is an overview of the lessons associated with the book *The Little Crooked House* (Lee, 2015). The original lessons in indigenous mathematics can be found in the paper, *A culturally based mathematics unit for grade seven students on Chuuk State*, submitted to the University of Hawai'i at Manoa in the context of the author's Master's program. Full lesson resources are available from Pacific Resources for Education and Learning.

## 1. Introduction

There are major problems with the teaching of mathematics in Chuuk:

- the current approach to teaching and learning of mathematics in the classroom is inappropriate and not meaningful,
- the 'western' (sometimes called 'main land') approach to the teaching of mathematics adversely affects students' perceptions of the value of their own culture, and consequently produces mathematics knowledge that is not useful nor beneficial to the needs and practice of the Chuukese people's indigenous ways of working and interacting, and
- the transition to the learning of classroom mathematics, because of its explicit exclusions of culture, has very little effect on students' success in the learning of mathematics.

These problems are addressed by a set of nine lessons associated with *The Little Crooked House* book (see Figure 1 for an example from the storybook, Lee, 2015).


*Souiimw* Curtis explained that they now needed to be sure the ropes made a perfect cross and he showed them an amazing way to do this. Under the *souiimw's* guidance, they stretched a rope between Sabrina and Jake and another between Enson and Jake, who was at one end of the length rope. Jake tied these two ropes together. He then pulled on the loop of rope letting it slide in his hands until it would go no further. He marked the position of his hands and moved the end of the length rope to this new position. Issack slid his end of the length rope to make it straight. Everyone could see that the ropes now formed a perfect cross even if they weren't sure they could explain why. Sabrina was certain there was something they had learned about triangles at school that might explain it and she decided to try to figure it out when she got home.

"Now we are ready to locate the four *iúr*," said the *souiimw*. "Sabrina, Jake and Enson, I want you to pick up the rope triangle you are holding and circle around until Jake is at the *nukeniféw* and the middle of the width rope is where Jake was before." The three friends circled as instructed and the *souiimw* announced that Sabrina and Enson were now standing exactly on the spots for two of the corner posts. He put sticks in the ground to mark them.

For the two other posts, Jake stayed at the *nukeniféw* and Sabrina and Enson circled once more until the middle of the width rope was lying on the other end of the length rope where Issack was sitting. Once again they marked the spots where Sabrina and Enson were standing.

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FIGURE 1. Example from *The Little Crooked House*, pp.8-9.

The lessons follow the successive stages in the building of a traditional Chuukese house as portrayed in the storybook. Each lesson is culturally authentic as it presents a stage in the house construction and the mathematics embedded in each stage.

## 2. Timing of the Lessons

The lessons cover a significant number of the grade seven standards and benchmarks for mathematics. The lessons can be distributed throughout the year as a particular set of topics is addressed or as an introduction to certain topics. Alternatively, they can be grouped together towards the end of the school year as a way of reviewing and pulling together the year's work. Lessons vary in length but tend to require about 2 hours of class time. Each lesson is divided into Activities for which the estimated time is given. Rarely do these activities exceed 45 minutes. This allows teachers to adapt lessons to the schedule for mathematics in their schools.

## 3. Lesson Structure

Each lesson starts with a list of the objectives. Where appropriate, the Chuuk benchmarks are indicated. To read these benchmarks, note that the middle number indicates the grade level. For example, MAT. 4.7.1, indicates a benchmark from Standard 4 (Patterns and Algebra) for Grade 7, and the 1 indicates the first benchmark for this standard: "Find the expression for the general term in a growing pattern and use it to find the general term in the pattern."

A list of materials required for the activities in the lesson to be fully implemented follows. Teachers need to prepare these materials beforehand. A few materials that are used in every lesson are listed in the early lessons but then assumed to be there. These materials are the copies of the storybook and the heavy paper and markers necessary to make the word wall cards.

The important vocabulary in each lesson is given under the title "Word Wall." Each word found there should be clearly printed on cardstock 11 inches by 2 to 3 inches (cutting a letter size sheet into 3 or 4 cards). These cards are prepared ahead of time and posted, as they arise in the lesson, on the Word Wall (an area on the board or a clear wall where the cards are visible to all students) using tape or poster putty. A Glossary at the end of the book offers definitions of the English words. The Chuukese words are presented in a glossary at the end of the storybook.

Classroom activities follow and within each activity a number of experiences are described. Resources related to these experiences can be found at the end of each lesson. Although most resources are for the teacher, some are worksheets for students. When this is the case, the resource number is indicated in the materials section so the needed number of copies can be prepared ahead of time.

Scattered throughout the activities are "Questions" which are generally not specific questions for the students but overarching questions that guide the inquiry. They can be copied on the board as they arise and addressed from time to time as the work progresses.

Every lesson closes with a brief plenary session. This either pulls together some aspects of the lesson or anticipates the next lesson, or both.

## 4. Chuukese Vocabulary

Although the lessons and related storybook are in English, the Chuukese words related to the building of a house and those used in measurements (for which there is no English equivalent) are introduced. See Figure 2 for an example. It is important to recognize the variations in these words, and in their written form, from one region to the next. The Chuukese measurement system is primarily gestural, not written. However, a book of lessons has no choice but to offer a written form. This is why each resource dealing with units of measure contains photos of the gesture involved. In the classroom, the accent should be on the gestures, not the written words.

❖ Resource 1f: Chuukese length measures

| Unit of measurement | Number indicators | Description |
|---|---|---|
| **NGAAF** | 1. engaf<br>2. ruengaf<br>3. ununga f<br>4. fengaf (fangaf) | Distance between thumb tips on outstretched arms |
| **ETINEUPW** | This unit is not normally used independently so no number indicators are given. | Distance from thumb tip on outstretched arm to the center of the chest |



**Relationship: etineupw + etineupw = engaf**

FIGURE 2. Snapshot of Lesson 1 for grade 7 with Chuukese length measure gestures and words.

## 5. Resources

See the MACIMISE website for the Grade 7 Lessons:
https://macimise.prel.org/wp-content/uploads/2015/06/Chuukese-House-Building-Supplemental-Lessons-and-Resources-for-The-Little-Crooked-House.-Grade-7.-Lee-Nokar.pdf