Journal of the California Mathematics Project
Volume **9**, 2018

One Last Circle

Andrea M. Aiona

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 Oʻahu, and like many Hawaiʻi 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 Hawaiʻi) 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 Oʻahu (Kailua, Kāneʻohe), where I was offered a Western-style education that seemed impervious to the place in which it existed. I didn't learn ʻōlelo Hawaiʻi (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 Hawaiʻi'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 Hawaiʻi'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 Hawaiʻi'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.

References

Aiona, A. M. (2014). *Participants' journeys in project MACIMISE (Mathematics and Culture in Micronesia: Integrating Societal Experiences)* (PhD). University of Hawaiʻi at Mānoa.

D'Ambrosio, U. (2001). What is ethnomathematics and how can it help children in schools? *Teaching Children Mathematics*, 308–310.

Dawson, A. J. (2015). Mathematics and culture in Micronesia. *Revista Latinoamericana de Etnomatemática*, *8*, 256–270.

Dawson, A. S. (2013). Mathematics and culture in Micronesia: The structure and function of a capacity building project. *Mathematics Education Research Journal*, *25*(1), 43-56.

do Carmo Domite, M., & Pais, A. (2010). Understanding Ethnomathematics from its criticisms and contradictions. In V. Durand-Guerrier, S. Soury-Lavergne, & F. Arzarello (Eds.), *Proceedings of the Sixth Congress of the European Society for Research in Mathematics Education* (p. pp. 11). Lyon, France: Institut National de Recherche Pédagogique.

Gerdes, P. (1997). Survey of current work in ethnomathematics. In A. Powell & M. Frankenstein (Eds.), *Ethnomathematics: Challenging eurocentrism in mathematics education* (pp. 331–372). SUNY Press.

Gerdes, P. (2001). Ethnomathematics as a new research field, illustrated by studies of mathematical ideas in African history. In J. J. S. na (Ed.), *Science and cultural diversity: Filing a gap in the history of sciences, cuadernos de quipu 5* (pp. 10 – 34). Mexico: Sociedad Latinoamericana de Historia de las Ciencias y Technologia.

Hanohano, J., Peter K. (2001). *Restoring the sacred circle – education for culturally responsive native families* (Unpublished doctoral dissertation). University of Alberta.

Hatch, J. A. (2002). *Doing qualitative research in education settings.* Albany, NY: State University of New York.

Wilson, S. (2008). *Research is ceremony: Indigenous research methods.* Fernwood.