QUANTI-NATIVE, KA HELU KAHIKO:
HAWAIIAN CULTURE-BASED EDUCATION IN MATHEMATICS

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By
Eōmailani Keonaonalikookalehua Kukahiko

Dissertation Committee:
Joseph Zilliox, Chairperson
Kimo A. Cashman
Julie Kaomea
Sarah Twomey
J. Keawe‘aimoku Kaholokula

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Abstract

The Common Core State Standards (CCSS) initiative, adopted by forty-five states, including Hawai‘i, has promoted universal mathematics and language arts standards that are “designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers.” (“Common Core State Standards Initiative | Home,” n.d.) While nationalized curricula aim to streamline and simplify classroom teaching, the Common Core may not be responsive to the needs of Hawaiian children who have the unfortunate distinction of being “disproportionately underrepresented” in math (Kaomea, 2011, p. 291; Hammond, Wilson, & Barros, 2012, p. 14).

Hawaiian Culture-based Education (HCBE), an indigenous curricular approach, provides a framework for “teaching and learning that are grounded in a cultural worldview, from whose lens are taught the skills, knowledge, content, and values that students need in our modern, global society” (S. M. Kanaʻiaupuni & Kawaiʻaeʻa, 2008, p. 71). Given the preeminent position of mathematics in classroom curricula and the success of HCBE in engaging learners, is it possible to enhance learning of this seemingly universal content area by incorporating traditional cultural concepts and ways of knowing?

Current literature indicates that the integration of culture and mathematics, “ethnomathematics,” can increase student engagement in the classroom. Using a qualitative design, this research project explored archival texts alongside the experiences of classroom teachers working in Hawaiian educational settings across the state who successfully integrate HCBE and ethnomathematics into their classrooms. This research
seeks to glean from the teachers’ manaʻo for the creation of mathematics curricula that is culturally responsive and offer practical suggestions to other educators working in Hawaiian and other diverse communities.
Table of Contents

Abstract.............................................................................................................................................. iv

List of Tables ......................................................................................................................................... xii

List of Figures ....................................................................................................................................... xiii

Mokuna I: Introduction to the Study ................................................................................................. 1

He ho‘olauna ........................................................................................................................................ 2

Ola nā iwi............................................................................................................................................ 3

He ‘a‘ali‘i kū makani mai au; ‘a‘ohe makani nāna e kula‘i......................................................... 5

Ka la‘i o Hauola. ................................................................................................................................. 6

He welo ‘ohana. ................................................................................................................................. 7

Ka Helu Kahiko .................................................................................................................................. 8

Statement of the Problem ..................................................................................................................... 9

Purpose............................................................................................................................................... 11

Need and Significance of Study ......................................................................................................... 11

Research Questions ............................................................................................................................. 14

Organization of Dissertation .............................................................................................................. 15

Mokuna II: Review of Related Literature ......................................................................................... 17

Challenging the Eurocentric Narrative .............................................................................................. 18

Challenging What Counts As Knowledge ......................................................................................... 22

Translation. ......................................................................................................................................... 26

Challenging the Disconnection Between Mathematics Education and Social and

Political Change ................................................................................................................................. 29
Researcher Background and Bias ................................................................. 61
Limitations of the Study ........................................................................ 61
Deviant Discourse ................................................................................... 67
Nā Kiulela, ‘Ilio Hulu Pāpale, a Pēlā wale aku ...................................... 70
Malama Makahiki ..................................................................................... 77
Ka Hanau ana o na Malama ................................................................. 81
Helu Hawai‘i .............................................................................................. 87
Helu Pa‘i‘ai ............................................................................................... 91
Mokuna V: Nā Leo Kumu ........................................................................ 94
Description of Participants and Sites .................................................... 94
Hikianalia ................................................................................................ 94
Maile ........................................................................................................ 95
‘Alaea ...................................................................................................... 97
Rovert Snikta. ....................................................................................... 97
Pualīlia ..................................................................................................... 98
Ku‘ulei Waikoloa ................................................................................... 99
Tristan .................................................................................................... 100
Kīholo ..................................................................................................... 100
HCBE in Math Context .......................................................................... 102
Language: Recognizing and using native or heritage language .......... 106
Integration of Hawaiian language in class. ........................................ 106
Hawaiian language materials and resources. ..................................... 108
Summary ........................................................................................................................................... 111

‘Ohana and Community Involvement ......................................................................................... 112
Integration of ‘ohana/community in curriculum........................................................................... 112
Communication between ‘ohana and teachers............................................................................. 114
Relationship between ‘ohana and teachers. .................................................................................. 115
Summary. ........................................................................................................................................ 116

Content .......................................................................................................................................... 117
Culture-based curriculum/content................................................................................................. 117

  Collaboration ............................................................................................................................... 120

  Compartmentalization. .............................................................................................................. 120

Place-based. .................................................................................................................................. 120

  HCBE and mathematics professional development opportunities ............................................. 122

Summary. ........................................................................................................................................ 125

Context .......................................................................................................................................... 125
Culturally grounded. ....................................................................................................................... 126

  I maika‘i ke kalo i ka ‘ohā. ......................................................................................................... 126

Culturally relevant community of learners. ................................................................................... 127
Community well-being, kuleana..................................................................................................... 128
Summary. ........................................................................................................................................ 130

Assessment & Accountability ........................................................................................................ 130
Demonstrate knowledge/skills. ...................................................................................................... 131
Application..................................................................................................................................... 135
Value to community, culture......................................................................................................... 136
Summary .................................................................................................................. 136

“Other” themes ........................................................................................................ 137

Cultural knowledge insecurities .............................................................................. 137

Ahikā ......................................................................................................................... 138

Hierarchy of knowledge ............................................................................................ 139

Common sense .......................................................................................................... 139

Gender gap ................................................................................................................. 140

He Punahele .............................................................................................................. 141

Mokuna VI: Conclusion ................................................................................................ 144

Introduction ............................................................................................................... 144

Hawaiian Archival Texts ............................................................................................. 144

Helu Hawai‘i ................................................................................................................. 146

Malama Hawai‘i ........................................................................................................... 149

‘Aole pau ka ‘ike i ka hālau ho‘okahi .......................................................................... 151

Hawaiian Culture-Based Education + Ethnomathematics = .................................. 152

Language: Recognizing and using native or heritage language .............................. 153

‘Ohana & community ................................................................................................. 157

Context ....................................................................................................................... 158

Assessment & accountability, content ..................................................................... 159

‘Āina and relationships, ‘āina relationships ................................................................ 160

Personal Reflections A‘o i ke koa, e a‘o nō i ka holo ............................................... 162

He welo ‘ohana .......................................................................................................... 162

Silence as complicity ................................................................................................. 163
List of Tables

Table 1. HCBE Components and Critical Indicators ................................................................. 56

Table 2. Participant and Site Data .......................................................................................... 94
List of Figures

Figure 1. Bird and boat poem ........................................................................................................ 67
Figure 2. One-to-one correspondence assignment ................................................................. 70
Figure 3. Nā kānāwai a Mose ...................................................................................................... 73
Figure 4. Gregorian and Hawaiian months by island .............................................................. 78
Figure 5. Genealogy of Hawaiian months .................................................................................. 80
Figure 6. Christian calendar ...................................................................................................... 84
Figure 7. Calendar used in Kula Kaiapuni classroom ................................................................. 86
Figure 8. Hawaiian counting system .......................................................................................... 87
Figure 9. Hawaiian counting system compared with bible ...................................................... 88
Figure 10. Western base system translated into Hawaiian ......................................................... 89
Figure 11. Market prices using Hawaiian and Western quantification ...................................... 91
Figure 12. Act 57, Section 30 ...................................................................................................... 156
Mokuna I: Introduction to the Study

Manomano a lehulehu ka ‘ikena a ka Hawai‘i. Four thousand and four hundred thousand are the knowledges of the Hawaiians. This famous ‘ōlelo no‘eau asserts through numeracy the multitudinous intelligences of the Hawaiian people. This research endeavor, a culmination of many years of study in the Hawaiian language, education, and more recently mathematics, seeks to delve into one of those knowledges, namely kuana'ike helu Hawai‘i, or a quantifiable, mathematical Hawaiian world-view. For the purposes of this paper I am utilizing Swetz’ (2009) definition of mathematical activity as a “conscious, systematic effort, a demonstration of an internalized concept that deals with the quantification and partitioning of objects and space in the environment” (p. 13). This understanding engenders the reframing of the way we engage in mathematics curricula taught in Hawai‘i’s schools, and allows us to reimagine possibilities for broader Hawaiian education. With this project I sought to reengage ancestral knowledge through a critical ethnomathematical and quantifiable lens through both written Hawaiian language archival mo‘olelo and spoken mo‘olelo of teachers who include Hawaiian knowledge in their mathematics instruction, reasserting our mo‘olelo Helu Kahiko, or Hawaiian mathematical sophistication.

Before we can embark on this research journey together it is critical that I introduce myself to you as the reader. Through sharing my own family stories within the contexts of being a Hawaiian, a mother, and scholar, I locate myself within the continuum of a larger Hawaiian mo‘olelo. As a learner and as a vulnerable participant in this process of rediscovery, I am also mindful of the negative role that research has played for Hawaiian and many other Indigenous communities. Therefore this research
project was developed upon a relationship of collaboration and trust. Next, I will introduce the study by articulating the statement of the problem, purpose and significance of the study, and identify my key research questions. Finally, I will give an explanation of the overall organization of this dissertation.

He hoʻolauna

Living in Waimānalo, “God’s Country,” I was fortunate to have grown up in one of the most beautiful places in the world. After school each day I would walk down to the beach, go for a swim, a walk, or even just contemplate the view from the Koʻolau mountain ridgeline to the horizon. As I began to study the Hawaiian language, I learned the concept of “one hānau.” Through this imagery I immediately connected back to the literal “sands of my birth” in Waimānalo, and understood more deeply the love that one can feel for an ancestral home. ʻŌlelo Hawaiʻi has given me the ability to articulate through language the connection that I feel with this ʻāina.

Ironically, living in an island paradise comes at a cost. Hawaiʻi’s reputation as a world-class attraction has resulted in fierce competition for resources of every kind, too often resulting in displacement and dislocation of indigenous Hawaiians. As a child I thought it was entertaining to see the aunties and uncles partying with an ʻukulele and beer in hand. Us kids felt we were lucky to be asked to go on the occasional “beer run” where we could get our own snacks. I came to realize however, that these festive parties often ended up with shouting and violence. It was not until I was older that I could understand the complexity of the challenges that faced my community. The families who were barely able to make ends meet and whose children were struggling in public schools were a stark contrast to the more affluent ones who could afford a beach-front property
and private schools for their children. Although I understand that economic status does not necessarily protect against alcoholism and drug addiction, it did seem to me that domestic violence was far more prevalent among the poorer families in my neighborhood, a neighborhood of extreme economic disparity.

Scholarship for me always begins with my connection back to this place. The ʻāina, and the people have shaped my experiences as a scholar, a Hawaiian, and a mother. These are all central to the articulation of my work.

**Ola nā īwi.**

Hawaiian language advocates believe that language, as a window to culture, is key to understanding self and that living language is key to a true understanding of who we are as a people. For me, that understanding invokes ways of living and knowing which are simple yet profound —the reciprocal relationship and interdependence of all living things; awe and appreciation for the great inheritance, Hawai‘i; moʻokūʻauhau -- understanding my place among an unbroken line of ancestors and future generations with whom there is an inextricable link.

My relationship with my tūtū, Pearl Kuʻuleimomi Amina Perry, has been of paramount importance in my life. As a model of a strong Hawaiian woman, she was raised in Waiākea Uka, on the island of Hawaiʻi. Although by the time I came along she had already moved to urban Honolulu, there were qualities about her that carried an aura of serenity, were very calming in this bustling city. She had a deep love for family and she always appreciated the little that she had. I would suggest that my ʻohana is matriarchal in general, but it is from her specifically that I formulate my ideas about my own identity as a Hawaiian woman and mother.
Orphaned at an early age Grams, as the hiapo, took on the kuleana of raising her younger siblings. She learned then, that in order to survive she had to fight -- fight being Hawaiian, fight being a woman, and fight being poor. Her inner conflict about being Hawaiian manifested itself in several ways. Although my Grams was raised speaking Hawaiian, she did not speak it in the home. Like those of her generation she believed that following in the American style would ensure survival, or even success for her own children in a changing society. She was from a big family, plagued with issues of domestic violence, and sometimes talked about her ‘ohana with reproach. “‘Ona mau” she called them and would later go as far as discouraging her own children from marrying Hawaiian.

Cautioned by tūtū’s reluctance to speak Hawaiian, I stepped into my first Hawaiian language class as a sophomore in high school. At that time, people called this the school for Hawaiians—a place where students of Hawaiian ancestry could get a good Western education. Now through a strategic and community engaged introspection, it is striving to be a truly Hawaiian school. This first Hawaiian language class had a profound effect on me, as I was even shocked to learn that there were people who could still speak Hawaiian. I decided that day that I needed to be involved in teaching the ‘ōlelo Hawai‘i. It was not until I graduated, however, that I learned about Pūnana Leo, a preschool where all teaching was done through the medium of Hawaiian language. I was truly amazed that children as young as three and four years old could speak entirely in this “new” language. I would go home after visiting the Pūnana Leo and talk to Grams in Hawaiian, sharing the new vocabulary that I had learned. Although she sometimes had reservations about
the way I spoke or the new words that I would use, I know that she was happy again in
having a hoa wala‘au.

I know that my inspiration to become a Hawaiian immersion teacher was a direct
result of my tūtū’s own struggles. Although she had to drop out of school at an early age,
she had a zeal for learning that she shared with us kids, and always reminded us to do our
best with the opportunities we were afforded. She wanted a better life for us, but also for
other Hawaiians who struggled as she did. My tūtū inspired and taught me by her
example -- she worked so hard just to survive, so even in this time where people are
proud to be Hawaiian, I can never take being Hawaiian for granted. When my
grandmother passed away she left a large collection of her writings with notes about each
member of her now extensive ‘ohana. Next to my name she simply wrote, my first
favorite. While I am not the first-born mo‘opuna, I know now that the idea of punahele
for my tūtū, was a direct result of our close relationship which flourished through our
‘ōlelo Hawai‘i.

He ‘a‘ali‘i kū makani mai au; ‘a‘ohe makani nāna e kula‘i.

I started with my hālau hula thirteen years ago. I remember distinctly because my
hiapo, Ku‘ulei, was just two. While I have always felt a strong desire to learn more things
Hawaiian, I feel that my original intentions with the hālau stemmed from my personal
insecurities about my own Hawaiian-ness. Through the years I have learned many mele,
oli, and mo‘olelo about my homeland. It was not until this past year, however, that I
learned what it meant to be ke ‘a‘ali‘i kū makani, the wind-resisting ‘a‘ali‘i.

Competing in the Merrie Monarch Hula Festival is a great honor. Beyond the
competition aspect, this festival has a proud history of maintaining Hawaiian culture
through hula. As such I was ecstatic when my kumu asked me to be a part of the competition line. The hula kahiko that he selected was his original composition that honored Likelike and began with an oli moʻokūʻauhau that connected her back with her ancestors Līloa and ʻAkahiakuleana. Each week we would rehearse for hours so that we could properly communicate this honorific oli, mele, through hula.

About two weeks before the competition, I got into a car accident. Although no one was seriously hurt, the crash resulted in a broken bone in my foot. As I didn’t want to disappoint my kumu and hula sisters, I returned quickly to hula, refusing to cast my foot, and would dance through the pain of my injury. When I would come home after practice, my husband would shake his head and tell me that I was exacerbating the problem by my continual dancing. While I acknowledged his concern, I felt I had no choice but to persevere. I continued to dance and prepare myself physically and spiritually for this journey.

When we finally got to Hilo, I felt relief from my physical pain instantly. I knew that in her one hānau, my grandmother was comforting and guiding me. When we took the stage the mele and oli and natural adornments came together with the spiritual and physical sacrifice to contribute to the mana of the overall performance that honored our aliʻi and ʻāina, and we were rewarded with the first place title, ka lei o ka lanakila.

**Ka laʻi o Hauola.**

As a people we make connections to our past, *ka wā ma mua*, through our lived experiences. To perpetuate the knowledge and traditions of our ancestors, however, we embrace our future, *ka wā ma hope*, through our children. I boast with both regret and pride that as a child, my activist parents often sacrificed family by redirecting their time,
energy and resources for the hope of a Hawaiian nation. As a mother, however, I learn from the sacrifices of our past and change the trajectory for a future course.

*Nānā i ke Kumu* volumes I and II have been inspirational books for me through the years. Pukui as an early Hawaiian scholar drew upon her native intelligence and bridged it with her expanding worldview as a Hawaiian woman. Her writings of traditional pregnancy and childbirth allowed my husband and me to seek a more cultural path for the birth of our son, believing that by invoking spiritual and practical approaches described, we could ensure a safe delivery. His arrival into this world through a home-birth, and subsequent planting of his ‘iewe in his ancestral home reassure me that he too will be firmly planted in the ways of his kūpuna, and through faith in our Hawaiian traditions and knowledge we will always have the strength to survive and thrive as a Hawaiian people.

**He welo ʻohana.**

“I’m just not good at math!” my daughter sobbed as I berated her for poor grades in her pre-algebra class. “Mom, I swear that when I tell Miss Lomilomi that I don’t understand something, she repeats her explanation in the exact same way.” For me what was most concerning in her assertion is that even at twelve, she had placed mathematics in the category of being something that was too difficult for her, and she did not feel that her teacher, who obviously had the content knowledge, was a good teacher. The subject was, in her eyes, too difficult for her. As she began to believe this, so too did her teacher. Thinking back upon my own school experiences, it was around this very time that I too had given up on math. I was disappointed, however, to see that she had come to the same conclusion in spite of my best parental efforts. My exasperation with my daughter’s
abysmal performance in her pre-algebra class lead to frustration for her, and
disappointment for me. I knew that even at twelve, doors would start to close for her. I
was also concerned that I had somehow, in spite of my best efforts to the contrary,
internalized and unwittingly transmitted a belief, reinforced by early negative school
experiences, in a “genetic predisposition” for doing poorly in math.

Ka Helu Kahiko

My daughter’s story, my story, draws attention to some of the issues that occur in
the context of a female teenage Hawaiian struggling in a math classroom. I know that my
dughter and I are not alone in our struggles with traditional math classrooms. Robert
Moses, founder of the Algebra Project, confirms with the following, “Not being ‘good’ in
math does not in any way imply inferiority, rather, it confirms that you’re just like most
everyone else” (Moses & Cobb, 2002, p. 12). He continues with the following,
“Illiteracy in math is acceptable in a way that reading and writing is unacceptable” (p. 9).

While Hawaiian students need to learn “Western” math in order to advance in a
global community, which recognizes the universality and relevance of certain math
conventions, we also need to learn and interface effectively with those conventions while
remaining grounded in and connected to our own traditional knowledge base. Being
“junk” in math leads to decreased opportunities for our children, and as Hawaiians we
need to be self-determining in our educational as well as our mathematical destinies.
“Math literacy and economic access are how we are going to give hope to the young
generation.” (Moses & Cobb, 2002, p. 12) How then do we provide hope for our
Hawaiian children who are currently “disproportionately underrepresented in the fields of
math and science” (Kaomea, 2011, p. 291)? Given the importance of mathematics in
educational success, it is daunting to consider that although our difficulty with math felt very isolating, it actually yoked us in with many other struggling math learners. Ironically, indigenous peoples find themselves: disconnected from the very tool that is supposed to liberate them from dire educational and economic circumstances.

As a parent of four, I have dedicated my studies to learning about my language and culture. I have passed on this knowledge to my children so that they too will know the stories of this ʻāina. I fear, however, that my children will not be able to cope with mounting economic pressures that are part and parcel of contemporary life if they do not acquire the critical and practical skills associated with math proficiencies. As a parent, I am concerned that these economic pressures may someday force my children from their ancestral home.

**Statement of the Problem**

Promoted as a universal and necessary tool for the academic advancement of children in the United States, mathematics has been granted unfettered, unquestioned access into classrooms. I was interested to read a recent newspaper interview with Kū Kahakalau (Pennybacker, 2008), director of Kanu o ka ʻĀina, a Hawaiian language public charter school in Kamuela, Hawaiʻi, that has been a leader in the Hawaiian focused charter school movement. She talked about the importance of Hawaiian language and culture for their charter school. She discussed the role that the school has played in the revitalization of Hawaiian history, language and culture, describing their approach to education as “cultural immersion.” Her next statement, however, is what struck me most.
We don’t teach math in Hawaiian because there are no traditional words for it – you’d have to make up new words. Our curriculum is relevant. We don’t use western textbooks, except for math. We start with our place, Hawai‘i, and then go outward. (Pennybacker, 2008)

Her statement is important for two reasons. First, she suggests that with the exception of math, every content area can be taught through “cultural immersion”. Second, she implies that mathematics is not a part of our Hawaiian knowledge base, and that we do not have a mathematical language, and therefore must rely on western standard textbooks. Unfortunately, I do not think that Kahakalau’s assertion varies greatly from the majority of teachers working in Hawaiian educational settings today.

“Mathematics has constructed a language which attempts to define with absolute exactness the parameters, dimensions, qualities and possibilities of space” (L. T. Smith, 1999, p. 50) and seemingly that language is not Hawaiian.

Is this assertion true? The very transliteration, makemakika, “dead mosquito” ironically references not only a dead, but alien insect species ascribed to have carried lethal diseases upon their unintended introduction into Hawai‘i. The word is wholly unconnected to traditional thought that might be expressed in the Hawaiian language, inferring that perhaps Hawaiians did not have their own mathematical traditions. I contend, however, that Hawaiians, like many other cultures, have a rich mathematical understanding of the natural world, and that this knowledge must find its way back into the classroom.
Purpose

The purpose of this project is to explore the integration of mathematics and Hawaiian culture through two lenses. First, this research will include critical ethnomathematical analysis of archival data including Hawaiian language newspapers and translated Hawaiian language mathematics texts used in early formal schooling to explicate a historical relationship and Hawaiian worldview of our quantifiable world.

Second, I have conducted interviews with teachers who choose to integrate Hawaiian Culture Based-Education (HCBE) strategies and ethnomathematics into their classrooms. As math teachers, these participants have demonstrated academic excellence in mathematics through their teaching and other conventional measures, namely teacher certification and Praxis examinations. In addition, these teachers have chosen to integrate Hawaiian culture, language, critical thinking, and social justice into their mathematics teaching as a comprehensive approach to mathematics education. The approach of integrating HCBE with the critical ethnomathematics framework enables Hawaiians and other underserved communities the opportunity to retrace their unique mathematical brilliance mainly overlooked today in the wake of high-stakes testing.

Need and Significance of Study

Despite major gains that Hawaiians and other Indigenous peoples have made in reclaiming our educational systems, colonization continues to play a very real role in shaping the parameters of our educational experience. Historically, Hawai‘i’s public educational systems have sought nationalized, external solutions to remedy our educational challenges, including teacher shortage, underperforming schools, and curricular reformation. It is not surprising, then, that curriculum initiatives imposed on
Hawaiians and other diverse learners in other occupied countries may be based on standard textbook approaches that marginalize through erasures of indigenous mathematical knowledge systems-and subsequent omissions of their mathematical contributions. I mua no ka ‘ulu a hala!

While research exists that promotes mathematics curricula that is diverse, culturally-based with strong emphasis on social justice (D’Ambrosio, 1999; Gutstein & Peterson, 2005; Kaomea, 2011; Moses & Cobb, 2002; Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009; Stinson & Wager, 2012); many schools, administrators and teachers in Hawai‘i may be reluctant to implement this progressive but divergent approach to mathematics education under the scrutiny of No Child Left Behind (NCLB)\(^1\), and its resulting accountability measures.

Paradoxical in America's assertion of educational autonomy over Hawai‘i's public schools is its own irresolute political relationship with Hawai‘i as an illegally occupied nation. (Sai, 2011) Hawai‘i’s continuing over willingness to pledge allegiance to national accountability measures allows the US to take on the incongruous role of colonizer and paternalistic educational caretaker simultaneously. Inherently problematic in this relationship is that while school accountability measures appear to advocate for those disenfranchised by poor education through “progressive sounding issues and are couched in seemingly progressive language it also continues an established tradition of the

\(^1\) The No Child Left Behind Act authorizes several federal education programs that are administered by the states. The law is a reauthorization of the Elementary and Secondary Education Act. Under the 2002 law, states are required to test students in reading and math in grades 3–8 and once in high school. All students are expected to meet or exceed state standards in reading and math by 2014.
conservative production of discourse that incorporates progressive language while advancing key elements of the neo-liberal and neo-conservative agendas.” (Apple, 2007, pp. 109-110)

Apple’s assertions indicate that while the rhetoric of NCLB is aimed at providing school reform for the most vulnerable populations of learners in underperforming schools through accountability and testing measures, these measures are also intended to constrain the subaltern and not disrupt the status quo. He continues with the following:

Reforms are then instituted that do not threaten dominant groups’ agendas. Rather they respond not to the original meanings inherent in key concepts within the discourse but to policies that create the conditions that dominant groups are able to control or that extend the influence of such groups in the sector of society out of which the concerns come. (p. 110)

Complicating the issue is that Hawai‘i’s public education system has a history of underperformance and “failing schools” in Native Hawaiian communities. Administrators in these schools are under intense pressure to demonstrate increased academic performance in schools, adopting pre-packaged curricular programs often designed by the testing companies, which demand teacher fidelity. This situation creates learning environments where teacher “teach to the test.” Lloyd (2007) adds:

Although the influence of high-stakes tests on teachers’ instructional practice is neither direct nor uncomplicated, the potential power of tests to affect the decisions and actions of districts, schools and teachers is great—particularly in the light of NCLB’s reliance on high stakes tests as the sole measure of accountability. (p. 329)
Again, this ignores a basic but critical educational principle -- that learners may respond most positively to content that is contextually and culturally familiar. Accountability in a Hawaiian context may not be articulable through “Common” Core State Standards. Hawaiian Culture-Based Education (HCBE) has demonstrated its effectiveness in engaging Hawaiian and other diverse learners across the state, and suggests an alternative to mainstream, nationalized curricula reform. (Kanaʻiaupuni & Kawaiʻaeʻa, 2008) Can then the union of HCBE and mathematics be a practical, alternative approach to engage underperforming mathematics students in Hawaiʻi?

**Research Questions**

The overarching questions that my research seeks to answer through this study are:

1. How can critical analysis of Hawaiian archival texts contribute to an ethnomathematics perspective for teaching and learning mathematics?

2. How does teacher discourse reflect the incorporation of HCBE together with ethnomathematics into the teaching and learning of mathematics?

The larger context of my research considers what HCBE looks like in a mathematics classroom. My study proposes to explore the interplay of mathematics and Hawaiian culture in Hawaiian Educational Settings (HES) through the lives and experiences of classroom teachers. I will utilize methods appropriate to a transformative critical Hawaiian feminist perspective for my research project. This will allow me to focus on the stories of the participant teachers as we co-construct relevance, applicability and meaning for HCBE in ethnomathematics.
**Organization of Dissertation**

Mokuna II is the first part of my formal literature review. In this chapter I highlight critical ethnomathematics literature within a primarily English language context. This chapter also discusses the framework for the critical ethnomathematics framework necessary to conceptualize the rest of the research project.

Mokuna III is a detailed description of my research methods. Here I outline my conceptual framework utilizing HCBE and moʻolelo through a transformative perspective. I will then give a description of my data collection methods utilized with the teacher participants presented in Mokuna V, as well as a framework for the critical “interrogation” of the Hawaiian literature detailed in Mokuna IV.

In Mokuna IV, I use a critical ethnomathematics perspective to evaluate Hawaiian language within missionary and Native Hawaiian language texts to elucidate curricular hegemony in the 19th century and subsequent to that. Of primary importance in this juxtaposition is providing a counternarrative to dominant, settler colonial curricular initiatives that were imposed in Hawaiʻi’s classrooms on Hawaiian children. This framework, developed by Mukhopadhyay, Powell, and Frankenstein (2009), commands us to engage in mathematics curriculum; challenging the Eurocentric narrative, challenging what counts as knowledge in school mathematics, and challenging the disconnections between mathematics education and social and political change. (p. 71)

In Mokuna V, I analyze the data presented by the teacher participant through the Hawaiian Culture Based Education framework, these components being organized by Language, Family and Community, Content, Context, and Assessment and
Accountability. I will also discuss the other significant data that emerged from the teacher participants that was not easily located within the HCBE framework.

Mokuna VI, the final chapter, will be a discussion of the research findings, and possible implications for the field, future research as well as a reflection on the dissertation research project and process. It is my hope that this will aid other researchers who seek to empower Hawaiian children through connection to ancestral knowledge.
Mokuna II: Review of Related Literature

This chapter presents a review of the literature organized within a critical ethnomathematics framework. The literature review will also include a discussion of curriculum development movements that have been designed to honor Hawaiian worldviews in teaching and learning.

For many, the idea that mathematics is so closely linked to culture may be incongruous. Like language however, mathematical constructions are inextricably linked to the way we view the world. “Mathematics is comprised of a diversity of practices that make it as historically, culturally, socially, and politically situated as any other human activity. It is grounded in human interactions with the environment and with one another.” (Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009, p. 1)

Mukhopadhyay et al. (2009) continue, “Throughout its short history as an area of practice and research, ethnomathematics has generated considerable controversy and resistance in at least three respects.” First, ethnomathematics, “questions the dominant Eurocentric narrative of the history of mathematics as a discipline.” Next, it “threatens the dominance of mathematics-as-the-academic-discipline” namely challenging the primary goal of mathematics to reproduce “academic mathematicians.” Lastly, “ethnomathematics has an explicitly political character, so it encounters resistance from those who want to cling to the myth of the neutrality of knowledge. (p. 71) Accepting these challenges, and the evolving nature of my understanding of ethnomathematics, I will use this framework to illuminate ethnomathematics in a Hawaiian context.
Challenging the Eurocentric Narrative

“The most obvious way to challenge the Eurocentric narrative is to offer a counternarrative” (Mukhopadhyay et al., 2009 p. 73). The Hawaiian counternarrative must include a discussion of the devastating role that colonization has played in education, and how subsequent curricular movements imposed by colonial education systems have supplanted Hawaiian mathematical knowledge systems through hegemony and erasure.

As a people, Hawaiians were nearly cut off from their traditional ways of living and knowing. In the mid- to late 1800s, for example, new Western-inspired laws had the singular effect of carving nearly all of the people away from the land. Fee simple title enabling private ownership was established, with relatively few receiving less than one percent of all Hawaii lands. (MacKenzie, 1991, p. 8)

As the rights of the native people in the land diminished, the rights of Westerners simultaneously increased. An 1846 act authorized sales of Government Lands and within four years over 27,000 acres of land had been sold, establishing a precedent for alienating Hawaiian lands. (p. 9)

The ensuing introduction of plantation economies wrested nearly 700,000 acres from the public domain by purchase and long-term lease. Annexation in 1898 resulted in alienation of 1.8 million acres, nearly one-half the Kingdom of Hawai‘i (MacKenzie, 1991). Benham and Heck (1998) continue with the following account of colonial devastation on Hawaiians.

For Native Hawaiians, who were involuntarily colonized beginning with increasing Western contact in the late 1700s and later conquered and annexed by
the United States in 1893, the result of prolonged contact with foreign values and government has been perhaps most devastating. Western domination has largely stripped us of our language, customs, social position, self-governance, and cultural identity. (p. 3)

During the period immediately prior to and following the illegal coup, speaking Hawaiian and engaging in the proud tradition of orature, through which traditional knowledge was transmitted, became increasingly disfavored by the American colonizer, until measures were taken to suppress the language altogether. The following excerpt taken from Kekuanaoa, president of the Board of Education from 1860 through 1868, cautions against subordination of Hawaiian language within the school system.

The theory of substituting the English language for the Hawaiian, in order to educate our people, is as dangerous to Hawaiian nationality, as it is useless in promoting the general education of people. If we wish to preserve the Kingdom of Hawaii for Hawaiians, and to educate our people, we must insist that the Hawaiian language shall be the language of all of our National Schools, and that English shall be taught whenever practicable, but only as an important branch of Hawaiian education. (Kekuanaoa as cited in Goodyear-Kaʻōpua, 2013, p. 13)

The substitution of English language for Hawaiian language eventually led to other kinds of educational substitutions. While represented as neutral, western, Eurocentric mathematics also downplays the contributions that other cultures have made to this collective knowledge. Bishop (1990) posits the following regarding the typical mathematics curriculum in schools.
One of the greatest ironies in the whole field is that several different cultures and societies have contributed to the development of what is called western mathematics: the Egyptians, the Chinese, the Indians, the Arabs, the Greeks, as well as the western Europeans. Yet, when western cultural imperialism imposed its version of mathematics on the colonised societies, it was scarcely recognisable as anything to which these societies might have contributed. (p. 61)

Bishop continues with an even stronger accusation regarding the origins of “western mathematics” calling it part of a “deliberate strategy of acculturation” (p. 55).

Intentional in its efforts to instruct in ‘The best of the West’, and convinced of its superiority to any indigenous mathematical systems and culture... The need was felt to educate the indigenous people only in order to enable them to function adequately in the European-dominated trade, commercial and administrative structures which had been established. (p. 55)

Through the colonization of these structures, foreigners were able to create an inroad for themselves into our mathematical systems. As Ngugi (1986) expresses, “The real aim of colonialism is to control the people’s wealth: what they produced, how they produced it and how it was distributed; to control, in other words, the entire realm of the language of real life” (p. 16). This controlling of wealth and natural resources is described here by Kamakau (1868), printed in Ka Nupepa Kuokoa, describing the insurmountable debt undertaken by the aliʻi engaging in the westernized economy in Hawaiʻi through the sandalwood trade.

O ke Dala e hookaa ai o keia aienui, o ka laau Ala. Nolaila, pii nui aku la na ʻlii a me na kaukaualii a me na pua alii a me na aialo a pau o ka Moi a me na ʻLii a me
The passage describes the ali‘i, the kaukau ali‘i, the pua ali‘i, and the aialo, along with the makaainana all being reassigned to gather this laau ala. Kamakau describes the devastation and many lives lost to starvation in this capitalist undertaking, which was in direct opposition to traditional subsistence practices. Pukui continues:

Long before the Western world began to speak of conservation, the Hawaiian child was taught the precept; if you uproot a plant or cut down a tree, plant a new one to replace it. The indiscriminate cutting of sandalwood in the 1820s must have shocked and bewildered many Hawaiians. Not only were forests destroyed, but because the men stopped farming in order to chop down trees, famine also resulted. (Pukui, Haertig, & Lee, 1979, p. 51)

Ngugi continues with the following “Economic and political control can never be complete or effective without mental control. To control a people’s culture is to control their tools of self-definition in relationship to others” (p.16). In Hawai‘i’s case, the creation of a new mathematical language specific to trade was precipitated by the increasingly foreign presence in Hawai‘i’s economy, which began to extend to other parts of society. One example of this was a new approach to measurement. Traditionally
measurements were based on the body. Anana, a non-standard measurement, was used to describe the distance between the tips of the longest fingers of a man, and were equated with one meter. The newer expression mika, transliteration of meter, was created in order to standardize this unit using the metric system. A second example in this insidious shift is in a complete recalibration of days. Traditionally, the pō mahina would determine what “day” it was. Each of these thirty mahina had a name and purpose, which were further divided into three anahulu, or ten-day divisions. Schools now use a more “Western” familiar approach. Pōʻakahi, Pōʻalua, Pōʻakolu, Pōʻahā, Pōʻalima, Pōʻaono, and Lāpule. This revamping of both measurement and concepts of time meant a complete paradigm shift in epistemological relationships that Hawaiians had to their world. As the foregoing illustrates, mathematics is neither neutral nor universal, and its place needs to be reexamined in the classroom, especially in Hawaiian educational settings that purport to teach through a Hawaiian worldview.

Mukhopadhyay et al. (2009) posit, “Mathematics has too often been implicated in exploitation of people for profit, and generally for dehumanized and mechanistic forms of control. Thus the myth and comfort of the assumption of neutrality of mathematics as a human activity is not sustainable. (p. 67)

Challenging What Counts As Knowledge

It is important to examine the critical and complex role that the structuring of explicit and implicit lessons through curriculum plays in the classroom. “Many people still equate a curriculum with a syllabus and thus limit their planning to a consideration of the content or the body of knowledge they wish to transmit or a list of subjects to be
taught” (Kelly, 2010). On the subject of educational curriculum, through its poisonous “common culture” pedagogy, Macedo (1994) maintains,

Institutions, particularly schools, reproduce the dominant ideology through a web of lies that distort and transfigure reality. Central to this cultural reproductive mechanism is the overcelebration of myths that inculcate us with beliefs about the supremacy of Western heritage at the same time as the dominant ideology creates other instruments that degrade and devalue other cultural narratives along the lines of race, ethnicity, language, and gender. (p. 37)

In mathematics, the Common Core State Standards (CCSS) have been used to create universal standards. “We teach to help students cultivate their talents, their character, and their aspirations” (“Hawaii content & performance standards,” n.d.). Following on this path, Hawai‘i, as one of the 45 states that have adopted the CCSS as a curricular approach, has embraced a philosophy that these state standards will impact student ability to perform better on mandated state assessments.

While the goals to the CCSS may not be problematic in and of themselves, “The overt and covert knowledge found within school settings, and the principles of selection, organization, and evaluation of this knowledge, are value-governed selections from a much larger universe of possible knowledge and selection principles. (Apple & King, 1977, p. 343) The CCSS continue with the following goals for all math students.

∞ We want our students to develop essential habits of mind, a curiosity, and the confidence which will prepare them to be successful as they progress to learn about more sophisticated mathematical ideas.
∞ We want our students to not just learn how to come up with answers through the manipulation of numbers and symbols; more importantly, we want our students to believe that mathematics makes sense.

∞ We want to nurture in our students the belief that mathematics is a valuable tool that can be used to make sense of the world and to make informed decisions in their lives.

∞ We want to motivate our students and help them to realize that they can be successful in mathematics and to choose to pursue further studies of mathematics.

(“Hawaii content & performance standards,” n.d.)

Giroux, (1991) cautions with the following, “If you believe that schooling is about somebody’s story, somebody’s history, somebody’s set of memories, a particular set of experiences, then it is clear that just one logic will not suffice” (p. 14). Gutstein & Peterson (2005) also add the following in their critique of current classroom trends in the mathematics classroom, “No math teaching--no teaching of any kind, for that matter--is actually neutral’ although some teachers may be unaware of this” (p. 6).

While many teachers and other educational stakeholders applaud the CCSS, as a streamlined mathematics curriculum, others have been critical of this universal standards movement, that does not take into account the unique and diverse needs of communities, with subsequent and often punitive testing measures (Rich, 2013). Another critique of the CCSS has been that they are currently only available for language arts and math. This curricular narrowing occurs to the detriment of other content areas with the justification given that “they are the areas upon which students build skill sets which are
used in other subjects. They are also the subjects most frequently assessed for accountability purposes.” (Common Core State Standards Initiative | Home,” n.d.)

While the CCSS aim to simplify through “common” state standards, national initiatives fail to recognize the right for Indigenous peoples’ education to be self-determining. Reform policies that aim to leave “No Child Left Behind” actually perpetuate public education as the “primary vehicle used to assimilate those who were perceived as different” (Benham & Heck, 1998, p. 9).

Mainstream public education has failed to meet the needs of Hawaiian and other diverse groups. The contributions and experiences of these groups are noticeably absent from the curriculum. Eisner (1985) refers to this as the “null curriculum.” This kind of curriculum includes “The options students are not afforded, the perspectives they may never know about, much less be able to use, the concepts and skills that are not part of their intellectual repertoire. (Eisner as cited in Flinders, Noddings, & Thornton, 1986, p. 34) Null curriculum may also occur within sub-fields of a discipline so while students may learn mathematics, they may never learn the sub-field of ethnomathematics.

Kaomea (2011) supports this idea of the Hawaiian mathematical null curriculum with the following:

Many early civilizations, including Native Hawaiians, achieved a high level of mathematical sophistication that allowed them to classify, order, count, measure, and otherwise mathematize their environment. However, the mathematical achievements and contributions of non-European cultures are largely overlooked in U.S. classrooms today. (p. 295)
Unfortunately, although the ethnomathematics movement aims at acknowledging contributions made to mathematics by diverse culture groups, it remains a relatively obscure but progressive approach to mathematics education. It is similar to other ethno movements, which include but are not limited to ethnobotany, ethnomusicology, and ethnogeography. Ethnomathematics reframes the way that we are able to view our mathematical world, and places us at the center of this world.

Translation.

A belief in necessity for translated math texts is demonstrated by the fact that in efforts to support the Kula Kaiapuni, (Ka Papahana Kaiapuni) the Hawai‘i Department of Education sought in 1990 for the first formal copyright permission from textbook publisher Addison-Wesley to translate the first comprehensive mathematics into the Hawaiian language.

Mathematics programs used in HLIP schools vary because of the availability of translated programs, teacher training, and the mathematics curriculum of the larger school. Mathematics programs, such as, Houghton/Mifflin (1995), the Addison-Wesley mathematics series (1990), Box-It and Bag-It, and Opening Eyes to Math (elementary) were selected for translation because they were recommended programs. The Investigations Mathematics Program* is the current recommended program. The Addison-Wesley mathematics series and Houghton/Mifflin mathematics program materials which were translated when the program first began are still being used as supplemental material for practice and drills. (Office of Curriculum, Instruction and Student Support, 2004)
Hawaiian translation can be problematic in its own right Kuwada (2013) explains, “Problems for contemporary translation have also grown out of the catastrophic decline in the number of Hawaiian language speakers and the devaluation of Hawaiian culture that went hand-in-hand with it. The small speaking population, together with the numerous cultural and academic demands placed upon that population, yields an extremely small pool of translators” (p. 57). While Kuwada mainly discusses translation of Hawaiian into English, NeSmith (2005) joins the argument by highlighting that even this “small pool” may not include native speakers of Hawaiian.

Native speakers play little or no part in the second-language acquisition of learners. The principal domains for learning Hawaiian today are the primary, secondary, and university classrooms, where over 99 percent of teachers are second language-speakers who are products of the schools themselves. (p. 3)

It should be not be surprising that second language acquisition learners (NEO), taking primary political charge for the Hawaiian language revitalization movement would seek out curricular materials comparable to resources being used for English language learners in mainstream educational schools, and subsequently did not acknowledge a Hawaiian tradition of mathematics. These mathematics texts, that were a direct translation from “Western” based textbook publisher, would have had little to no Hawaiian context within their original English curriculum, and therefore heightened potential for confusion when translated.

These texts’ translations, in addition to other curricular movements in Kula Kaiapuni, were the impetus of the Kōmike Huaʻōlelo Hou, “A committee that was formed to facilitate the modernization of the Hawaiian lexicon” (Wong, 1999, p. 105).
Many of these words were created specifically to cope with the rapidly changing vocabulary needed in mathematics and science. Māmaka Kaiao: A Modern Hawaiian Vocabulary (2003) introduces the text with the following:

Living languages throughout the world are in a state of constant change and growth, and so it is with the Hawaiian language. Therefore, in order to provide assistance to all Hawaiian-language speakers in this new era, Māmaka Kaiao is once again being printed to serve as a companion to the Hawaiian Dictionary by Pukui and Elbert. (p. xvii)

Papa Huaʻōlelo Makemakika was published in 1994 by Hawaiian language expert Larry Kimura and served as a precursor to Māmaka Kaiao. This text was created specifically for mathematics terms, and served as a guide for the KPK. “No laila, mau no ka paipai a nei Komike i ko oukou makaala ana i ke ola o ka kakou olelo ma na manawa e pupu ai ka olelo i ka loaa ole o kekahi huaolelo Hawaii kupono.” (Māmaka Kaiao, 2003, p. vii)

Tam (2012) suggested however, that instead of seeking newer English texts for contemporary translation, we should first examine the math texts printed in Hawaiian during the 1800s, a time when Hawaiian was still the language of education for Hawaiians and non-Hawaiians alike. His research uncovers many mathematical terms that were used in Lahainaluna texts that vary greatly from the newer terms in Māmaka Kaiao.
Challenging the Disconnection Between Mathematics Education and Social and Political Change

As a Hawaiian collective, we have fought hard for rights associated with educational autonomy. Hawaiian-focused charter, and Hawaiian language immersion schools, grounded in Hawaiian language and culture give us real examples of “cultural kīpuka,” (Goodyear-Kaʻōpua, 2013) the potential of what education can look like for all Hawaiian children.

I attend to the tensions between asserting Indigenous educational self-determination and working within a settler state school system by invoking the metaphors of safety zones and cultural kīpuka (stands of continued Indigenous cultural growth). For kīpuka to be able to regenerate life they must grow. Trees and ferns find and expand cracks in the hard, dry lava, thus expanding and changing the conditions of possibility. If the function of a safety zone is to contain, marginalize, stagnate and strangle, the function of the kīpuka is to transform conditions of death and destruction and to renew the potential for life. How do educators work to protect and proliferate kīpuka without being constrained as mere safety zones?” (p. 8)

As educators, parents and children, we need to assert every public educational institution in Hawai‘i should serve as a cultural kīpuka rather than “political spectacles” (Apple, 2007, p. 110). School reform policies exacted on our behalf should be responsive to the needs of our communities, rather than dominant groups’ agendas. To do this we need to ensure that every child educated in Hawai‘i DOE receives an education that honors their unique cultural traditions and ways of knowing. Like other Indigenous
peoples, Hawaiians have the right educate our children as we see fit. Article 31, of The
United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) asserts the
following:

Indigenous peoples have the right to maintain, control, protect and develop their
cultural heritage, traditional knowledge and traditional cultural expressions, as
well as the manifestations of their sciences, technologies and cultures... They also
have the right to maintain, control, protect and develop their intellectual property
over such cultural heritage, traditional knowledge, and traditional cultural
expressions. (“United Nations Declaration on the Rights of Indigenous Peoples,”
2008)

This development of intellectual property must include the right to (self)
determine educational standards appropriate for our children. Sadly, colonization may
continue to frame the way we look at ourselves, and ultimately the lens with which we
view our world. Smith (1999) says the following:

One of the supposed characteristics of primitive peoples was that we could not
use our minds or intellects. We could not invent things, we could not create
institutions or history, we could not imagine, we could not produce anything of
value, we did not know how to use land and other resources from the natural
world, we did not practice the ‘arts’ of civilization. (L. T. Smith, 1999, p. 25)

Reassertion of Hawaiian ways of conceptualizing time and space, as well as other
inherently mathematical ideas in the broader context of decolonization and transformative
action is social justice in action. Freire posits that utilizing mathematics for social justice
should train students to “challenge the injustices of the status quo as they learn to rewrite their world. (Freire as cited in Stinson & Wager, 2012, p. 6)

Teachers working within Hawaiian Educational Settings have the opportunity to use mathematics to rewrite educational histories through assertion of cultural mathematical legacies. Goodyear-Kaʻōpua (2013) notes the difficulty of working within educational systems that have long histories of colonial control where “just enough culture is allowable so long as it does not threaten or undermine settler-colonial relations of power” (p. 8). Gutstein (2009) however, issues this command,

The main focus is an analysis of the political dimension of the call for a cultural perspective on mathematics education. To restore dignity is unquestionably a matter of political action, but many critics claim that looking for political correctness in mathematics education is going too far. It is difficult to deny that mathematics, like general education, is an arm of political and ideological systems. What can one say if one proposes a pedagogical practice that aims at eliminating belligerence, arrogance, intolerance, discrimination, inequity, bigotry and hatred, and it is labeled as going to far? (Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009, p. vii)

To problematize what a comprehensive ethnomathematics curriculum could look like for students in Hawaiʻi’s classrooms is to first acknowledge that mathematics is multifaceted and should be taught in a way that honors the unique educational legacy of Hawaiʻi and its people. Liliʻuokalani reminds us with the following,

But will it also be thought strange that education and knowledge of the world have enabled us to perceive that as a race we have some special mental and
physical requirements not shared by the other races, which have come among us.

(Liliuoklani as cited in Denzin, Lincoln, & Smith, 2008, p. 218)

As Hawaiians, we have been indoctrinated in Western-style educational systems forging a path for Hawaiians divergent from the ones of our ancestors. We return however, to the validation of our traditional ways of knowing by teaching our moʻopuna the ways of their kūpuna by our return to our uncommon ways of knowing.

**Hawaiian Culture-Based Education**

Critical in this research project is an understanding of curricular approaches that will imbed and normalize Hawaiian ʻike and pedagogy into teaching for all students in Hawaiʻi. It is important to include these models and pedagogical approaches as a contrast to the dominant hegemonic, nationalized curricular reform. While I have chosen to use the Hawaiian Culture-Based Education model for my research project, I would also like to highlight Nā Ala ʻIke, and Papakū Makawalu as complementary curricular approaches that provide strong foundations for the conceptualization of Hawaiian learning and teaching and as such, should also be utilized by teachers working in Hawaii’s educational arena.

Kanaʻiaupuni and Kawaiʻaeʻa (2008) studied the impact of culture-based education (HCBE) strategies in the Hawaiʻi Department of Education (HIDOE) as well as in Native Hawaiian charter schools. “Culture-based education is consistent with more in-depth treatments referring to the grounding of instruction and student learning in the values, norms, knowledge, beliefs, practices, experiences, places and language that are the foundation of culture” (p. 71). Their overall research objective was to “understand
and describe culturally relevant education and its impact on students to inform the
development and advancement of meaningful educational strategies” (p. 70).

This research suggests that the inclusion of culture into instruction across content
areas has a positive impact on students. “The desire to improve educational delivery and
outcomes has prompted significant advancements in culture-based education as a
foundation for community driven, place-based, relevant educational approaches that more
effectively engage children and their families in lifelong learning and leadership” (p. 67).

The following are key components of culture-based education adapted from the
Hawaiian Culture-Based Education Framework of Kana‘iaupuni and Kawai‘ae’a (2008)

∞ **Language** - Use of Hawaiian language

∞ **Family and Community** – Actively involving family and community in the
development of curricula, everyday learning and leadership.

∞ **Content** - Based on traditional culture that recognized the importance of Hawaiian
spirituality

∞ **Context** - Structuring school, classroom, and other learning interactions in
culturally appropriate ways.

∞ **Assessment and Accountability** - Gathering and maintaining data using various
methods to ensure student progress in culturally appropriate ways. (p. 75)

HCBE like ethnomathematics has a broad understanding and usefulness in
engaging learners from diverse cultural backgrounds.

**Nā Ala ‘Ike**

Nā Ala ‘Ike have been designed collaboratively to promote culturally healthy and
responsive learning environments. These cultural pathways require a paradigm shift in
our current thinking of educational reform and assessment. This approach combines traditionally Hawaiian ‘ike with a further approach for incorporating new knowledge into our worldview and a framework for the kinds of knowledges and relationships that should be valued in a culturally responsive way. (Kawai‘ae’a, n.d., p. 3)

“Nā Ala ‘Ike is a framework for developing a comprehensive support system which promotes community and student-centered learning environments. They support experiences that foster and shape the development of learners to become responsible, capable, caring, healthy human beings in spiritual, intellectual, emotional, physical, and social ways. As a result, students will be able to better reach their full potential with a strong cultural identity and sense of place.”

∞ ‘Ike Pilina (Relationship Pathway) – Nurturing respectful and responsible relationships that connect us to akua, ‘āina, and each other through the sharing of history, genealogy, language and culture. (p. 13)

∞ ‘Ike ‘Ōlelo (Language Pathway) – Using Hawaiian language to ground personal connections to Hawaiian culture, history, values, and spirituality, and to perpetuate indigenous ways of knowing and sharing. (p. 13)

∞ ‘Ike Mauli Lāhui (Cultural Identity Pathway) – Perpetuating Native cultural identity through practices that strengthen knowledge of language, culture and genealogical connections to akua, ‘āina and kanaka. (p. 13)

∞ ‘Ike Ola Pono (Wellness Pathway) – Caring for the wellbeing of the spirit, na‘au, and body through culturally respectful ways that strengthen one’s mauli and build upon responsibility for healthier lifestyles. (p. 14)
‘Ike Piko’u (Personal Connection Pathway) – Promoting personal growth, development, and self-worth to support a greater sense of belonging, compassion, and service toward one’s self, family and community. (p. 14)

‘Ike Na‘auao (Intellectual Pathway) – Fostering lifelong learning, curiosity, and inquiry, to nurture the innate desire to share knowledge and wisdom with others. (p. 14)

‘Ike Ho‘okō (Applied Achievement Pathway) – Helping generations attain academic, social, and cultural excellence through a supportive environment of high expectations. (p. 15)

‘Ike Honua (Sense of Place Pathway) – Demonstrating a strong sense of place, including a commitment to preserve the delicate balance of life and protect it for generations to come. (p. 15)

‘Ike Kuana‘ike (Worldview Pathway) – Providing a solid grounding in Hawaiian worldview that promotes contributions to local and global communities. (p. 15)

Reframing the way we assess students gives teachers an opportunity to attend to the unique intelligences of each learner. It also ensures that the knowledge we teach in our classrooms are representative of the ‘ike we wish to impart on our children.

Papakū Makawalu

The challenge of creating a mathematics curriculum that is culturally responsive may be that we are not yet able to conceive of a knowledge system that is completely shorn of current hegemonic curricular initiatives. (Kawai‘ae‘a, n.d.) proposed that “defamiliarizing inquiry” be used to “look beyond dominant narratives and give voice to the previously marginalized or voiceless” (p. 15). She continues:
I propose that educational researchers who are committed to exposing oppression and recovering the histories and perspectives of marginalized people may benefit from new interpretive tools that enable researchers to seek meaning behind or beyond familiar surface impressions or communications. (p. 16)

“Western” or “academic” mathematics is rife with the contradictions of its troubled history. As Hawaiians we cannot accept dominant mathematical narratives as indicative of our cultural understandings and ways of knowing. While seeking to engage with this knowledge that is inherent to our culture, it has been systematically defamiliarized through colonization. This is why it is critical to engage in a system that reengineers our perceptions of knowledge and what really is essential for Hawaiian children to learn. Papakū Makawalu, as a research methodology, forces us to relocate the locus of knowledge construction to reexamine our Hawaiian worldview and compartmentalization of knowledge.

Papakū Makawalu is the ability of our kūpuna to categorize and organize their natural world and all systems of existence within their universe. Papakū Makawalu is the foundation to understanding, knowing, acknowledging, becoming involved with, but most importantly, becoming the experts of their systems of this natural world. (Kanahele Kanakaʻole, n.d.)

∞ Papahulilani - The space from above the head to where the stars sit. It is inclusive of the sun, moon, stars, planets, winds, clouds, and the measurement of the vertical and horizontal spaces of the atmosphere. It is also a class of experts who are spiritually, physically, and intellectually attuned to the space above and its relationship to the earth.
∞ *Papahulihonua* - Inclusive of earth and ocean. It is the ongoing study of the natural earth and ocean and its development, transformation and evolution by natural causes. It is also a class of experts who are spiritually, physically, and intellectually attuned to this earth and its relationship to the space above and the life forms on it.

∞ *Papahānaumoku* - Moves from the embryonic state of all life forces to death. It is the birthing cycle of all flora and fauna inclusive of man. It is the process of investigating, questioning, analyzing and reflecting upon all things that give birth, regenerate and procreate. It is also a class of experts who are spiritually, physically and intellectually attuned to things born and the habitat that provides their nourishment, shelter, and growth.

The Papakū Makawalu are significant as an approach to curriculum development in the following ways. First, they honor a genealogical relationship to knowledge and creation identifying that as Hawaiians we are connected through ancestry to a deep and profound understanding of our natural world. Second, rooted in natural systems of development, transformation and evolution, the Papakū Makawalu acknowledge us as a part of its history. Lastly the Papakū Makawalu do not limit the parameters of knowledge production to secular experience, but also seek spiritual connections often absent from learning experiences today.
Mokuna III: Methods

This chapter presents an overview of the research paradigm followed by the conceptual framework, description of participants and sites, data collection and analysis.

**Transformative Indigenous Research Paradigm**

Articulating a single research paradigm used for this research project was a difficult task. I contend that while this research oscillated between the transformative and Indigenous paradigms that it also embraces larger families of multiple research realities simultaneously.

Indigenous methodologies are often a mix of existing methodological approaches and indigenous practices. The mix reflects the training of indigenous researchers which continues to be within the academy, and the parameters and common sense understanding of research which govern how indigenous communities and researchers define their activities. (L. T. Smith, 1999, p. 143)

Mertens (2007) describes research in the transformative paradigm with the following “the role of the researcher in this context is reframed as the one who recognizes inequalities and injustices in society and strives to challenge the status quo” (p. 212). It reconstructs a body of knowledge that carries hope and promotes social change among the historically oppressed. “The purpose of research is to destroy myths, illusions and false knowledge and therefore empower people to act to transform society” (Chilisa, 2012, p. 36).

The methodology of the transformative paradigm relies heavily on participatory research. The use of individual interviews, focus groups and journal reflections, allowed research participants to create multiple meanings of HCBE and have a role in the larger
goals of this research process. All participants had opportunity to view their personal contributions for the larger research project. This ensured that the participants, as stakeholders felt comfortable with the way they were being represented by the data.

From an epistemological standpoint “knowledge is true if it can be turned into practice that empowers and transforms the lives of the people” (Chilisa, 2012, p. 36). This research project, which sought to analyze and glean perspectives and practice for a Hawaiian ethnomathematical curricula for use in the “classroom” positively impacting the learning of Hawaiian and other diverse students, has the potential to drastically transform the face of mathematics teaching and learning. “The relationship between the researcher and the researched is not based on a power hierarchy...but involves a transformation and emancipation of both the participant and the researcher” (p. 36).

The ontology in the transformative paradigm embraces the perspective that “reality is constructed based on social location and that different versions of reality are privileged over others. Reality has multiple layers, the surface reality and the deep structures that are unobservable” (p. 36). One “pathway” to these layered realities is through critical interrogation of Hawaiian language texts, which explicates deliberate strategies of acculturation, that impact mathematics instruction today. Examining multiple quantifiable worldviews within mathematics education, allows the creation for multiple ways of being within a Hawaiian context, linking our knowledge experiences with those of our ancestors.

**Conceptual Framework**

The conceptual approach to this research project is to bring together Hawaiian culture-based education (HCBE) and moʻolelo (story-telling) through a Hawaiian,
feminist perspective, to critically examine the impact of HCBE in the mathematics classroom. It is my assertion that a blending of these theories is necessary to articulate the unique nature of the research. It is my hope that placing HCBE and moʻolelo in the forefront of my frameworks will enable me to conceptualize research findings in a way that draws upon and honors a Hawaiian world-view while most importantly providing students with educational tools that will ensure successful navigation of today’s increasingly complex world.

Berry (2006) calls this method of joining together research methods a bricolage, a blending together of different methods and tools appropriate for the task at hand. “Bricoleurs keep in mind major principles of relationality, multiplicity, complexity and, most importantly, criticality for social action and justice.”

In articulating the role of HCBE in the mathematics classroom it is my hope, as the researcher, to weave together my stories with those of my participants. This style of “collaborative” interviewing calls for researchers to “acknowledge their personal, political, and professional interests. Instead of insisting on rigid separation of researcher and respondent, they have construed the interview as an active relationship occurring in a context permeated by issues of power, emotionality, and interpersonal process” (Ellis & Berger, 2001).

Moʻolelo.

In utilizing storytelling as a research method, it was important to understand the role that these moʻolelo have played for Indigenous peoples. Archibald (2008) explains,

Each Aboriginal nation has particular traditions, protocols and rules concerning stories and the way that stories are to be told for teaching and learning purposes.
The types of stories can vary from the sacred to the historical, from the cultural traditions to personal life experiences and testimonials. (p. 83)

The stories of these teachers as a part of the larger educational moʻolelo of our people plays an important role in determining our future educational trajectory. L. T. Smith (1999) asserts,

Story telling, oral histories, the perspectives of elders and of women have become an integral part of all indigenous research. Each individual story is powerful. But the point about the stories is not that they simply tell a story, or tell a story simply. These new stories contribute to a collective story in which every indigenous person has a place. (p. 144)

Being a faculty member within the College of Education also provides another vantage point from which I critically examine my role within the academy. I must work for the betterment of the collective rather than the individual. I do this with the following encouragement from G. H. Smith (2004):

Where indigenous peoples are in educational crises, indigenous educators must be trained to be change agents whose primary task is the transformation of undesirable circumstances. They must develop radical pedagogy that is informed by their cultural preferences and by their own critical circumstances. They must be taught about the importance of reflecting on and questioning their work. (p. 51)

Kaomea (2005) adds to this as she writes, “We seek to reclaim our indigenous stories and the indigenous practice of storytelling, as we begin to replace the stories of the colonizers with stories from our communities and struggle to once again find our indigenous voice” (p.79). “Oral stories are born of connections within the world and are
thus recounted relationally. They tie us with our past and provide a basis for continuity with future generations” (Kovach, 2010 p. 94). I reinforce the idea that for Indigenous scholars every isolated struggle for self-determination, language, culture, and identity contributes to the collective struggle for self-determination, language, culture, and identity.

Many native scholars have used stories and story telling as a method of articulating the Indigenous research agenda. Wilson (2009) says the following in his own efforts to reshape his role as an Indigenous researcher.

“The use of an Indigenous research paradigm when studying Indigenous people requires the holistic use and transmission of information. Consequently, I present the information in this study in a way that is more culturally appropriate for Indigenous people by taking the role of a storyteller rather than a researcher/author.” (p. 32)

Through our stories we locate ourselves at the liminal space between our kūpuna and moʻopuna and seek to honor both.

When taking on the role of a storyteller, Cashman, (2012) shares that his stories are purposeful and help his daughter to understand her kuleana as a Hawaiian.

I wander spiritually through writing, guided by our kūpuna and not the rules of another, through celebrations past and present...And the wandering helps the events of the past turn into stories for the future-stories that will naturally become a celebration of the spirit that moves us. The stories remind us, everything we do for our people, our ʻohana, and our ʻāina is spiritual and needs to be celebrated. (Cashman, K. 2010)
Cashman’s assertions and celebrations are important in that they connect us with the kūpuna, ka wā ma mua, and our moʻopuna, ka wā ma hope. Our existence in this time is important but also temporary so our stories remain when we can no longer be here in a physical form. “Oral stories are born of connections within the world and are thus recounted relationally. They tie us with our past and provide a basis for continuity with future generations” (Kovach, 2010, p. 94). The research we do isn’t for some obscure community in some exotic research paradise, for the benefit of society in general, but in our own families as a part of a larger lāhui Hawaiʻi.

An important consideration in using moʻolelo as a research method should be the deeper haʻawina of the story being told. For Indigenous scholars, that purpose is often political. Kaomea (2005, 2009) uses both haʻi moʻolelo and counter-story. “Counter-story telling as a research methodology is particularly appealing to me because Native Hawaiians, like Native Americans, Africans, Mexican Americans and other subordinated groups, have always told stories” (Kaomea, 2009 p. 82). As a Hawaiian scholar, I am here to give voice to those whose stories have been silenced.

Counter-stories are informed by critical theory, and other social struggles. Creswell, (2006) posits critical theorists are “Concerned with empowering human beings to transcend the constraints placed on them by race, class and gender” (p. 27). To build on this, Bogdan & Biklen (2002) suggest a researcher who employs critical theory “would rather benefit those who are marginalized in the society because they believe that the current way society is organized is unjust. Empower the powerless and transform existing social inequalities and injustices” (p. 21).
Building on critical theory, and similar to counter-storytelling, critical ethnographies are the research stories and projects that are undertaken to critique and engage in the struggle for social justice. “Critical ethnographers are mere culture bound mortals speaking from very particular, race, class, gender and sexual identity locations (Foley & Valenzuela, 2005, p. 218).

Critical ethnographers use moʻolelo kūʻē to address society’s dirty little secrets.

Critical ethnography begins with an ethical responsibility to address processes of unfairness or injustice within a particular lived domain. The critical ethnographer also takes us beneath surface appearances, disrupts the status quo, and unsettles both neutrality and taken-for-granted assumptions by bringing to light underlying and obscure operations of power and control. (Madison, 2005, p. 5)

In examining the intersection of Hawaiian moʻolelo and feminism, I acknowledge that my worldview as a Hawaiian female with children may be discernably different than that of my male counterparts. It is through my personal journey through education, raising children, and being a part of the evolving continuum that connections with other female scholars are made. bell hooks writes, “Feminists are made, not born. One does not become an advocate of feminist politics simply by having the privilege of being born female: Like all political positions one becomes a believer in feminist politics through choice and action” (hooks, 2000, p. 7). My own “feminist politics” is a narrative of evolving identity, told through personal stories. “Feminist scholars have worked hard to create spaces within the academy in which the emotional, irrational, and embodied world of the scholar can find resonance and recognition” (Twomey, 2012, p. 4).
Description of Participants and Sites

For this research project, I used purposeful sampling to select eight participants who are current mathematics teachers. The next criterion was that the participants teach at a Hawaiian Educational Setting (HES). Initially, I prospected for eligible project participants at Hawaiian language Immersion schools (Ka Papahana Kaiapuni), Hawaiian-focused charter (Nā Lei Naʻauao), and schools in predominantly Hawaiian communities K-12. I later included research sites at the tertiary level, each setting being publicly accessible and accountable to Common Core State Standards either through direct instruction (teaching their own students) or through teacher training. It is also important to recognize that while I was already acquainted with several of the research participants, other teachers and educators suggested potential participants as they discovered the intent of my research project.

I recognize that due to my “purposeful selection” (Creswell, 2009, p. 178), of my participants, results of this research project may not be representative of typical mathematics classrooms in Hawaiʻi. The small number of participants interviewed, the added component of HCBE, and the fact that the majority of the participants teach in schools on Oʻahu suggests this study may not be indicative of other curricular movements occurring on other islands within the state, especially within formal public educational institutions. Notwithstanding the foregoing, it is intended that this research design, a seed rooted in the first indigenous story, moʻolelo, engendering the wisdom of our ancestors, will build upon their unassailable foundations to the strength and enlightenment of all the generations to come.
Anonymity

In order to protect the anonymity for research participants and school sites, participants self selected a pseudonym to be used throughout the study. Furthermore each school setting was randomly assigned a color that would be used to identify the school when referred to by the participant. While I do not provide testing data particular to each school, I do mention here a global view of the NCLB Status of each school. One of the sites was in good standing, unconditional, one was in good standing pending, three were in restructuring, one was planning for restructuring, and the last was in its first year of corrective action. The remaining two sites were tertiary institutions not evaluated under NCLB.

Hawaiian Educational Settings

Prior to the institutionalization of education in Hawai‘i, the Hawaiian nation was known as one of the most literate nations in the world. Hawaiians proved themselves to be globally competitive in their ability to acquire and employ foreign concepts and knowledge, to their benefit, by being active participants in all aspects of their education…Hawaiian education existed long before the arrival of Western culture and continues to present itself in various forms and arenas. (Office of Curriculum, Instruction and Student Support, n.d.)

As soon as the native language was rendered into written form, Hawaiians enthusiastically took up reading and writing as a national endeavor. In two generations, nearly the entire Hawaiian population was literate in their own language, surpassing America, England, and most of the world for the percentage
of people able to read and write. For the remainder of the 1800s and beyond general literacy among Hawaiians was the norm. (Nogelmeier, 2010, xii)

In stark contrast to the aupuni palapala, a nation of fervent readers, literacy competency for Hawaiian children today has been an area of concern for many educators as evidenced through current summative assessments both in language arts and mathematics. For Hawaiian students taking the Hawai‘i State Assessment (HSA) just 62 percent were proficient in Reading and a mere 48 percent in mathematics. (OHA, 2012)

These statistics underscore the need for language arts and mathematics curriculum that engage students in a learning context that assures their educational success.

Financial stresses upon Hawaiian ‘ohana conflate issues of school performance. “Native Hawaiian children have the highest rates of poverty of all major ethnic groups in the state of Hawai‘i. The economic challenges Native Hawaiian families face appear to have significant effects on their children’s performance in school” (S. K. Kana‘iaupuni, Malone, & Ishibashi, 2005, p. 208).

While Culture-Based Education that employs a critical lens may be of particular interest to Hawaiian children and teachers in KPK, Hawaiian Community and Hawaiian Focused Charter Schools it is also necessary for a broader audience of students, teachers, and communities to engage in the rethinking of our mathematical engagement as a whole.

We definitely believe students of color should learn mathematics for social justice, given the profound impact of racism on their lives, which is exacerbated by the current economic crisis and a system that increasingly regards them and their communities as disposable. But in contrast to the notion that only they should learn critical mathematics, we believe that all students, including those from
schools and communities of privilege, need to study their reality and learn mathematics to understand and shape the world for the better. (Gutstein & Peterson, 2013, xxi)

**Ka papa’hana kaiapuni.**

Hawaiian language advocates established immersion schools because they knew that language, as a window to culture, is key to understanding self and that living language is key to a people’s understanding of who they are. For Hawaiians, that understanding invokes ways of living and knowing which are simple yet profound -- the reciprocal relationship and interdependence of all living things; awe and appreciation for the great inheritance, Hawaii; moʻokūʻauhau -- understanding their place among the unbroken line of ancestors and future generations with whom they form an inextricable link.

Hawaiian-medium schools are a frontrunner in the efforts to preserve Hawaiian language and provide culturally grounded education to Native Hawaiian children. Also known as Hawaiian immersion schools, they maintain that language is the basis of culture and that a strong cultural identity will in turn promote successful educational outcomes. (S. K. Kana‘iaupuni et al., 2005, p. 308)

Ka Papahana Kapiolani define their philosophy with the following,

KPK establishes a rich Hawaiian context for learning in each of its schools. Further, it assimilates Western K-12 content at schools whose curriculum, instruction and assessment methods are directed by Hawaiian language, culture, values, traditions and ways of knowing. In doing so KPK is a venue for extending the Hawaiian education into the future. (p. 2)
With over twenty years of experience, KPK has actualized new generations of Hawaiian language speakers that will continue revitalizing Hawaiian language revitalization for future generations of Hawai‘i’s children. Graduates of the KPK are now sending their own children to KPK, realizing multi-generations of learners that have been taught through the medium of Hawaiian language.

**Native Hawaiian charter schools.**

Frustrated by the challenges of conventional public school classrooms in meeting the needs of Native Hawaiian students, several Native Hawaiian communities seized opportunities for independence and autonomy offered by the charter school movement. Of the twenty-three start-up charter schools in the state of Hawai‘i, about half are Hawaiian focused. “We have to look at a system that is Hawaiian, to teach Hawaiian children in a Hawaiian way” (Kahakalau, n.d.).

Aligning with worldwide indigenous educational reform efforts, Nā Lei Na‘auao is using the national charter school movement as a vehicle to provide viable choices in education at the community level. Nā Lei Na‘auao supports the growth of models of education throughout the Hawaiian Islands, which are community-designed and controlled and reflect, respect and embrace Hawaiian cultural values, philosophies and ideologies. Nā Lei Na‘auao schools make up 45 percent of the state’s 27 start up charter schools, serving over 4,200, over 91 percent of whom are of Hawaiian ancestry. (“Kanu o ka aina learning ‘ohana)

These schools have been pivotal in experiential, ‘āina based learning sites that have reshaped educational destinies for Hawaiian children.
**Hawaiian Community Schools**

For the purposes of this research project I define Hawaiian Community Schools as schools that may be located in Hawaiian Homestead communities or schools that serve high populations of Hawaiian students. I acknowledge the strength of ʻohana who believe that our geographically accessible schools should be accountable to the community it serves. This is always a challenge but has become increasingly difficult with “failing school” labels that undermine school morale.

Public schools are under attack not because they are failing or are inefficient but because they are public, an unwanted reminder of a public sphere and set of institutions whose purpose is to serve the common good and promote democratic ends, values, and social relations. (Giroux, 2010, p. 349)

More than any other kind of social institution, public schools must provide productive and positive learning experiences for children. Noguera (2013) explains, “Education has become the real basis of the social safety net for poor children in America—public education that is. No other institution is charged with the mandate to care for their needs.” (Box, 2013)

While alternative educational institutions such as Hawaiian-focused charter and private schools have been viewed as the solution to Hawaiʻi’s public school woes. As a Hawaiʻi collective we need to ensure that the educational opportunities afforded to each student in our public, community schools reflects our collective commitment to the creation of these safety nets for all children.
Data Collection

The data for this study were collected through two distinct efforts. First, Hawaiian language archival data was utilized to analyze how early teachers translated mathematics texts in Hawaiian for classroom instruction. I will also use texts written by Hawaiians in the Hawaiian language to juxtapose the divergent path of Hawaiian and Western numeracy in the 1800s. Next, I will include qualitative data gathered from participant teachers through math identity reflection, semi-structured interviews, and a focus group with participating teachers. The ability to connect current curricular initiatives for Hawaiian and other diverse students to honoring the knowledge systems of their ancestors allows students to more fully engage and take ownership of their learning experiences, not only creating knowledge systems that change content parameters but also to provide contexts for living within those knowledge systems and identifying within them.

Archival data.

The accessibility of Hawaiian primary sources has been significantly increased through collaborative and technological advances, which have worked to digitize aging books, newspapers and other resources written in the Hawaiian language. Nogelmeier (2010) directs us as scholars to examine and critically reexamine the foundational body of Hawaiian research that has been done to inform us about us.

The impact of leaving most of the Hawaiian writings out of the mix of modern knowledge is that every form of history written, every cultural study undertaken, and every assumption made over most of the last century should be revisited in light of those neglected sources. Lacking the core insight of these sources affects
the entire system—how people today understand Hawai‘i, past and present; the
nature of Hawaiians are perceived here and abroad; and how Hawaiians view
themselves, those around them, and the rest of the world. Misconceptions that
have been generated and perpetuated without this foundation of reference vary
from benign to destructive. (Nogelmeier, 2010, p. xi)

New online resources such as Ulukau, a free online Hawaiian Electronic library
are readily available to those who seek to use and revitalized the Hawaiian language.
More than ever before it is now possible for interested learners to access Hawaiian
language materials that previously had limited availability, if at all. Utilizing Ulukau
engages and encourages other learners to “unpack the implicit and explicit messages
being conveyed” (Vasques, Harste, & Albers, 2010, p. 265) by these Hawaiian language
texts.

My personal search for a deeper understanding of mathematics through a
Hawaiian lens necessitated the utilization of texts written in or translated into the
Hawaiian language during a time when Hawaiian was still the language of
communication in Hawai‘i. While the resources are written both by Hawaiians and non-
Hawaiian, it is my contention that both groups facilitate increased understanding of
mathematics through a Hawaiian historical lens. Like the ethnomathematics conceptual
frame outlined in Mokuna II, I contend that these foundational texts will too challenge
the Eurocentric narrative, challenge what counts as knowledge, challenge the
disconnection between mathematics and social and political change.
Teacher interviews.

In expanding the role of moʻolelo, I was able to use an initial individual interview to create and or reestablish connections with each of my research participants. These interviews were conducted at a site of the participants’ choosing and generally lasted from 45 minutes to an hour. While I had a set list of questions for these semi-structured interviews in English (Appendix E) and Hawaiian (Appendix F), each of the interviews were managed in a way that both the participants and I, as the researcher, were able elaborate on questions that were posed during the interview. The conceptualization of the interview format drew on the wide overlay of Hawaiian Indigenous and feminist research methods. DeVault and Gross (2011) suggest that feminist interviews construct meaning in experiences both “personal” and “political”, interviewing participants that were extensions of “themselves.” “Drawing on the political traditions of testimony and consciousness-raising and the research traditions of life history and open-ended interviewing, feminists have brought forward a wealth of previously untold stories--those of marginalized peoples” (p. 173).

Math identity reflection.

It was important for me as the researcher to establish the stories of each of the research participants within the context of their own mathematical identities. “The identities we form and the connections we make with the discipline of mathematics ultimately affect our academic and career choices” (Edwards, 2010, p. 1). Typically, learners of mathematics are seldom indifferent to their own learning experience and are often polarized into lovers and haters, of the content area. I wanted to hear the stories of these mathematics teachers of demonstrated expertise in order to connect with emergent
salient themes that might promote mathematical efficacy in future students and math teachers.

**Focus group.**

After interviews and classroom observations were complete, I invited each teacher to participate in a focus group (Hatch, 2002, p. 132) facilitated by me and one kōkua. The central focus for this group was to discuss research themes that emerged from the math identity stories and interviews. It was my hope that this focus group would facilitate rich conversations with practical suggestions for each Hawaiian Educational Setting.

**Data Analysis**

As soon as the initial interview was completed for each participant I looked for emerging themes in the data. This included both the initial interview and the math identity piece. I transcribed each interview and kept a digital copy on my secured external hard-drive. I then coded my data into the following five categories of Hawaiian Culture-Based Education.

1. *Language*
2. *Family and Community*
3. *Content*
4. *Context*
5. *Assessment and Accountability*

Provisional coding allowed me to organize the collected data with flexibility to revise, modify, delete, or expand to create new categories (Saldaña, 2013, p. 144). Participants were unaware of the HCBE framework being utilized for data coding,
therefore I feel that their answers were reflective of their natural teaching philosophies outside of this rigid structure.

Upon completion of the focus group I then divided the data even further to reflect the critical indicators of the CBE framework within each component. The critical indicators allowed a further analysis into emergent data themes by grounding the framework into the responses of the teacher participants.
<table>
<thead>
<tr>
<th>Components</th>
<th>Language</th>
<th>Family &amp; Community</th>
<th>Content</th>
<th>Context</th>
<th>Accountability &amp; Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Indicators</td>
<td>(a) Integration of Hawaiian language in class</td>
<td>(a) Integration of ʻohana/community in curriculum</td>
<td>(a) Culture-based Curriculum</td>
<td>(a) Culturally grounded context</td>
<td>(a) Demonstrate knowledge/skills</td>
</tr>
<tr>
<td></td>
<td>(b) Hawaiian language materials and resources</td>
<td>(b) Communication between ʻohana and teachers</td>
<td>(b) Culture-based content</td>
<td>(b) Culturally relevant community of learners</td>
<td>(b) Application</td>
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<tr>
<td></td>
<td></td>
<td>(c) Relationship between ʻohana and teachers</td>
<td>(c) Experimental</td>
<td>(c) Community well-being, kuleana</td>
<td>(c) Value to community, culture</td>
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<td></td>
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<td>(d) Community-based</td>
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<td>(e) Place-based</td>
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</tbody>
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Table 1. HCBE Components and critical indicators. S. M. Kanaʻiaupuni & Kawaiʻaeʻa, 2008.
Validity as Kuleana

Central to validity of this research project is kuleana. Kuleana as an articulated, genealogical relationship of responsibility demands that each portion of the research project is done in a way that brings honor to Hawai‘i and its people. This is accomplished by utilizing Hawaiian language archival texts and teacher voices in addition to contemporary mathematics scholarly contributions to contribute to the future and ongoing ethnomathematics curriculum that imbues a Hawaiian worldview.

Member checking (Chilisa, 2012, p. 166) was utilized upon completion of the interview coding. Each participant was given a transcription of the individual quote excerpts that they had contributed during the research portion of the project. They then had the opportunity to review, clarify, and/or delete any quotes that would be used in the final dissertation; this ensured that each participant felt comfortable with the way their voice was being represented in the data.

Ethics

I underwent the formal Human Studies Program (HSP) approval process established by the university to rectify past breaches of research ethics by the academy. Following the approval of my exempt application (Appendix A), I sought Hawai‘i Department of Education (HIDOE) approval, as my study would have involved DOE employees in their educational settings. As noted earlier, the DOE did not approve my proposal (Appendix G) to conduct teacher and classroom observations.

Beyond the formal HSP process, as an Indigenous Hawaiian researcher, my ethical research considerations are culturally bound. “The word itself, ‘research’ is probably one of the dirtiest words in the indigenous worlds’ vocabulary” (L. T. Smith,
Therefore as a female, Hawaiian researcher, the kuleana of approaching this project in an appropriate way was of the very highest priority. As a researcher I seek to honor my research relationships. Wilson (2009) reminds us,

An Indigenous axiology is built upon the concept of relational accountability. Right or wrong; validity; statistically significant; worthy or unworthy: value judgments loose their meaning. What is more important and meaningful is fulfilling a role and obligations in the research relationship—that is being accountable to your relations. (p. 77)

*I ka ‘ōlelo nō ke ola. In language there is life.* This proverb has been used to demonstrate the strength of the Hawaiian language. I use it here to articulate both the relationship that I have to the ‘ōlelo Hawai‘i as well as to demonstrate the strength of our words as Hawaiians. In choosing a qualitative approach to research, I acknowledge the power of shared language as transformative through the interview process.

*‘Ike aku,*’ike mai, kōkua aku, kōkua mai; pēlā ihola ka nohona ʻohana. Recognize and be recognized, help and be helped; such is family life. Through Hāloa, Hawaiians have a familial connection as ʻohana.

*E huli i ka lima i lalo.* Turn your hands down to work. My kuleana as a researcher is to transform undesirable circumstances, not to collect personal accolades. The researcher should focus on the work and not personal gain.

*Hoʻokahi lā o ka malihini.* Only one day as a foreigner. As a researcher I embrace the research process as reciprocal. After one day, I have shared kuleana with each of my participants to meet their needs in the process.
In addition to these aforementioned ‘ōlelo no‘eau, kuleana to my research participants and to my Hawaiian community informs my research.

For indigenous and other marginalized communities, research ethics is at a very basic level about establishing, maintaining and nurturing reciprocal and respectful relationships, not just among people as individuals but also with people as collectives and as members of communities, and with humans who live in and with other entities in the environment. The abilities to enter into pre-existing relationships; to build, maintain and nurture relationships; and to strengthen connectivity are important research skills in the indigenous arena. (Dunbar Jr., 2008, p. 97)

**Language of Research**

Although my dissertation is written in English, I acknowledge the erudite nature of Hawaiian as a language of research. As such, I will be drawing upon Hawaiian language resources and conducting several of my interviews in the Hawaiian language with limited translation.

Standard academic writing may not be able to express these ideas in a way that is respectful of their intent. Part of the importance of developing an Indigenous research paradigm is that we can use methods and forms of expression that we judge to be valid for ourselves. We can get past having to justify ourselves as Indigenous to the dominant society and academia. (Wilson, 2009, p 14)

“Ordinary people must be able to read and understand my ethnography. How can academics possibly serve the people they write about if their subjects cannot understand what they write?” (Foley & Valenzuela, 2005, p. 224).
The trend toward language creativity in research has been employed by researchers seeking to reach outside of the academic research community. In Simpson Steele’s (2008) dissertation, the quotes of her research participants parallel her own discourse in that she created a space for them within her own text to support her own writing. In addition to her written dissertation she also performed her research findings in theatrical form.

Researchers have also been very honest about how the process begins to take a personal toll on their lives. Makaiau & Freese (2012) have used journaling as a part of their research on self-study and even included excerpts in their final product. Lather & Smithies (1997) in their book Troubling the Angels: Women Living with HIV/AIDS voice their research struggles through running subtext.

People make sense of their lives via story lines or narratives that are available at particular cultural moments. No life fits neatly into any one “plot” line and narratives are multiple, contradictory, changing and differently available, depending on the social forces that shape our lives. (p. 125)

**Instrumentation**

I informed participants of the purpose of the study in writing prior to each interview. Each participant received an “Agreement to Participate” (see Appendix B) sheet describing the purpose and design of the study along with a consent form (see Appendix C). I conducted the initial interview at a site of the participant’s choosing and audio recorded each interview, which was later transcribed.
Researcher Background and Bias

As a former teacher in the Kula Kaiapuni, I have a strong bias that Hawaiian education occurs through Hawaiian language and culture. Participants, however, may have varying conceptualization of what HCBE looks like. Second, although I am a part of the Hawaiian teaching community, I am not a mathematics instructor at the high school level and have limited mathematical competency at the advanced levels, which will undoubtedly affect the outcomes of these collaborations.

I am also working under the research assumption that the level of HCBE instruction will vary according to the kind of Hawaiian Education setting the research participant is teaching in their culture-based education research, found that Hawaiian-medium charter schools had the highest level of HCBE, followed by Kula Kaiapuni, Hawaiian Focus Charters, then Conventional DOE classrooms. Although I have not chosen to distinguish Hawaiian medium from KPK schools, I anticipated the challenge of one of my sites being both a Hawaiian medium and Hawaiian Focus Charter School.

Limitations of the Study

There were several limitations encountered in this study. First, there are a limited number of mathematics teachers in Hawaiian Educational settings and perhaps fewer who feel that they are able to integrate culture and mathematics in the same classroom. Second, the study is limited to eight participants so the findings may not be generalized to a larger population. Next, if the participant is teaching in a school that already has a Hawaiian educational focus, teachers may not feel the need to incorporate culture into the classroom. Lastly, there may be a concern about the provisional assignment of categories for the data analysis; i.e., as a researcher I may not be as open to responses that do not fit
neatly within these categories. However, data collected outside of these five categories will be separately compiled for those interested in doing research in HCBE.
Mokuna IV: ‘Okoʻa ka Helu Kahiko, ‘Okoʻa ka Helu Hou

In this chapter, I will analyze Hawaiian texts (texts written in the Hawaiian language) written in the 1800s through a critical ethnomathematical theoretical framework. These texts contribute to a deeper understanding of Hawaiian knowledge systems that are inherently mathematical contrasted with early texts written and or translated by missionaries, identifying early sources of discursive teaching practices and cultural hegemony that continues within contemporary mathematics curriculum. As will be illustrated by early missionary student textbook material, the Christian message, explicit or even subliminal and an inextricable part of text, is presented in a way that gives it prominence over actual mathematics content. Given that traditional Hawaiian knowledge includes customs and ways of knowing antithetical to Christian beliefs and practices, it is not surprising that these texts would not only be dismissive of Hawaiian knowledge, but in the same process supplant and suggest negative associations with respect to non-Christian knowledge and practices.

My use of Helu Kahiko to describe the dichotomy in these views is based on Kanepuu’s account (1867) of M. Kekuanaoa, president of the Board of Education from 1860 through 1868 admonishing a Hawaiian man for his failure to properly calculate the number of huli through the Hawaiian counting system with the following, “He aha ko oukou mea i haalele ai i ka helu kahiko o ko kakou aina, kainoa e hana no oukou ma ka helu hou, a e hana no ma ka helu kahiko? The terms Helu Kahiko, a Hawaiian worldview of quantification, and Helu Hou, the foreign, “Western” approach, are utilized. While this binary, Helu Kahiko, and Helu Hou, is still problematic in that it continues to
locate Hawaiian knowledge in relation to the colonizer, it utilized early understandings of
hegemonic inherent in Christian practice in within mathematics education.

As a second language learner of Hawaiian (NEO), I am keenly aware of my
Hawaiian language limitations. As such I have included figures of the Hawaiian texts
here so that any reader may co-construct possible complementary and/or alternative
understandings of all included passages for possible use in educational mathematics
instruction. This approach is similar to Kuwada’s theory on “embedded” translation
(2013b), where multiple translators are involved in creating meaning of a single text for
translation. “Embedded” curriculum and professional development proposes that students,
teachers, and parents as stakeholders of Hawaiian education should be invested in the co-
creation of curricular materials for classroom use. This approach is in direct opposition
with curricular movements that, as Kelly (2010) accuses, aim to, “teacher proof”
curriculum.

To bring about change from outside the school, is to view the teacher as a
technician rather than as a professional, as an operative rather than as a decision-
maker, as someone whose role is merely to implement the judgments of others
and not to act on his or her own. (p. 112)

As discussed in detail in Mokuna II, there exists many different understandings of
ethnomathematics. While I acknowledge that my own understanding is evolving, I draw
upon Mukhopadhyay et al.’s (2009) ethnomathematical “challenges” (p. 71) as well as
Vasques, Harste, and Albers’ (2010) strategies for “critical interrogation” (p. 266) of text
to properly analyze the archival Hawaiian literature presented within this chapter. These
questions adapted from Vasques’ et al.’s ethnomathematics framework are
What came to mind as meaning was made?

What does the text aim to do?

What meaning was made of the text?

What stances/perspectives were used to frame the readings of the text? (p. 271)

To reiterate, the goals of utilizing ethnomathematics in mathematics instruction are

- Challenging the Eurocentric narrative in mathematics;
- Challenging what counts as knowledge in school mathematics;
- Challenging the disconnections between mathematics education and social and political change. (Mukhopadhyay et al., 2009, p. 72)

It is counterproductive to dictate which item of literature addresses which element of the aforementioned ethnomathematics theoretical framework. Instead, I suggest that it is possible to engage in more than one challenge at a time. To challenge the Eurocentric narrative in mathematics is also to challenge what counts as knowledge in school mathematics. These challenges may occur simultaneously, and in any order.

Relevant in this discussion are Smith’s (G. H. Smith, 2004) “lessons in transformative praxis,” (p. 50) which include the elements of conscientization, resistance, and transformative actions as integral to counter-hegemonic education strategies. He rejects the notion that these concepts must be addressed linearly or individually. Smith continues, “All of the above components are important; all need to be held simultaneously; and all stand in equal relation to each other” (p. 51).

Gutstein (2005) discusses, “The broader issues of the opportunity to learn, access, and equity all demand that marginalized students get the chance to develop mathematical
I use this “reading” to explore Hawaiian texts that have been underutilized in mathematics teaching and learning. “Mathematical power” describes the potential for students and teachers to develop this critical agency through ‘ōlelo Hawai‘i. ‘Ike nō i ka lā o ka ‘ike; mana nō i ka lā o ka mana. ‘Ike no i ka lā o ka ‘ike; no i ka lā o ka mana. Know in the day of knowing; mana in the day of mana. Both the knowledge and the mana are contained within our language. Ngugi (1986) refers to this as the “magical, power of language” (p. 11).

As we enroll our children into transformative educational sites predicated upon authentic Hawaiian cultural and linguistic traditions we must be ever vigilant that each learning experience is reflective of this counter-hegemonic movement. For educators working within our own cultural kīpuka, safety zones of Hawaiian education, as well as the wider community of Hawaiians in community schools, this kuleana is great.
Deviant Discourse

Figure 1. Bird and boat poem.
Na Na Misionari i Pai. (1835). *He palapala mua na na kamalii: E naaauo ai i ko lakou wa opiopio.* (p. 9)

The first text (*Figure 1*) is an excerpt taken from an early educational primer. While the early pages of the book teach basic counting and letters, this, the first formal, longer passage in the book, deviates contextually from what precedes it. As this is not a research paper on subversive literature, the following are merely some cursory observations of Figure 1 to underscore early missionary attempts at relegating Hawaiian knowledge to the margins of irrelevance.

First, the manu does not look native in origin, the manu that our Hawaiian people were well familiar with. This manu looks like the American eagle, ʻaeto. Its posture is
warlike (used as a national symbol of American, it is usually clutching a quiver of arrows in its talons). Could this image, strangely prophetic, be foreshadowing the future prolonged illegal American colonial occupation of Hawaiian lands?

Next, the relative size of the two images, bird and ship, are disproportionate and do not make sense, unless it means to suggest the eagle as the symbol of America and the moku as its lesser appendage; (i.e., a colony or outlying territory).

Third, the ship is western-style, not Hawaiian in origin. In fact, both illustrations bird and ship, are foreign. The accompanying test dislocates the locus of learning for Hawaiians from their own experiences, and oral traditions and relocates them within external written texts.

Lele ka manu ma ka lewa
Holo ka moku ma ke kai
Pili ka make me ka hewa
Hele ke ola me ka maikai

Birds fly in the sky
Boats sail in the ocean
Death goes with immorality
Life goes with goodness

Boats, life and death send a strong message to impressionable children to abandon their sinful, pagan ways. Relevant here is Gee’s (1990) discussion of primary and secondary discourses.

Primary Discourses constitute our first social identity, and something of a base within which we acquire or resist later Discourses. Secondary Discourses are
those to which people are apprenticed as part of their socializations within various local, state, and national groups, and institutions outside early home and peer-group socializations. (p. 168)

As early missionaries had control of these educational institutions they were also able to proselytize what is maikai and therefore rewardable, and what is hewa and subsequently punishable.

The form of the poem is also alternating end rhyme, lewa and hewa, more conventional in Western literature. Hawaiian “poetry” while diverse often utilized sophisticated styles of repetition and linked assonance as a mnemonic devices that facilitated the memorization of lengthy passages including genealogies.

For Hawaiian children, formal education becomes the forum for “civilization.” This subversive, value-laden message couched in seemingly innocuous stanza is dangerous and treats Hawaiian children as deviant. Gee continues. “In becoming a full member of school Discourses…children run the risk of becoming complicit with values that denigrate and damage their home based Discourse and identity” (p. 4). The text’s explicit message is that their primary, customary discourses would eventually equal death. If you do bad, you will be punished and/or die.

Critical literacy supposes that while engaging in text from a critical perspective, we become “agents of the text rather than victims of text” (Vasques et al., 2010, p. 66). Freire describes this as “naming the word and the world” (M. W. Apple, 2013, p. 27). My own complicity came upon reflection math homework assignment had come home with my son, challenging our ‘ohana worldviews (Figure 2).
Even within the seemingly safe zone of his Kula Kaiapuni, he was receiving the message that basic enumeration was foreign, and that like the birds and boats presented earlier, we do not have our own animals to count. This ideology necessitates translation of “Western” texts as sole resources of mathematics curriculum development. Swetz (2009) describes counting with the following, “Counting involves the establishment of a one-to-one correspondence between a set of objects and a sequential set of words or symbols.
designating numbers” (p. 13). Shall impressionable, second language learners of Hawaiian be taught that squirrels (kiulela), beavers (ʻilio hulu pāpale), and chipmunks (no translation) are ideal for the establishment of one-to-one correspondence within a Hawaiian context?

Maaka, Au, Lefcourt, and Bogac (2001) retell the experience of a child in a Hawaiʻi DOE classroom during math instruction. While struggling to understand what a raccoon was, he became overly frustrated perceiving that because he not know what a raccoon was, by extension he did not know how to subtract them. They explain:

For many children of diverse cultural and linguistic backgrounds, school learning consists of a series of “raccoon-like” experiences. The disparities between teachers’ assumptions about what children know and what children actually know is one aspect of the mismatch between the culture of the school and culture of the home. (pp. 342, 343)

With prompting this child may have been encouraged to distinguish between subtraction, a skill that he utilizes daily and the raccoon, an animal that he had never seen much less experienced. It is concerning that the curriculum “mismatch” that occurs in classrooms around the state that reinforces the idea that enumeration is not part of Hawaiian cultural practice, and that students may lose confidence or become indifferent to their learning experience. The National Council of Teachers of Mathematics takes the following position in early childhood mathematics.

Teachers should guide children in seeing connections of ideas within mathematics as well as with other subjects, developing their mathematical knowledge throughout the day and across the curriculum. They must encourage children to
communicate, explaining their thinking as they interact with important
depth and sustained ways. (NCTM, n.d.)

When not familiar with the context of the animals they are asked to count, students
cannot interact with mathematics in deep and sustained ways. While I believe that
students should be well versed in “important” --also referred to as “Western,” “academic,”
and/or “classical” (each term is problematic) mathematics-- typical mathematics
classroom instruction, primarily focused on a narrow understanding of mathematics is
problematic. Ethnomathematics has the potential for a deeper level of engagement as
students experience academic success, maintain cultural competency, and develop a
critical consciousness through which they challenge the status quo. (Ladson-Billings
1995 as cited in Mukhopadhyay et al., 2009, p. 66)
Figure 3. Nā kānāwai a Mose
Na Na Misionari i Pai (1835) *He Palapala Mua Na Na Kamalii: E Naauao ai i ko lakou wa opiopio.* (p. 14)

One possible translation of the foregoing book title is *A Beginning Primer for Children: So that they will be learned in Adolescence.* An alternative translation however, could be *Beginning Scriptures for Children: So that they will be civilized in their Adolescence.* Again problematic is that this math text is subverted with the Christian ten commandments to supplanting native belief systems. Kaʻaihue (2010) suggests,

Biblical ideology presented Christian propaganda to replace those histories, deliberately devaluing Hawaiian knowledge. In asserting that Hawaiian knowledge is not good enough to be printed, read about, and discussed in schools,
promotes an ideology of Protestant white supremacy. Through the process of being “civilized,” the children learn to separate themselves from their “dark” pasts.

(p. 79)

This text utilizes counting to encourage children to embrace Christian teachings. The lesson then goes on to recite each commandment, asking students to submit to the supremacy of one God as a one-to-one correspondence lesson. Each commandment carried with it a moral compass for how children should behave if they were to be “maikai.” Literacy, and by extension mathematical literacy was seen as a humanizing tool. Gee (1990) explains, “Literacy, it is felt, freed some of humanity from a “primitive” state, from an earlier stage of human development. If language is what makes us human, literacy, it seems, is what makes us “civilized” (p. 50).

This example is taken from the same primer (Na Na Misionari i Pai, 1835), and follows a basic counting lesson. “E helu pono mai oe i akaka. Akahi, alua, akolu, aha, alima, aono, ahiku, awalu, umi.” It continues by, asking students to enumerate responses for a lesson about Moses and the ten commandments. (Figure 3)

The lesson begins, “Ehia papapohaku a ke Akua i haawi mai ai ia Mose? Elua. Ehia kanawai o ke Akua i kakauia maluna iho o ua mau papapohaku la? Umi.” (p. 14) The lesson continues by having each child recite each commandment, most in direct conflict to Hawaiian cultural practices. In this analysis I will focus my attention on the first, second, fourth, and seventh commandments that lend themselves naturally to this mathematics discussion.

O ka mua; Aole ou Akua e ae mai ma mua o’u. Thou shalt have no other gods. O ka lua; Mai hoomana i ke kii. No graven images or likenesses.
Hawaiians hoʻomana many gods. The term kini akua reminds us that this number may have been upwards of 40,000. Gutmanis (1983) remarks not only on the multitude of Hawaiian gods but also their purpose with the following. Many are the gods of Hawaii. So numerous are they that in ancient times they were called na pua aliʻi ʻuhane or the chiefly flock of spirits. These gods are to be found no only in the heavens but also in the plants, birds, fish, rocks, and everything of nature, a god for every need of man. (p. 3)

It has been argued that Hawaiians had no problem embracing Christianity as a new faith, because “Ke Akua” was the addition of just one more god to the Hawaiian pantheon. Through these commandments, and other biblical doctrine, we are taught that Christianity does not reciprocate the same philosophy. Malo (1996) goes on to discuss the personalized nature of Hawaiian hoʻomana, describing that difference of religion for each person at each station in life.

He kuee ka hoomana ana a na kanaka ma Hawaii nei i na [a]kua kii, no ka mea, he akua okoa ko kekahi kanaka, okoa loa ko kekahi kanaka, pela no na [a]lii kane, he okoa ke akua o kahi alii, me ke aku o kahi alii, aole like pu. (p. 61)

O ka ha; E malama pono i ka la sabati.

The need to “malama” the sabbath necessitated a shift from the anahulu, to the contemporary, seven-day week. The sabbath day, Lāpule, became the day where

2 “The traditional Hawaiian week consisted of ten lunar phases per week called anahulu.” (Nuʻuhiwa, 2013)
Hawaiians were encouraged to attend formal church services. This paradigm shift allowed early missionaries to recalibrate the Hawaiian calendar, and adopt the Gregorian calendar instead. Ianuali, Pepeluali, Malaki, ʻApelila, Mei, Iune, Iulai, ʻAukake, Kepakemapa, ʻOkakopa, Nowemapa, Kēkēmapa, while promoted as Hawaiian months are indicative of a dominant time system implemented to further foreign interests in Hawaiʻi.

O ka hiku; Mai moe kolohe.

While moe kolohe is translated as adultery, this may have also included fornication, and homosexuality. While Christianity would have kanaka ʻōiwi ascribe to one man + one woman = maikaʻi. Or even one-to-one correspondence one man (only one) to one woman (only one), who are formally married. Hawaiian relationships were more free in nature, “moe aku, moe mai” (Kameʻeleihiwa, 1992) and not constrained by monogamy, gender, and particularly not marriage, but rather a more complex hierarchical system. Male, the contemporary transliteration for marriage carried with it Christian understandings of one man and one woman. “From the missionaries: adultery, fornication, illegitimate child, bigamy, harlotry, lewdness, carnal intercourse, and the blanket concept that covered all these ideas, sin” (Pukui & Haertig, 1972, p. 95). Hawaiians have always had healthy appreciation for loving sexual relationships. While mathematics instruction may not have explicitly played a role in the conversion of Hawaiians to Christianity, this text demonstrates that early missionary teachers did use math to further biblical doctrines within school instruction.
Malama Makahiki

Oliveira (2009) maintains, “Place names can have rich histories. It is often possible to follow the “genealogy” of a place by noting the various names given to a place over time” (p. 103). Likewise, through our genealogical relationship to kūpuna, mathematical knowledge begins by reasserting these connections through names through places and spaces Smith (1999), in expanding on Freire’s work speaks to the importance of naming and renaming.

It is about retaining as much control over meanings as possible. By naming the world people name their realities. For communities there are realities that can only be found in the indigenous language; the concepts which are self-evident in the indigenous language can never be captured by another language. (p. 157)
Figure 4. Gregorian and Hawaiian months by island.
Thomas, S.P. (1895) Ka buke lapaau me na mea pili kaulana. Honolulu. (p. 7)

Upon cursory glance, the author provides a useful tool of reference comparing the Gregorian, western-style solar calendar with the Hawaiian equivalents. This chart illustrates the correspondence between Western, transliterated months of the year and are Hawaiian ideas of time, even accounting for difference between islands. D’Ambrosio (2006) points out that the way societies record time inheres in their particular culture and geography.

Calendars synthesize the knowledge and behaviors necessary for the success of the stages of planting, harvest, and storage and are obviously associated with the myths and rituals directed at the entities responsible for this success, which guaranteed the survival of the communities, therefore calendars were local. (p. 12)
Charlot (2005) includes the following commentary on scholar Kepelino assessment of the mathematical knowledge contained in the Hawaiian lunar calendar.

A common theme of such writers is the value of Hawaiian knowledge. Kepelino states emphatically that knowledge of the lunar calendar was not just superstition, but was a part of ko Hawaii nei naauao kahiko ‘the ancient wisdom of our Hawai‘i’; it was brought to these islands over a thousand years before Bingham and the other Calvinist teachers arrived. (p. 20)

Kaulana Mahina scholar Kalei Nu‘uhiwa writes about the challenges of these kinds of one-to-one comparisons (Figure 4) above.

Attempting to match the Gregorian solar calendar with the Hawaiian lunar calendar is always a challenge. There are 3 schools of thought regarding when the Hawaiian day starts. Suffice it to say that the Kaulana Mahina followed the lunation of the moon or the moon’s cycle. Trying to match the lunar day with the solar day does not always happen. (Nu‘uhiwa, K., 2013)
This “calendar” recounted through moʻokūʻauhau, encapsulates the relationship of each element of the natural environment to time and space. Ao is the man, Po is the woman, born to them is Kapaakuokahonua, a son. Kapaakuokahonua is the man Kapapakuokahonua is the woman, born to them is Kalaniiluna, a son. Kalaniiluna is the man, Kahonuailalo is the woman, born to them is Kekuahiwi, a son. Kekuahiwi is the man, Kekualono is the woman, born to them is Kapapalimulimu, a son. Ka papalimulimu is the man, Kapapalahalaha is the woman, born to them is Kekaiakea, a son. Kekaiakea
is the man, Moanaakea is the woman, born to them is Hinaaimalama, a daughter, future mother of Ikuwa.

Ka Hanau ana o na Malama

O ke Ao ke kane o ka Po ka wuhine,
hanau mai ka laua o Kapaakuokahonua he keiki kane.

O Kapaakuokahonua ke kane, o Kapapakuokahonua ka wuhine,
hanau mai ka laua o Kalaniiluna he keiki kane no,
o Kalaniiluna ke kane, o Kahonuailalo ka wuhine,
hanau mai ka laua, o Kekuahiwi he keiki kane no,
o Kuahiwi ke kane, o Kekualono ka wuhine,
hanau ka laua o Kapapalimulimu he keiki kane no,
o Kapapalimulimu ke kane, o Kapapalalahala ka wuhine,
hanau ka laua o Kekaiakea he keiki kane no,
o Kekaiakea ke kane o Moanaakea ka wuhine,
hanau ka laua o Hinaaimalama ka wuhine,
hanau o Ikuwa he keiki kane no,
o Ikuwa ke kane, o Kapohakoelele ka wuhine
hanau o Welehu he kane no,
o Welehu ke kane, o Kaiehu ka wuhine,
hanau ka laua, o Makalihi he kane,
o Makalihi ke kane, o Haliilua ka wuhine,
hanau ka laua o Kaelo he kane,
o Kaelo ke kane, o Kahoanoku ka wuhine,
hanau mai ka laua o Kaulua he kane no,

o **Kaulua** ke kane, o Kaulawena ka wahine

hanau ka laua o Nana he kane no,

o **Nana** ke kane, o Kahueloiki ka wahine,

hanau ka laua o Welo he kane no,

o **Welo** ke kane, o Kahueloku ka wahine,

hanau mai ka laua, o Ikiiki

o **Ikiiki** ke kane, o Malamaihaneeleki ka wahine,

hanau ka laua o Kaaona

o **Kaaona** ke kane, o Malanaiku ka wahine,

hanau ka laua, o Hinaiaelelele, he kane

o **Hinaiaelelele**, ke kane, o Kapauliokalani ka wahine,

hanau ka laua o **Hilinaehu** a me **Hilinama** he mau mahoe laua,

oia ka hanau ana o na malama,a me keia mookuauhau, ka hea ia ana o na inoa o na malama, ma ka helu a keia pae Aina, i ka wa kahiko a hiki i keia wa.

Hawaiian genealogy scholar Kameʻeleihiwa (1992) reminds us of the important role that genealogy play for Hawaiians.

Genealogies are the Hawaiian concept of time, and they order the space around us. Hawaiian genealogies are the histories of our people. Through them we learn of the exploits and identities of our ancestors—their great deeds and their follies, their love and their accomplishments, and their errors and defeats. (p. 19)

When casually reordering the Hawaiian months of the year to place Ianuali in the preeminent position, the older sibling Ikuwa is demoted to descendant rather than a
progenitor for each following month, this disrupts the birthright of each of the Malama Hawaii. Next, while Hawaiians are not related to Ianuali, they are related to the elements of Ao and Po, the earth and sky and by extension space and time itself, as older siblings. This understanding of “cultural contract” is of paramount importance for children learning their relationship to their kuleana. DeSoto Ka’aihue (2010) expresses this idea through genealogy discourse.

“Moʻokūʻauhau or genealogy discourse is the way in which marginalized peoples must encounter erasures” (p. 86). Within these relationships are embedded kuleana inherent in the Hawaiian social network. She continues, “The kuleana of the elder sibling is to feed, protect and nurture the younger. The kuleana of the younger sibling is to care for and obey the elder sibling” (p. 86).

This discord in solar and lunar time systems, through time difference, in addition to religious underpinnings in traditional calendars were the impetus for this “Alemanaka Kristiano”. (Figure 6)
This calendar had “evolved” to exclude the complication of the lunar malama Hawai‘i as well as the individual moon phase names, replacing them with transliterated days and could quite easily be utilized in a contemporary classroom. While recognizing the limited understanding that we may have with older mnemonic time devices, it is in these complications, the mathematical ideas that showcase the polarity of our Hawaiian and “Western” cultural knowledges from that we experience the beauty and diversity of culture.
Translation has been the primary source for curriculum development for use in Kula Kaiaipuni and other bi-lingual Hawaiian schools. Translation of English language resources can be particularly insidious as it is the transmission of western ideas disguised in our mother tongue. Wong (1999) explains,

The predisposition of the Hawaiian community (as well as many others) to accept binary standards as legitimate has made it possible for the promoters with the greatest economic and political means to establish positions of authority from which to define authenticity and use that definition to promote their versions of language. (p. 97)

This final calendar is one used in Kindergarten instruction at a Hawaiian language immersion school. In efforts to resource Kula Kaiapuni with curriculum for classroom use, materials are created or translated by a second language majority that embody characteristics of the dominant language. NeSmith (2005) refers to these speakers as NEO Hawaiian language speakers. “NEO speakers are changing the way Hawaiian language (and by extension, Hawaiian cultural values) is understood, expressed and embodied. This change is transforming Hawaiian identity” (p. 3).
This calendar is indicative of curriculum produced that has been created within a cultural kīpuka (Goodyear-Kaʻōpua, 2013) that is constrained by adherence to dominant time narratives. While the presence of Hawaiian words and months would indicate that this is reflective of a Hawaiian worldview, it is a narrow translation of the Western calendar, reaffirming that even within our native language schools there is a strong western influence on curriculum.
Helu Hawai‘i

| 4 kahi, hookahi in kauna, | oncé, 4 |
| 10 kauna | 100 kauni |
| 10 kaau | 100 mau |
| 10 lau | 100 mano |
| 10 mano | 100 nini |
| 10 nini | 100 lehu |
| 10 lehu | 100 pino |
| 10 pino, 100 naolwale | 10,000,000 |

A nela aku no e like me ku mea i man.

*Figure 8. Hawaiian counting system.*
Kanepuu, J. H. (1867, January 21), Ka Helu Hawai‘i. *Ke Au Okoa.* (p. 3)

Many historical Hawaiian newspapers printed as early as 1867 warned of the dangers of forgetting Hawaiian cultural traditions. Kanepuu writes the following specifically about forgetting our mathematical traditions.

E nana i ka papa o na mea ana i hoike ia ma ka helu kamalii, ma na pepa (“Ua kapaeia ka oiaio,” 1895) a ma mua iho o ka papa hoonui; aole no he hana mau o na kupuna o kakou i ka helu i keia wa e hana ia nei i ka haneri. Ma ka hale makeke ma Ulakoheo, a ma na wahi kuai ia e ae a pau, ke maa mau nei no na kanaka, wahine a me na kamalii ma ka helu i hoikeia maluna ae nei. (p. 3)

While Kanepuu contends that men, women and children were all well versed in Ka Helu Hawai‘i, an increasingly foreign presence necessitated the need to manipulate the traditional counting system to accommodate the more widely accepted base ten number system. The following passage, like Kanepuu’s, from the newspaper Ka Makaainana (*Figure 9*) supports the academic nature of the Helu Hawai‘i in comparison to the introduced system within the Bible.
The author here suggests that counting in Helu Hawai‘i was common for the prophets, geomancers, and orators as part of the kahuna class. These “mystic” practices would most likely have been problematic for increasing numbers of foreigners. He asserts the superiority of the Hawaiian counting system over that of the foreign counting system “O ka helu Hawaii ka oi, aole o ka na haole.” Interestingly he goes as far as to remark on the preexistence of the Hawaiian counting system to the time of Christ and the Bible. This would suggest that it may have been preferable for missionaries to teach and implement their counting system rather than navigate through one that was rife with
Hawaiian cultural and religious practices. D’Ambrosio (2006) states, “The use of formal language inherent to academic discourse has been a major cause and instrument of deterrence. School organization and curricula have been instruments for the denial of participation in the dynamics of society...Mathematics, like other sciences, used to be impregnated with religious, social, and political considerations. (p. 137) We see here that Hawaiian math and Western math are not the same.

Figure 10. Western base system translated into Hawaiian
Leonard, G., (1852) *He Huinahelu oia ka Helunau me ka Helukakau i Huiia*. Honolulu.

As Bishop (1990) posits asserting mathematical dominance was part of a “deliberate strategy of acculturation.”

Trade and the commercial field generally, this is clearly the area where measures, units, numbers, currency and some geometric notions were employed. More
specifically, it would have been western ideas of length, area, volume, weight, time and money which would have been imposed on indigenous societies. (p. 53)

While I agree that these imposed systems were a part of a strategy for acculturation, it is critical to note in the next example below that helu kahiko as well as helu hou accommodated both knowledge systems; western economy, western weights alongside, Hawaiian customary, “non-standard” measurement. This “Pidgin” mathematics is indicative of the Swetz (2009) ideas on the cultural evolution of mathematics. “It reflects the culture it serves and, in turn, is shaped by that culture. Cultural trends in mathematics are constantly evolving” (p. 13). This example demonstrates the reciprocal impact on mathematical systems when participants move beyond hegemonic knowledge relationships to glean new mathematical practices shared honoring multiple cultural perspectives.
Figure 11. Market prices using Hawaiian and Western quantification
K., (1844, Sepatemaba 3) No ka Nonanona, *Ka Nonanona*, (p. 3)

Ka puua, 1 pauna, 3 keneta;

Ka puua anana\(^3\) mai 6$ a 10$

\(^3\) Fathom: formerly the distance between tips of the longest fingers of a man, measured with arms extended on each side (Pukui)
Contemporary classroom instruction generally introduces, anana, muku, and iwilei as “non-standard” measurements based on a man’s body, then iā and kapua‘i as yard and food standard. Should dominant worldviews dictate the referent standard? These curricular stop gap measures and rethink the way we engage with our cultural knowledge. Kaomea (2011) suggests,

If we are to prepare our students to seek sustainable, culturally appropriate solutions to global and societal problems that no one yet knows how to solve—or that no one has seen before—they will need a firm grounding in the accumulated wisdom of our ancestors coupled with excellent creative thinking and mathematical problem-solving skills. (p. 293)

Cultivating mathematical capacity in our children must begin with their experiences. ‘O ke kahua ma mua, ma hope ke kūkulu. First, the foundation, then the building. To encourage critical thinking skills in mathematics we must encourage students to critique power structures that eliminate our place in mathematical history. Through the analysis of these Hawaiian texts I have shown that mathematics, a seemingly universal and neutral content area has been used to acculturate Hawaiians into dominant Western educational paradigms. It is imperative that we understand these origins

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4 A measure of length from fingertips of one hand to the elbow of the other arm, when both arms are extended to the side.

5 Collarbone. Measure of length from the collarbone to the tip of the middle finger with the arm extended.
collectively, in order to ensure that contemporary Hawaiian educational settings to not unwittingly replicate discursive teaching practices located within the deep structures of current educational practices. The next chapter seeks to connect historical mathematical perspectives to the teaching practices of mathematical educators within Hawaiian educational settings by honoring the voices of our kumu.
Mokuna V: Nā Leo Kumu

This chapter is the first time that we will hear from the teacher participants and how they understand teaching and learning mathematics through the HCBE lens. While I had initially approached ten teachers about this project it is fitting that the final amount of research participants numbered eight. Makawalu here literally refers to the eight sets of teacher eyes that imbued this research moʻolelo with practical and thoughtful insight.

Description of Participants and Sites

Table 2. Participant and Site Data

<table>
<thead>
<tr>
<th>Participant Pseudonym</th>
<th>Site Pseudonym</th>
<th>Type of Hawaiian Educational Setting</th>
<th>Age of Participant</th>
<th>Years Teaching</th>
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<tr>
<td>Hikianalia</td>
<td>‘Ula‘ula</td>
<td>Hawaiian Community School/Post-HI</td>
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<td>8</td>
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<tr>
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<td>Melemele</td>
<td>Hawaiian Community School/Post-HI</td>
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<td>16</td>
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<td>Poni</td>
<td>Hawaiian Community School</td>
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<td>Uliuli</td>
<td>Hawaiian Focused Charter School</td>
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<td>1</td>
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<td>Rovert Snikta</td>
<td>‘Ele‘ele</td>
<td>Hawaiian Focused Charter School</td>
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<tr>
<td>Kuʻulei Waikoloa</td>
<td>‘Alani</td>
<td>Ka Papahana Kaiapuni</td>
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<td>‘Ākala</td>
<td>Ka Papahana Kaiapuni</td>
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<tr>
<td>Kīholo</td>
<td>Uakea</td>
<td>Ka Papahana Kaiapuni/Hawaiian Focused Charter School</td>
<td>36</td>
<td>12</td>
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</tbody>
</table>

Hikianalia.

I first saw Hikianalia’s work through an invitation for a summer professional development session for teachers. Although I was not able to attend this first year, this cyber invitation stuck with me. I was encouraged that work was being done utilizing
culture and traditional Hawaiian knowledge to engage learners in mathematics. Several years later that summer institute has expanded into a yearlong professional development program to include STEM learners and teachers, and various other stakeholders, allowing Science, Technology, Engineering, and Mathematics collaborations through a cultural context. My initial face-to-face meeting with Hikianalia was informal and pleasant, and even through this first meeting I connected with her genuine and humble nature. While her initial mathematics training was at a Hawaiian community school, as a current college professor, she now has had the joy of teaching mathematics at the tertiary level as well. Hikianalia is a crew-member with the Polynesian Voyaging Society and is intimately involved with the impending World Wide Voyage where she will continue to connect mathematics to ancestral knowledge.

Growing up, I often felt like I was misunderstood. I felt like my knowledge and appreciation of education and mathematics in particular wasn’t validated. Thus, I learned to memorize and regurgitate for standardized testing and examination purposes. I could do drill and kill, and I was okay in mathematics but I constantly felt a disconnect with textbook philosophies and Western mathematicians. I grew up in Hau‘ula and I loved learning from my uncles and aunties how to live off the land and ocean. My definition of family is the extent to which you are willing to do something for another person, and not necessarily relation by blood quantum. (Hikianalia)

Maile.

I met Maile while working at Melemele. She taught sixth grade students on the “English side” of a school that taught both English language and Hawaiian Language Immersion
students. Although we never taught together formally, her passion for the students came through when we would have faculty meetings. I was pleasantly surprised to learn that she had moved to the university around the same time as I and was teaching math education courses and observing teacher candidates in their field experiences. We even had the opportunity to travel abroad together for a gathering of ethnomathematics educators.

*I don’t really remember learning math when I was in elementary school at all. I think I was in 8th grade and was in pre-algebra. I remember watching the teacher write on the overhead transparencies that were on a roll. She would wind and wipe the transparency roll while we watched. She used the overhead to lecture so that she could face the class and make sure that we were not making noises or misbehaving. I remember her saying that working to solve for a variable was like unwrapping a present. That made no sense to me. I had a terrible trigonometry instructor at a community college. He would lecture every class, all class. And assign all kinds of work, collect it, and never go over it. Everybody seemed confused. At the end of the semester, we were having a final exam. I was so confused and had had enough. I walked out in the middle of the exam. He followed me down the hall and asked me to please come back and to just try to finish it. He said that I was the best student in the class. I came back and took the exam. I got a B in the class. Years later, I realized that it was all about circles and triangles, but this teacher never made any conceptual connections in class. Instead it was just rote formulas.* (Maile)
ʻAlaea.

While taking several introductory Hawaiian language courses ʻAlaea cultivated a love for Hawaiian language and culture. She was ecstatic to learn there was a teacher preparation program that prepared students to work specifically in Hawaiian communities, charter and immersion schools. As an avid learner, she became licensed in both math and science and was always seeking out ways to learn more. Ma ka hana ka ʻike. She has devoted her time and efforts to her students at the charter school, encouraging them through cultural connections to mathematics and science. It was at this initial teaching position that she first connected with the waʻa kaulua, and its potential for connecting kids to mathematics through sailing. She has since become a crew member with the Polynesian Voyaging Society and will be sailing on the World Wide Voyage.

I’m not sure exactly why math appealed/appeals to me. I am also religious, so perhaps I enjoy math’s supposedly universal truths that require an investment in “faith,” but I also feel reassured by the sense of order that math creates within an otherwise chaotic world. Even now, when feeling stressed about things outside of my control, I often find comfort in working out a few algebra or geometry problems: for me, making a few calculations is like taking a few deep breaths. (ʻAlaea)

Rovert Snikta.

I first met Rovert Snikta when he was a cohort student seeking licensure as a secondary math then science teacher. He had always displayed an inherent sensitivity in his teaching that allowed him to connect with both his classmates and students on a deeper level. When he attained his teaching license he was immediately hired at ʻEleʻele,
while a Hawaiian-focused charter school whose philosophy of teaching mirrored his own.

While he has dreams of returning home to start his own charter school, he excels at his school and is the epitome of an embedded teacher.

Pualīlia.

Ironically, when I first met Pualīlia to discuss a teacher preparation program I was involved with, she was fresh from graduation with a mathematics degree. She began by explaining how important holistic well-being was for her and that she would like to teach students about lā‘au lapa‘au, perhaps more than mathematics. She talked about her strong concerns for her community of Wai‘anae, and how the health disparities had encouraged her family to learn about growing their own food through aquaponics to embrace a healthier way of living. Her connections to mathematics were fostered by a high school math teacher, who had encouraged her to pursue a degree in mathematics. It was isolating as the only Hawaiian woman in most of the courses during her undergraduate mathematics. While a student she was able to return to her community to teach mathematics and her students were equally amazed by her knowledge of mathematics, and that she was from Wai‘anae.

_I love math because math is life and life is math. I find everything that exists cannot be explained without math. Math makes everything make sense (to me). In nature there is Math, in beauty there is Math, anything I can think of can relate or does relate directly to math. Like Aristotle said, “The so-called Pythagoreans, who were the first to take up mathematics, not only advanced this subject, but saturated with it, they fancied that the principles of mathematics were the principles of all things.”_ (Pualīlia)
Kuʻulei Waikoloa.

I first connected with Kuʻulei Waikoloa as a hula sister, joining a hālau hula at the same time. Together we learned oli, hula, lei making, through the serious learning environment that comes with schools of traditional learning. So when I took a kindergarten teaching position at the school she taught I was grateful that she took me under her wing and really guided me in my first year of teaching. I was especially interested in connecting with her on this research project because her master’s thesis centered on incorporating Hawaiian counting systems in her mathematics teaching of Algebra.

In elementary, intermediate and high school, math learning was memorization and analyzing patterns. Mathematics seemed very “black and white” in other words, there was a “right answer” and the students’ job was to find that answer. I remember doing words problems and algorithms. But in school, there was only one way to solve any given problem. We didn’t have different strategies to choose from. In college, however, math seemed a little more abstract, especially in higher levels classes. College math classes were remarkably different than classes in high school and considerably more challenging. I have always considered myself very good at math. I took Algebra in Eighth grade and every math class (Geometry, Trig, Calculus etc.) offered at my high school. I continued math in college through Algebra 4. It was always my favorite subject in school, and a class that I had an easy time excelling in. I love to analyze and figure things out, which is what I enjoy about math. (Kuʻulei)
Tristan.

Initially an engineering student, Tristan excelled in both math and science but found his calling in learning about Hawaiian language and culture. As a Hawaiian student, he did not learn these things going to school; he did not gain this knowledge in school. For years Tristan would tell me of his plans to become a mathematics teacher in the Kula Kaiapuni, and then through his perseverance he did. His master’s thesis focused on examining the mathematics texts translated at Lahaināluna, for appropriate vocabulary to be used in high school mathematics courses, and he continues to work and to grow as a teacher through his own professional development in mathematics. He has also modeled a love of life-long learning through his commitment to hula and lauhala weaving.

‘Aʻole au i mālama ‘ia i ka ʻōlelo Hawaiʻi. ‘Aʻole aʻo koʻu mau mākua iaʻu i nā mea Hawaiʻi. Aʻo au i ka ʻōlelo a me ka ʻike Hawaiʻi i koʻu wā kulanui. No laila manaʻo au hiki iaʻu ke hōʻike i nā haumāna hiki ke ola me he Hawaiʻi la. Maikaʻi kākou kēia. He waiwai kēia. ‘Ano kaumaha au i kaʻu mālama ana, mālama ʻole ‘ana i ka ʻike Hawaiʻi. (Tristan)

Kīholo.

I extended an invitation to Kīholo, asking for her participation in this research project after a chance meeting with one of my Hawaiian language mentors. I casually mentioned to her the scope and intention of my project and she strongly encouraged me to seek out Kīholo because of the work that she was doing with her high school students integrating math with cultural practices. Her ability to see tradition through a mathematical lens remains impressive. It was therefore not surprising to learn that her
original intent in college was to become the next Isabella Abbott. He wahine akeakamai nō hoʻi.

*Iaʻu ma ke kula haʻahaʻa, ua haʻaheo maoli au i kaʻu kālena ponoʻi ma ka makemakika. He lālā au o ke kime hoʻokūkū no ka papa ʻeono, a, wahi a koʻu mau hoa papa, inā ʻaʻole nō i ʻōmaʻimaʻi au ma ka lā hoʻokūkū, inā paha mākou i lanakila ai. He manaʻo hoʻomalimali paha, ʻaʻole paha, akā, ma ka wā keiki, ua paulele wale koʻu hilinaʻi ʻana iaʻu iho ma kēia hanana hoihoi a leʻaleʻa ʻo ka makemakika. Eia naʻe, ma ke kula waena, ua loli loa koʻu kuanaʻike. Kainō a he iʻa nui au o ke kai hohonu; eia kā, ma ke kula hou, he pāoʻo pili pali wale nō au. “He aha lā kēia mea he hōʻailona helu? I mea aha ka hualau? He aha ka hualau? No ke aha aia nā pīʻāpā ma loko o kēia polopolema?” Ua pīholo nō au i ka papa makemakika; ua paʻakikī, ua huikau, he ʻike hūnā ia. Noi pinepine au i koʻu makuahine no ke kōkua, ʻoiai ʻaʻole i lawa ka wehewehena o kaʻu kumu, a ʻaʻohe oʻu pilina me ia, a he mea ʻē wale ke kipa ʻana iā ia ma hope o ke kula (ma ke ʻano he wā tua paha). Ua pau ka haʻaheo, lilo i hilahila, lilo i hoka. Kaumaha ka naʻau, kānālua au iaʻu iho, huli au i kālena ʻē aʻe e haʻaheo ai. Tsa, makemakika, he mea ʻole ia! (Kīholo)

As discussed in Mokuna III, I have used the HCBE framework for provisional coding of the data of the math identity piece, personal interview, and focus group. In this chapter I will use the HCBE components along with their critical indicators to further disaggregate the data. As this is a rigid, predetermined structure for coding, I have highlighted additional themes that have emerged and were not addressed by this framework.
HCBE in Math Context

The Hawaiian Culture-Based Education framework is a “community-based participatory research project, representing a collaborative effort of the Hawai‘i Department of Education, several Hawaiian organizations, and Native Hawaiian and other charter schools in the state.” Therefore in utilizing the HCBE framework, it was necessary to first develop an understanding of how each teacher participant understood mathematics through the HCBE lens.

Acknowledgement of systems, philosophies, methodologies, and knowledge that have existed since the beginning of time. Often absent from critical conversations, culture-based education is a tool for empowerment, validation and celebration. My “educational setting” includes formal, nonformal, informal, and other environments from classroom to the wa’a and beyond. In these educational settings mathematics teaching and learning looks like passion, about content, excitement about sharing knowledge with others and an extension of bringing communities together through a common vision. (Hikianalia)

Hikianalia’s definition echoes the HCBE goals of empowerment through critical conversations. She also acknowledges that these “critical conversations” are often absent. Hikianalia goes on to describe the diversity of settings that may be utilized for this kind of mathematics engagement. For Rovert, it is in the work itself that the learning occurs. Ma ka hana nō ka ‘ike.

Perpetuate Hawaiian culture; ho‘omau, ho‘ōla, ho‘oikaika, ho‘okumu, ho‘okanaka. Sustain opportunities to practice arts, agriculture, aquaculture, observation, etc. (Rovert)
Maile brings in a new element in that HCBE must also be receptive to the needs of individuals or subgroups that learn in different ways.

*Communities, inside and outside of schools, need to be sensitive and responsive to the backgrounds and needs of individual and subgroups of students. To carefully and with humility examine the spaces and designs of learning communities, we need to pay much more attention to differing worldviews rather than distilling ideas down to a predominant one.* (Maile)

Critical in her understanding of HCBE is that HCBE learners may be diverse. Instruction should be receptive to individual and even sub-group needs of learners. This element recognizes that there may be diversity in Hawaiian teaching and learning styles in the classroom.

*Hawaiian culture-based education validates the experiences and personal esteem of students. It validates my mission as a kumu, I don’t have to hold back or filter the mana’o that I wish to impart.* (ʻAlaea)

In ʻAlaea’s manaʻo, HCBE lends itself naturally to curricular autonomy not dependent on a prescribed curriculum that may present a dissonant view from their home learning Discourse, or as Rovert suggests, promote the “dominant narrative.”

*All education is culture-based. “Hawaiian” Culture-Based education is, by nature, confronting the idea that the dominant narrative is culture-less and neutral. A truly, fully culture-based education then is so immersive that the students are unaware that the curriculum is tailored to a culture.* (Rovert)

Culture is often representative of the “other.” Rovert’s assertions confronting the “culture-less,” or “neutral” dominant narrative remind us that we must be critical when
teaching “culture-based” education. Maile also cautions us to rethink the contributions of diverse cultures to “Western” mathematics.

*Like when people think about math, they don’t think about their culture, but that’s what ethno-math is doing, it’s looking at where culture and math have intersected, the math that we…call math today is the result of all of these cultural experiences… but what’s happened is… there’s this one type of math has been privileged over all other math and that’s what’s been transmitted to everybody. . For many, it doesn’t make sense, because it does not fit their worldview and culture. (Maile)*

Ethnomathematics, as a lens for HCBE, honors peoples and knowledge relationships that have contributed to the larger body of mathematics knowledge. Tristan expresses that establishing relationships with the content knowledge and the environment of learning are critical.

*Culture-based education is the means to connect students with the environment and content they are comfortable with or have a connection to. In my class I use culture as a means to establish a pilina between math and the world they are familiar with. I want my students to be able to explain the world they know with math. (Tristan)*

Inherent in explaining the “world they know” is the idea that mathematics may serve different purposes based on the cultural context of the learner. Kuʻulei supports this idea in the following,

*Ma loko o ka makemakika e helu ‘ia ana ka manawa, nā mea, ka lumi, ke kōwā ma waena o nā mea, ke ana ‘ana i kekahi mea. Kuʻu manaʻo o ia ka makemakika,*
ka helu ‘ia ana i na mea like ‘ole. I ka wā kahiko ‘oko’a ko lākou kuana’ike i ko kākou kuana ike. ‘Oko’a ho’i ko lākou pō’aiapili. Mana’o au pono kākou e ho‘ōla hou, ‘a’ole maopopo inā ua pau ma kekahi wā, pālā paha, ho‘ōla hou i ke kuana’ike a nā kupuna. ‘O ka makemakika kekahi māhele o ia kuana’ike.

(Ku‘ulei)

Kīholo’s understanding of HCBE may be useful for educators who grapple with Hawaiian (educational) modernity.

*Education that begins in an understanding and appreciation of Hawai‘i,*

Hawaiians, past-present-future, ‘āina, ‘ōlelo, lāhui, mo’omeheu and seeks to move students and families into successful, appropriate, and meaningful products, lives and futures. CBE should prepare students for future success, whether college, career or other. It should always reference and respect culture, and not be afraid to revive past traditions (or advocate for new ones!) It should ground students and families in their identity while making room for new learning, attitudes, paradigms. (Kīholo)

Inherent in her understanding of HCBE is that it is dynamic and should be representative of a living, learning people. As such, issues of Hawaiian educational modernity need to be confronted by classroom teachers. Kīholo continues,

*Responsive and dynamic to the particular students and always changing. I’m not sure what it looks like yet. I keep changing my mind.* (Kīholo)

HCBE and its use should not be fixed in space or time, and as teachers we are challenged to ensure that our understandings do not stagnate. It is also important that in its evolution we continue to look to the sources of foundational knowledge.
Language: Recognizing and using native or heritage language

Integration of Hawaiian language in class.

Aloha nui au i nā keiki aloha nui au i ka ‘ōlelo Hawai‘i. ‘Ike au i ke waiwai o ka ho‘ona’auao ‘ana ma loko o ke kula kaiapuni i ka holomua o nā keiki. ‘Ike ho‘i au i ka holomua o ka ‘ōlelo me ka lāhui Hawai‘i. E ulu ana ka ha‘aheo o ke keiki. ‘Oiai e a‘o ana lākou i ke kaiapuni. (Ku‘ulei)

Ku‘ulei understood the value of immersion education for her students in that she could see the advancement of both the language in her students and the broader Hawaiian collective. She also feels that during her tenure as teacher she has seen an increase in pride through Hawaiian language education. Tristan, who also teaches in a Kula Kaiapuni adds the following.

He kula kaiapuni kēia. ‘O ka pahuhopu hiki i nā kama ke ‘ōlelo Hawai‘i e ho‘ōla i ka ‘ōlelo makuahine. A‘o au i ka makemakika. Makemake au e ho‘okomo i nā hua‘ōlelo kūpuna no ka makemakika. Maopopo ia‘u he mana‘o haole he mea haole ka pili helu ka makemakika nō hoi. Akā ina hiki i na kānaka āpau ke ho‘ōla hou i ko kākou ma kēia au hou. Hiki ke ho‘oulu hou aku i ka lāhui paha. Akā nae he mau pilikia he mau ālai, he mau mea e kāko‘o ai but no kēia kula hana mau mākou, hana nui mākou i kēlā me kēia lā i ke a‘o ʻana no nā haumāna. (Tristan)

As a high school mathematics teacher he feels extreme pressure on his language acquisition and subsequent use within the classroom. As such he tries to incorporate “huaʻōlelo kūpuna” or what he views are traditional words and or understandings to explain advanced mathematics concept. By seeking out older vocabulary words Tristan highlights a complex issue for NEO Hawaiian language speakers--teaching in a content
area that demands its own communicative language beyond Hawaiian language competency. While most teachers will utilize Māmaka Kaiao, as its contemporary lexical contributions, Tristan feels that by utilizing primary math texts, written or informed by traditional speakers, Hawaiian mathematical vocabulary is a closer representation of Hawaiian worldviews. Maile adds this complementary thought:

_Hawaiian language behaves very differently than English. There are ways that we can express our relationship to things in Hawaiian and I think that that’s the inherent nature of the language. That is very different than English, which objectifies things. What I think is dangerous is that we are translating this distilled mathematical language through Hawaiian rather than looking at the inherent mathematical relationships -- to the environment, to the world, to our values and beliefs--and in the effort to emancipate and lift up our people we’re educating them in the dominant forms._ (Maile)

As such, Hawaiian language integration within the classroom becomes a more complex issue of integration or liberation. Tristan continues,

_Ua heluhelu au i nā puke pilihelu puke hōʻailona helu mai Lahainaluna mai i ka wā kahiko, ka wā makahiki 1800. ʻOiai kamaʻāina au, hoʻolālā au i nā kānaka like ‘ole pili i ke kula kaiapuni, hōʻike au iā ia i kēlā mau puke a hoihoi ʻo ia. ʻŌlelo ʻo ia ua hāʻawi i ka haʻawina i kona mau kānaka i kona keʻena. Inā nui nā kānaka e heluhelu ana i kēlā mau puke mai ka wā kahiko a nā kupuna, then kūkulu paha lākou i ka haʻawina._ (Tristan)

These issues, while linguistic, creep into the content choices for HCBE. Tristan encourages a hui of Hawaiian language speakers to engage in the collaborative
development of mathematics curricula exploring traditional textbooks. Kīholo adds the following about her own efforts to make sense of Hawaiian vocabulary, traditional and contemporary.

I don’t remember what the brand new word for diagonal is, but it’s probably something not useful but what they used in the older textbooks is this word that says kaha lala... so it’s make a mark from one corner to the other that’s exactly what it says, kaha lala, that’s a diagonal so, yeah... I totally support what you said... at the same time, it’s always been our own kūʻē manaʻo that we are going to teach both languages at the same time. (Kīholo)

For ‘Alaea, using Hawaiian language at Uliuli allowed her to foster deeper engagement with her students who were not accustomed to hearing ʻōlelo Hawaiʻi anywhere outside of Hawaiian language class.

I’m very much far from being fluent, but the things I understand, like the concepts of kumu or aʻo, or even just hōʻike, the kids have been really surprised, they’re like, wait, we’re in math class, right? I’m like, yes you’re still in math class but, you’re also in Hawaiʻi, and we have an opportunity here because, English is an official language and Hawaiian is an official language, and today that blew the kids’ minds. (ʻAlaea)

**Hawaiian language materials and resources.**

I have included some of the comments of teachers on Hawaiian language within the broader conversation of content, specific to teachers incorporating Hawaiian language into their mathematics instruction.
I had to teach my own self math in Hawaiian but, those books, I was reading them, I had mentioned that they’re very difficult to read because they they’re written in the style of people in that era, of the 1800s. Everyone was native speakers so I’m trying to read them and I’m like, what are they trying to say? You break it down, you really understand like oh, they’re basically saying subtraction, oh, they’re using the ideas that they know of their environment it was very beautiful, they’re beautifully written. (Tristan)

While Tristan tries to teach himself through Hawaiian language math texts, Ku’ulei relays the concern that she has never had the opportunity to take Hawaiian language courses specifically targeted to mathematics instruction. She has, however, taken Hawaiian language and math courses separately, aiming to piece together her own Hawaiian language mathematics instruction.

ʻAʻole au i kono i kekahai papa e nānā nui ana i ka ʻōlelo makemakika. Pehea e ʻōlelo ai i kēia? Penei e hoʻohana ai i kēia huaʻōlelo. Ua hele mai ʻo Kumu Nui i loko o koʻu lumi kekahai mau mahahiki i hala aku nei. Nānā ʻo ia i kekahai haʻawina makemakika a ʻōlelo ʻo ia hoʻopuka ʻoe i kēia huaʻōlelo manaʻo au hoʻāʻo paha ʻoe i kēia so ua hoʻāo au. Makemake au e noho ʻo ia i loko o koʻu lumi kēlā me kēia lā o ka mahahiki. ʻAʻole au ʻike inā hemahema kaʻu ʻōlelo.

(Kuʻulei)

The issue of Hawaiian language and math also converge for students as well. Kuʻulei explains that her instruction begins with language surrounding math, then content. She feels that if students can’t grasp that language they will not grasp the mathematics.
No ke aʻo ana i ka makemakika? Nui nā pilikia. ‘O ka mea nui loa o ka ‘ōlelo ka mea mua e nana ai ma nā haawina like ole. ‘O ka ‘ōlelo ka mea mua e nānā ai. ‘O ia ka mea mua e aʻo ai i nā keiki. No ka mea inā ‘aʻole lākou ‘apo i ka ‘ōlelo pilikia ka ‘apo ‘ana i ka manaʻo o ka makemakika ka makau makemakika. Ua paʻakīkī. No laila hoʻaʻo mākou e kākulu i ka ‘ōlelo ma mua, ma kēla me kēia haʻawina ‘okoʻa nā huaʻōlelo e hoʻohana ai no laila ‘o ia ka mea e nānā mua ai ka ‘ōlelo. (Kuʻulei)

While immersing students in Hawaiian language, Kīholo suggests that we look critically at how we include English language instruction within the classroom.

It’s a political decision, right? Look at language, the language of colonization cannot always be allowed to be the language of the classroom. I understand that, I totally understand that, however it’s not about me and my battles and my generation for our entity culture and no colonization, it’s what’s going to be good for these kids and this future that I can’t imagine for them. So, I give them as much as I can, as much as we can, so that they will be successful no matter what. (Kīholo)

For Rovert, the political nature of using ‘ōlelo Hawaiʻi in the classroom is also tied into the tremendous pressure he feels from “that test.”

I use a lot of ‘ōlelo when I’m teaching, but never in math class, and because there’s so few hours and it’s so hard to pass that test, there’s no room to have a philosophical conversation about other cultures that use math. (Rovert)
In addition to the foregoing challenges regarding Hawaiian language and mathematics, Tristan also raises the concern that for some students, challenges may not be with mathematics acquisition but instead their participation in Ka Papahana Kaiapuni.

ʻOkoʻa kākou mau kumu ʻoi'aiʻa'ole ka olelo Hawai'i ka ʻōlelo mua, ʻokoʻa nā haumāna, because they're forced to learn Hawaiian. ʻIke au i kēlā pilikia. Some of them they hate to be they hate being here. I see it. ʻAʻole maopopo iaʻu ke kākoʻo ʻana iā lākou. Just ʻōlelo Hawaiʻi, ʻōlelo Hawaiʻi! (Tristan)

Summary

Participants engaged in the discussion of Hawaiian language in the mathematics classroom and raised many critical issues regarding the use of Hawaiian language in mathematics instruction. To problematize the component of Hawaiian language in HCBE, they have to expand the issues to more than just recognition and or inclusion of Hawaiian language in the classroom. Teachers’ comments unveiled that Hawaiian language challenges underpinned content, context, and assessment, particularly in mathematics.

Whilst NEO Hawaiian language learners are eager to participate in language revitalization efforts within schools, they also recognize the limitations of their language competency in classroom discourse particular to mathematics. This leads to subsequent insecurities when instructing other NEO learners within schools. Participants discussed Hawaiian vocabulary (both old and new), grammar and curriculum development. As there is no prescribed curriculum for mathematics instruction in Hawaiian language environments, curricular choices are done at the school, and even teacher level. While this increases school and teacher autonomy, individual teachers are ultimately responsible for their own Hawaiian language mathematics curriculum development. There is limited
opportunity for external Hawaiian language competency evaluation outside of formal Hawaiian language courses, so teachers may reach out individually to Hawaiian language instructors or traditional Hawaiian language texts for informal linguistic support.

‘Ohana and Community Involvement

As we include families and communities in the development of learning that is culturally based, I begin with this quote from ‘Alaea that honors our relationship as Hawaiians to knowledge itself. Imbued in this knowledge relationship are the math and also the love.

People who are interested with the kuleana of teaching math that we all kinda have our own relationship...yeah, we all have our own relationship with math...it is love/hate, it is mostly love...we love anybody who...like when we give math lessons, we’re also giving kinda aloha. (‘Alaea)

Integration of ‘ohana/community in curriculum.

We physically go outside of the classroom and do a field study right and so some of our field studies have been to um Mokaeia Island, fishing village, Aunty Joni and Kehaulani talk with us about continuing the conversation about geometry so they talk to us about the geometry of the fish pond and why the ‘auwai are put in a certain location and what kind of fish like come in at certain times and then like the moon cycles. (Hikianalia)

For Hikianalia, field study, as an opportunity to further engage students has been underutilized in traditional mathematics instruction. Hikianalia is able to generate student interest through changing the learning environment as well as the source of instruction. By drawing on expertise of community sources, she encourages her students
to expand their worldview of what mathematics instruction looks like and where math learning can occur.

By hosting a “pō makemakika” Uakea has engaged families and the community to engage in mathematics instruction through games and use of manipulatives. It was important to “hōʻoluʻolu,” to make mathematics a pleasant learning experience for the families.

_Hōʻoluʻolu i ka makemakika no ka ‘ohana no nā makua me ka manaʻo e mālama ana mākou i kekahi pō makemakika no ka ‘ohana e hele mai ‘oukou a e ‘ike ana ‘oukou ma o kā mākou mau pāʻani ‘ike ana ‘oe akamai au i ka makemakika hiki nō ke ola. A ma o kēlā hiki ke ola, ‘ike nō au hoʻohana au i ka makemakika._

(Kīholo)

Through hōʻike, ‘Eleʻele has also been able to connect parents with what their keiki are learning in their “classrooms.” They have also been able to extend learning invitations to interested parents and community members. By fostering reciprocal learning relationships with students, parents, and communities Rovert has been able to open his mathematics classroom to greater learning experiences.

_There’s a lot of stuff that’s built into our schedule that makes it easy and super tangible. Every family’s required to show up on the last Saturday of the quarter so that the kids can hōʻike whatever they’ve been doing, there’ll usually be a theme so like one quarter will be like a math and science theme so everything we present is math science oriented and language arts oriented._ (Rovert)

He also views his role as a teacher, to “match” the school curriculum to the home learning environments of makua and kupuna.
I think we’re constantly checking ourselves to figure out, does our curriculum match with what they’re learning from their makua and their kupuna? And you know some of their makua and kupuna are lost, and admittedly so, and you know, they eat McDonald’s and they feel bad about it, but then we have so many other like, makuas and kupunas in our community that are still practicing, you know, like, they’re still feather workers, and they still weave, and they still... they still hunt, they still fish, they still take care of the forest, they still pound poi, they still grow kalo. So the way we check to make sure our curriculum is in check is does that match with what they would be getting from their kūpuna and how do we integrate the two together. (Rovert)

His acknowledgement that the school curriculum should also be responsive to what students are learning at home realizes the integration of ʻohana and community into the classroom.

**Communication between ʻohana and teachers.**

It was difficult as the researcher to differentiate between participant reflections on communication separate from their relationships with ʻohana. This excerpt from Rovert reveals the rewarding nature of working and living in the same community as your students.

*So the students walk past my house everyday. I get honks and horns and moped. Everybody going by says hi to me and because I live so close and we share a car my ipo and I and walking up to school so the first couple of years especially, when we were like real short on car... I’d walk up with the kids and walk down with the kids. It’s neat to just be living in the same space as a lot of them my*
family has like record of being in Makiki and teaching in Makiki and living up and around this area, that’s not my community because we focus on Papakōlea and Maunalaha and Wai‘anae yeah, in many ways that’s not my community so it’s hard to negotiate when to be that when to be part and when to not be part.

Even if you take…out like the Hawaiian-ness of it…teachers tend to teach not where they live…you know? And it’s…what I really love about ‘Ele‘ele is, when we see students in the store, they come and aloha us…and I would never do that with any of my teachers because there was this like, this barrier teachers lived somewhere else and they came in to teach you, and then they left which is unfortunately what, I think, West-side gets used to because there’s so much like, revolving door with the teachers. (Rovert)

**Relationship between ‘ohana and teachers.**

Rovert reflects here on the open and inviting learning environment that they have engendered at ‘Ele‘ele.

*We treat our students like family, their families feel welcomed here, they feel welcomed here, you know, when they walk into the door it’s just very, it has a very ‘ohana feel and I think that a lot of teachers and a lot of other schools can achieve that in their classroom, but then as soon as they leave the door, it’s like that’s not an ‘ohana space out there.* (Rovert)

Kīholo suggests that many of her parents may have had negative experiences with education, and mathematics in particular. She perceives that these negative experiences have created a fear of mathematics that is then acquired by their children.
ʻO kekahi mea ʻe aʻe, and it’s probably not very PC, but ʻōlelo au anyways makaʻu nā makua i ka makemakika, unless loaʻa iā lakou kekahi hana pili mau i ka helu, ka mea ʻo ka moʻohelu ʻoe, a i ole kekahi hanana ʻepekema a i ʻole kekahi mea pili i ka makemakika. Loaʻa nō kekahi he makaʻu, he hopohopo, i loko o nā kānaka no ka mea e like me kaʻu i ʻōlelo ai. He mea systemic kēia. ʻAʻole i kōkua ʻia kēlā mau mākua Hawaiʻi ma ko lākou wā a ke hoʻoili aku nei lākou i kēlā makaʻu i ke keiki. (Kīholo)

While not identifying the root of the challenges, Tristan commiserates on the lack of mathematical support for his Hawaiian language immersion students.

ʻAʻohe kākoʻo ma ka hale. He mea nui kēlā. (Tristan)

While Pūnana Leo, as a private Hawaiian language pre-school, mandates Hawaiian language courses for parents, as part of its educational program, these classes are not compulsory for families of students entering into KPK K-12; subsequently many parents who have not gone through formal Hawaiian language classes may not have the Hawaiian language capacity to engage their children at home. This is especially true for mathematics, which has its own large body of mathematical terms.

Summary.

The integration of ʻohana and community into the mathematics curriculum has been articulated in varying ways by the teacher participants. First, by taking students outside the conventional classroom school learning environment participants were able to draw upon the expertise of the communities and families as integral to their math instruction. Next, by reexamining what a mathematician looks like and subsequently what counts as mathematical knowledge, students were able to recognize the
mathematical expertise within their own families who still engage in traditional practices. Additionally, as there was a recognized reluctance of many families to participate in math related activities, schools would hōʻoluʻolu mathematics for the ʻohana so that they could change negative perceptions that families felt about mathematics. This allowed teacher participants to reengineer positive learning experiences not only for the charter school student but the entire family and community of learners. Lastly, one teacher also felt a high level of responsibility to have school curriculum parallel home learning experiences allowing for a reciprocal curriculum relationship on the part of the school, ʻohana and community.

Content

Key Component: Making learning meaningful and relevant through culturally grounded content and assessment

**Culture-based curriculum/content.**

*In mathematics, there is more potential for Hawaiian culture and certainly language to be integrated.* (ʻAlaea)

ʻAlaea’s simple statement encourages teachers to think creatively in integrating Hawaiian culture and language. She continues with the following ideas for professional growth and how she’s implemented these ideas to her own teaching.

*I also seek out opportunities, especially when they are free, on campus,*

*somewhere’s giving a talk about anything related to, especially related to Hawaiian culture, like Kalei Nuʻuhiwa giving a talk on campus for something going on in their loʻi on the other side of the island, or go to it, because, inevitably I’ll run into other educators I’ve befriended who are very cognizant of the issues in*
Hawai‘i. As far as math education and they’re actively looking for solutions, they’re eager to kind of talk story and share what has worked and what hasn’t worked maybe, like exponential relations with the concept of mo‘okū‘auhau, for example, and seeing if they would bite on that more than if I just explained it, oh, okay, this is how you might figure out mathematically. (‘Alaea)

Rovert notes that in gathering curricular ideas, he draws on the expertise of his own teaching faculty at ‘Ele‘ele. He made the pointed observation that close working relationships at his school were just as valuable as out of state conferences.

*Number one stop is our peers. I think we have so many different types of talent on our staff and I think a lot of people go to far away conferences looking for fresh ideas, and I think that’s good, and we are going to far away conferences, we’re going to Vegas and Milwaukee this summer, and Mid Pac too often we don’t have relationships with our staff at schools not enough to just share with each other, you know? Like, I get inspired walking into my colleagues’ classroom, because I don’t get to see them every day and you know, each of us have such a different style and you know, it works in all different ways that a lot of my new ideas just come straight off the other side of the campus from the community.* (Rovert)

Kīholo adds makahiki-inspired math to her curriculum development of lessons that she is piloting with her secondary students.

*We mine culture for inspiration, and seek out ways to connect difficult mathematical concepts to concrete experiences and ‘āina.*

*Hukihuki: Balancing equations*

*Kōnane: Coordinate plane*
Hōlua: slope, rate of change (Kīholo, 2013)

For Kīholo, combining experimental mathematics lessons with physical makahiki challenges, she provides content learning that easily engages students. Hikianalia gives an example of how she has been able to integrate her algebra content with larger issues of math and the environment within a context of social justice.

In algebra, among the key topics are rates of change and linear functions. At the Hawai‘i Institute of Marine Biology in Kāne‘ohe Bay, there is a super sucker that clears approximately a ton of invasive algae each time it goes into the bay.

Through a field study and experiential, real-world applications, students are able to make connections between mathematics and the environment. More importantly, they reflect on issues of social justice and being ethically responsible citizens. We need to clear invasive algae so we can protect our coral reefs, and this in turn positively impacts the environment and our island home. (Hikianalia)

In addition to social responsibility, Hikianalia challenges her students to change their perceptions about who is considered a mathematician and what mathematics learning looks like.

Write a reflection of a “mathematician” of your choice. This person cannot be of European ancestry and a male. At first, some students don’t know how to respond because in their mathematical training, they have studied mathematicians such as Euclid, Pythagoras, and Descartes. I try to provide my students with opportunities to validate their culture and community, and challenge them to take ownership of their learning by making individualized connections between the classroom and their real-world experiences. (Hikianalia)
Collaboration.

In addition to selecting content that had a cultural focus, Pualīlia expressed the importance of developing relationships for ongoing collaborative feedback while developing math lessons.

I’ve been involved with this thing called lesson study with our complex. So the small schools and the math teachers would meet, work together, make a lesson, and then one teacher would teach the lesson and everybody would watch, and then you know, take notes, see what the kids are doing, what they are writing, what are some problems they face and then we all come together and discuss. I got to go to other schools. It’s been the best professional development for me.

(Pualīlia)

Compartmentalization.

For Rovert, separating content into discrete categories is lasting a relic of colonial influence on the educational system.

You know in your naʻau, this is the things that they need to know, into these categories math…and then the science box and then the social studies box and…to me, things don’t really fit that well in to the math box, because the whole box, the box, the idea of math as a discipline, as a category, is a colonial idea.

(Rovert)

Place-based.

For Kuʻulei the understanding that mathematics occurs differently in diverse geographic regions comes easily. The language of counting, quantifying, measuring things in our natural environment would be particular to this place.
For Kīholo, this recognition goes a step further as she discussed the Uakea adoption of Singapore Math as a culturally responsive mathematics curriculum for her Kaiapuni school site.

Singapore math goes concrete, pictorial, abstract, which is exactly ke ka'ina hana a'o nō nā Hawai'i. So, kēlā progression concrete, pictorial, abstract, makes sense iā kākou na Hawai'i. At least kākou Hawai'i ma kēia kula so 'o ia ke kumu i koho 'ia kēlā papahana Kinapoa. Not because it’s better than ko kākou mea Hawai'i, but because its mākaukau ready to go and there’s lots of room i loko o kēlā polokalamu, kēlā papahana no ko kākou ho'okā'oi 'ana, so the other cool thing about Singapore math is that it’s based, all the problems are Singapore culture related so they’ll talk about. How many durians does Li Mei have and if Li Mei gives away 4/5 of the remainder of the 2/3 that he has then how much can he give to Shuan. You know like okay look this is stuff that those kids in Singapore know about they understand what it is. So we can take that as a la'ana and make that pili hou aku i nā keiki. Our kids especially these kids at Uakea need to have it be real, need it to be relevant, I cannot teach you about equations unless you see that equation to have a purpose so we chose Singapore math cause its gonna give us the best advantage to make Hawaiian math or Uakea math.

Kīholo’s support for the Singapore style of mathematics are predicated on the idea that both the style of teaching and place-based scenarios allow her students to readily
make connections to the content. She feels that through the math capacity building opportunities that Singapore math provides she will eventually feel comfortable enough to adapt it for the creation of Hawaiian math or even a curriculum particular to her school site.

**HCBE and mathematics professional development opportunities.**

The difficulty for some teachers is that while they understand their content area through a traditional lens, they may not feel as comfortable or prepared to develop curriculum that is outside a structured curriculum or text.

*I wish math could be more hands-on because these kids they hate being in the classroom for an hour and thirty minutes, working out of a book, they want to go outside, and we are the farmers, we’re known for farming but the kids now, mostly want to hunt, so they’re all into hunting, fishing, diving, all that kind of stuff, and I would love to relate it more to that... so they would be more interested, but it’s hard from a teacher’s stand, to provide all these lessons, and come up with all these things and then, I don’t know, to have it for every day... and to get past all the standards, it’s really difficult to do. I would love it if somebody could help me.* (Pualīlia)

She continued by talking about a proposed opportunity she had to integrate her math instruction with voyaging.

*Nainoa Thompson came two times to meet with us and they’re like, yeah, we think you’re so enthusiastic and we really want you on board and I was like, I’m down, but you gotta help, support me with something because I don’t know how I’m going to relate this in my class, because I don’t know how to navigate, I don’t*
know all this voyaging stuff...they’re like yeah, yeah, we’ll come back. And so and so’s like, oh you just wing it. I’m like, I’m not going to just wing it! I don’t know what the heck to do! (Pualīlia)

While voyaging is an excellent opportunity to integrate mathematics and cultural practice, Pualīlia did not feel comfortable to implement these lessons without proper training. Tristan echoes Pualīlia’s sentiment for the need of more organized opportunities for mathematics instructors to engage in professional development specific to HCBE in mathematics.

ʻAʻole lawa ka manawa e hana ai i kēia. ʻAʻohe nui nā kanaka e hana ana i kēia ʻano. ʻAʻohe hui ʻaʻohe kime e kākulu ana i kēia mau haʻawina. ʻO au ka mea wale nō. (Tristan)

For Tristan, the isolation and frustration that he feels as a new teacher tasked with the massive responsibility of instruction, curriculum development, and cultural integration for mathematics is an ongoing challenge. Kīholo suggests that the difficulty in HCBE curriculum development for mathematics when she attempts to connect “Hawaiian mathematics” to the idea of kaona, which is not “ahuwale.” In order to truly unveil the kaona, learners must be willing to dig deeper than the surface understanding of how they have experienced mathematics and truly immerse themselves in the culture.

E like paha me ka manaʻo o ke kaona ma ke mele, he mea ahuwale ʻole ka hoʻoilina makemakika Hawaiʻi. “I ka nānā nō a ʻike,” wahi a nā kūpuna.

Pololei loa kēia! Ke nānā aku kākou i ka hoʻoilina o ka wā i hala, ʻike ʻia nō ko nā kūpuna kamaʻaina i kēia mea he makemakika. He mea maʻamau ia, e like paha me ka hanu, ke kīkoʻo ʻana aku o ka lima; he mea noʻonoʻo kūhohonu ʻole
ʻia. No ia maʻa wale o nā kūpuna, ʻaʻole i lilo i mea kū hoʻokahi. Lilo wale i ke “kāʻei kua” o ka moʻomeheu. Na kākou o nei wā ke kuleana e ʻimi, e hoʻomōakāka, i lilo ia mea i ke “kāʻei alo.” I koʻu wahi manaʻo, ʻo ka pilina aloha ma waena o ke kumu a me ka haumana ka mea e hoʻoholomua ai kēia mea ʻo ka makemakika. “Na wai hoʻi ka ʻole o ke akamai; he alanui i maʻa i ka hele ʻia e oʻu mau mākua!” (Kīholo)

For Kīholo, in order to truly gain insight into what a Hawaiian mathematics curriculum could look like you have to search, dive, pray and dream through a Hawaiian worldview.

Pili nō ka makemakika i ka moʻomeheu Hawaiʻi. But, e like me nā mea ʻē aʻe ma ka moʻomeheu Hawaiʻi ʻaʻole ahuwale, inā hoihoi ʻoe nāu nō ʻe ʻimi a e luʻu, e pule, e moeā, nui ka pilina nui nō, inā ʻaʻole i loaʻa ka makemakika i ko kākou kūpuna, pehea lākou e hana ai i kekahi hana. (Kīholo)

Rovert offers a solution for a group of invested cultural mathematics teachers to become that critical core and develop HCBE math lessons through a concerted effort.

I think that’s one thing we need too. It’s time with native peoples, to have that time to sit and think about the culture and the math, just dive into it, instead of are you busy Monday? Ok, let’s meet on Monday…let’s have something where we all can collectively come together and know that, ok, we gonna talk about culture, but also about math. (Rovert)

While Rovert contends that as part of his teaching responsibility he attend many meetings to comply with school accountability measures, he acknowledges that having the space and time to critically think about a collaborative and comprehensive
mathematics curricula has not yet occurred. ‘Alaea supports his suggestion with the following encouragement for multiple contributions for a Hawaiian math curriculum.

*I look forward to there being more curriculum out there so that’s readily available, that teachers can, you know, they don’t have to look for it, it’s all ready. They’re well aware of it, they have multiple curriculum to chose from, not just the one Hawaiian math curriculum.* (‘Alaea)

**Summary.**

There were a variety of approaches undertaken by these teachers to integrate HCBE into their mathematics content. Participants spoke about attending community opportunities for learning and becoming the link to integrate culture with mathematics. Singapore math was discussed as a readily available curriculum that engaged student learning through culturally relevant scenarios. Important in this integration was the recognition that the Singapore curriculum was adaptive and also made room for lesson creation particular to makahiki. One participant looked at the idea that mathematics content should also engender socially responsible students in and out of the classroom.

While many of the participants discussed the freedom and opportunity they felt in developing HCBE mathematics curriculum for classroom use, several participants expressed their concern with trying to create content without proper training, support or time. Participants were also interested in multiple mathematics curriculum ideas that imbued HCBE and ethnomath. ‘A’ole pau ka ‘ike i ka hālau ho’okahi.

**Context**

Key Component: Structuring school, classroom, and other learning interactions in culturally appropriate ways.
Culturally grounded.

A lot of schools, the vision and the mission is sort of like something they put on paper because that’s what you do when you start an organization, but for us, we’re going to quote the mission and vision if you talk to any of us because like, we revisit it all the time and it’s central to what we’re trying to do. I’m pretty sure the mission is the three words: Hoʻokumu, Hoʻokele, Hoʻomana. (Rovert, 2013)

In Rovert’s thoughts, teacher investment into the mission and vision of the school is an integral part of fostering a culturally appropriate context. In addition to the school mission, he encourages his faculty to take the time to partake in the huli ka lima i lalo activities that lend themselves to school cohesiveness.

If we could just spend more quality time with each other, if we just work stream together, work loʻi together, I think we would understand each other better and feel each other better. I mean, like, certain people are slated to go on certain projects at certain times, but in terms of just the on-board-ness, it’s kind of like, if you don’t paddle, then within one or two years, you fall off our waʻa. (Rovert)

I maikaʻi ke kalo i ka ʻohā.

ʻAlaea continues with the “onboardness” idea that teacher “professionalism” should model the learning context through their appropriate behavior. At her school an extra emphasis was placed on teachers eating well and participating in community service activities, often these activities took place during non-school hours.

I liked that they privileged Hawaiian culture especially with so many students, or just I guess I’m biased I think that any school in Hawaiʻi should privilege Hawaiian culture. I also liked the way that they emphasized holistic well being.
They wanted the kids to eat healthy and so they weren’t allowed to bring junk-food to school as a part of their lunch and they were encouraged to do community service, engage in outdoor activity and things that benefit their community along with their academic stuff that is what they encouraged, that was like the philosophy. (ʻAlaea)

For Kīholo, the kuleana of being named after such an important Hawaiian figure is apparent in their school mission. She even goes as far as to express that each teacher, student and family should be versions of this paragon.

‘O ka nuʻukia o kēia kula nei, ʻo ia nō e mâlama ʻia ʻana ka maualiola o kākou mai kēlā hānauna a i kēia hānauna me ka manaʻo na kākou, nā kanaka e ola nei i kēia wā na kākou ke kuleana e hoʻomanaʻo, e hoʻohana a e hoʻolaha aku i nā mea o nā hānauna ma mua a e kanu aku ma ke ʻano he ʻanoʻano ma ke ʻano he huli paha i loko o nā keiki o kēia ko lākou wā i hiki ke ola mau nā mea Hawaiʻi i i hiki ke hoʻokāʻoi paha inā ua hiki ke hoʻokāʻoi. Manaʻo mākou he mea kūpono a he mea maikaʻi kēia ʻoiai ʻo K. K. Uakea ko mākou meʻe, he meʻe Mauiliola ia no mākou ke kula. A ʻo Uakea kekahī kanaka i hoʻopōmaikaʻi ʻia me ka ʻike pāpālua ma kekahī ʻano no ka mea ua ola ʻo ia ma kekahī wa kāhului ua ʻike nō ʻo ia i ke koʻikoʻi o ka me Hawaiʻi ka mea kahiko a ua ʻike nō ʻo ia i nā ālaina a me nā mea paʻakikī e hiki mai ana ma ka wā huliau. (Kīholo)

Culturally relevant community of learners.

The interest of the kids, they always come into the room hating math, hate fractions, and hate negatives, adding, subtracting negative numbers…that’s the two hardest things we struggle with, so I try to provide a good environment for
them so they like me, so they kind of think, oh she’s cool, so maybe you know, math is cool too. I would say just the standards and what the kids got to know and how it doesn’t, you don’t really use those things in real life, so they don’t really care about it. (Pualīlia)

Through fostering positive relationships with her students, Pualīlia inspires her students to connect with their own math learning and to rethink their hatred of this content area.

**Community well-being, kuleana.**

*I’m trying to create agents of change who will look at things differently and challenge the status quo.* (Maile)

For Maile, mathematics is an important tool to foster students who will change undesirable circumstances, and challenge the status quo. Kuleana, a complementary understanding of social responsibility is explicated with this statement of Rovert's regarding his students.

*Grounding in foundation like the direction, connection which the students are going and then student empowerment, and so, everything we do is around those things and the ultimate long term vision is to create students who are agents of change whether that’s local, regional, or if they choose to like look at more global issues, but that school is an active thing and that a teacher’s going to give you something, you need to give something back to your community, whatever community you feel pili to I think if you stick around long enough to graduate, you graduate with a sense of kuleana, whether it’s your lāhui, your ‘āina, your ‘ohana,*
or just your favorite teacher, but you graduate feeling like you got something and
you’re going to give something. (Rovert, 2013)

For Rovert, principal among his own responsibilities as a teacher is instill the idea
of kuleana into his students. While this kuleana may vary for each student, the
recognition that they have a larger responsibility to effect positive change is foremost. He
continues here with his personal understanding of his kuleana as a “critical other” relative
to his students.

*I came into this movement and this renaissance from a political standpoint, being
a haole-Japanese settler and trying to deal with that, and then relearning history
and how history took place. I became a teacher because I think we waste so much
time, like, waiting for kids to come and come and finally, it’s like they go to
college and they then maybe then they’ll wake up and kind of see what’s going on
and I think it’s an opportunity to sort of short-cut all the B.S. in order to realize
what your kuleana is. So I like the idea, it’s just an experiment really, of trying to
start the discussion of kuleana earlier in a student’s life. (Rovert)*

For Pualīlia, being raised in Wai‘anae in a geographic area with large numbers of
Hawaiian families, and quite often associated with negative socioeconomic statistics
instilled in her the kuleana of giving back to her community. Her easy rapport with
students and expertise in teaching mathematic in addition to her roots in the community
gives students the encouragement that they can excel too.

*I taught in Wai‘anae, of course, which was my hometown, my own community,
which I always want to give back and I always wanted to teach other Hawaiian
kids, especially math, because I majored in math and I didn’t know what else I
wanted to do in life and so I figured I could help other kids achieve their goals through math. (Pualīlia)

While teachers may never know the impact that they have on all learners, Hikianalia spoke enthusiastically about the positive influence that teachers have had on herself and her mentor, Nainoa Thompson, through a return to celestial navigation. *Pwo navigator and Polynesian Voyaging Society Executive Director Nainoa Thompson* talks about the process of learning and to the role of education. What changed learning for both of us was having teachers as role models that invested in each individual student on a personal level. These educators weren’t just teaching content such as quadratic functions, but they thoughtfully explained the relationships between intercepts, zeros, and solutions, and how these pertained to life. (Hikianalia, 2013)

**Summary.**

For these participants, having the opportunity to teach in a context directly impacts their ability to implement the other HCBE components. There was also recognition that in some teaching contexts, individual teachers may feel empowered to implement HCBE practices but there may not be a critical mass of teachers who have the ability to make connections outside of their individual classrooms.

**Assessment & Accountability**

Key Component: Gathering and maintaining data using various methods to ensure student progress in culturally responsible ways.
Demonstrate knowledge/skills.

We need to pass that test and so, here we were when we pass the test and then the next year they tell us we’re failing again so I think we’re ready to just say, f%&k you guys! (Rovert)

Teachers feel extremely frustrated with testing measures that are imposed externally.

*I work for the D.O.E., so our focus is always to pass the test. No, like it seriously is I’ve been to so many trainings. Now we’re gearing towards the common core curriculum, so of course, that’s everything I’ve been learning about and that’s our whole goal, is everyone's kids do a benchmark test to practice for the test and then they have three chances to take their test to pass so we’re always like keeping track of their scores and then we have this thing where we adopt students, so like, the students that are really close to passing then teachers will adopt them and work with them one-on-one. (Pualīlia)*

While Pulīlia communicates a model that they have utilized for tracking student benchmark scores and subsequent student adoption, Tristan encourages a school-wide, longitudinal model for managing student progress.

*Hau‘oli loa au inā hiki i ke kula, inā hiki i nā kumu āpau ke kākulu i kahi streamline curriculum. Mai ka papa mālaa‘o a i ka 12. Laki kākou laki kēia kula he papa mālaa‘o a i ka papa alaka‘i. Mana‘o au, there should already be one in place. So you can track the progress of every single haumāna from kindergarten ‘til 12th grade. You can see what their strengths are. (Tristan)*
Pualīlīa continues with the changing nature of DOE processes regarding student assessment under the CCSS.

*Math is so much more complex in schools today using Common Core Standards, and even I have to take a step back and really figure out how to explain to the students how to answer the question. The DOE has even changed their HSA tests and now instead of having multiple-choice problems, students must be able to explain, justify, and show on the test. I hate that I always have to think about these tests and the seriousness of them, I wish math could really be explorative and fun where the students have no fear of getting a wrong answer because it isn’t always about just getting the “right” answer, it’s about how you got your answer and if it makes sense.* (Pualīlīa)

Romert expands on the hukihuki that he feels as a teacher being responsive to the needs of his students, as future kūpuna.

*Should we set up this eleventh grader to go to college and be successful in a math classroom? Or should we set up this eleventh grader to be a valuable kūpuna that understands the plight of the world and does something about it. We try to de-emphasize the idea of your math intelligence is your total intelligence but I think that at our core, some of us still believe it all of us still believe it to some extent. We don’t want the kids to feel that way, we ourselves as teachers went through that system, we all jumped through that hoop, and we all got Master’s degrees because we had the SAT scores to go to college. I try so hard to get my staff to not only praise the three hundreds but it’s just so natural that that’s what happens so I hope you’ll never hear me say that these are the kids that made it. I always say,*
these are the kids that improved the most, because these are the kids that tried the hardest to make a difference, but we’re stuck on that. We’re so stuck on that. Yeah, had one girl go up like seventy points, which is like many grade levels, in a course of half a year, but she didn’t pass and so she wouldn’t have been recognized but I gave her a certificate. (Rovert)

Rovert recognizes that imposed assessments do not accurately reflect the progress that students have made, and may not encourage them to grow as learners. Maile expands with her thoughts on how cultural and traditional math have been treated as though disparate and unconnected, in classroom instruction as well as in internal struggles over what students should know.

*I would say it (culture) doesn’t often enter into traditional math, but this is new, the field of ethno-math just started, like in the 70s. So I’m hoping it will be more, I’m struggling with how I integrate it. I don’t know, because there’s this dichotomy of how I want to explore traditional ways of knowing, but I feel this responsibility to prepare students with what they’re expected to know. You know?* (Maile)

Kīholo and ‘Alaea, both high school teachers, discuss the challenge of student remediation, and students not having learned (well) the mathematics that should have been covered in previous instruction.

*Kids aren’t prepared for the levels of math that they are suppose to be receiving on paper kids still struggle with decimals, fractions, all kinds of basics, I think pre-algebra basically, they feel kind of shaky on, maybe they just remembered something long enough to put down on the test and then they received a high*
enough grade that they’d be able to be passed on, maybe the teacher ran out of time in their previous school years, but I feel like most of my time in that year was spent, because I was teaching pre-algebra, algebra, geometry. Most of the time I spent reviewing previous concepts they should have known. (ʻAlaea)

Kīholo support this sentiment but continues with the following encouragement for struggling students, saying if they will just persevere that is how they will succeed.

Any kid no matter what pae they are if they’re super struggling or super got it, if they can only put in investment of time if they just try pēlā e lanakila ai. Pēlā e aʻo ai. For a keiki to be mākaukau not only should they know how to multiply and add and subtract and divide. And know about fractions and decimals and percents by 7th grade but they should also be hoihoi. (Kīholo)

While teachers grapple to implement assessment and accountability measures that accurately reflect student learning, Rovert offers the following suggestion for future student assessments.

I think it’s going to take another generation. I think we’re too spoiled already. It’s going to take a generation of kids that grew up in a world where it wasn’t emphasized. The Kaiapuni kids and the charter school kids, and hopefully they can paint a vision of what a smart student looks like.

(Rovert)

The notion is that students who have been raised in learning environments that honor HCBE, like charter and KPK settings, should one day design the assessments for future generations of learners.
I think what’s missing is a focus on children. I think our focus is on standards and on assessment but not on children. Children should be the focus. (Maile)

While Maile reminds us to return our teaching focus to the needs of our children, teacher participants commented at length regarding the stress of dominant assessment and accountability measures implemented in their schools. While trying to honor HCBE in their mathematics instruction, teachers also feel the pressure to increase student performance.

**Application.**

ʻAlaea gives an example of how she was able to connect her classroom mathematics assessments with the school’s project based learning.

*I would ask a student a question about involving degrees, so they would be a geometry student, and they would have to try to change the direction of the canoe to go in that direction. This has happened on one occasion, it was really cool…so I didn’t say, okay, your final is this, but it gave me hope that might potentially be a form of assessment, being able to be in some kind of situation and if they don’t make the right call, we’re going to hit the reef, or something’s going to happen that motivates them. (ʻAlaea)*

She also gives us an example of how reframing classroom assessment can be used to create collective success.

*They were also assessed based on their willingness and ability to help other people because sometimes students could easily help other people, they are very smart, they’re very bright, and they’re very, well skilled in math but they wouldn’t necessarily lend their skills to help anybody else…and then other students maybe*
wouldn’t get it as well but they would try to help others and, in doing so, that’s where they would have their aha moments, which is awesome to see, because they felt empowered and they were also empowering someone else, so that was really great to witness. (ʻAlaea)

**Value to community, culture.**

*Our success is just passing the test, their HSA test, that’s all they really have in ninth and tenth grade anyway and then, even the jobs there are so like scarce it’s scary.* (Pualīlia)

In this quote, Pualīlia shows the pressure that she feels to have her students pass “the test,” and while her students are a few years away from graduation, she reflects on the bleak job market for her students. For Tristan, the perceived benefit of increased student math competency is the alleviation of economic pressure for families.

*Whether it be finances, pilikia nā kanaka āpau i ke kālā. Mālama kālā, pilikia loa kēlā. Inā hiki iaʻu ke noʻonoʻo ke kolikoli paha e wānana i ka hele ʻana ke kālā i ʻō i ʻaneʻi. You have them worry less about money you have less problems at the house. Then they don’t have to worry about being poor. That’s just one big pilikia for everybody. Its just the kālā and a lot of the time it’s cause they don’t know math.* (Tristan)

**Summary**

While teacher participants were amenable of using HCBE type assessment in their classroom they also spoke very passionately about external assessment and accountability measures they felt they had little control over. They also spoke adamantly against high-stakes testing measures they felt did not accurately assess the mathematical capabilities of
their students and imposed labels on their schools. Ironically the schools that have the
greatest potential to implement HCBE mathematical assessments may also be the schools
under the greatest amount of pressure to demonstrate increases in their student
performance through assessment measures that are not culturally based.

“Other” themes

The following excerpts examine the salient themes that were not specifically
addressed through the HCBE framework, but played an important role for these teacher
participants.

Cultural knowledge insecurities.

For Maile, her reluctance to include certain aspects of HCBE was rooted in
perceived lack of expertise in her Hawaiian-ness. She didn’t feel that she had the right to
speak on behalf of Hawaiians because of being raised in a way that she didn't feel was
Hawaiian.

I’m Hawaiian, but I don’t feel qualified to be Hawaiian. So, just because I have
the blood, doesn’t mean that I behave in what I believe to be Hawaiian ways and
so, I don’t believe I have the right to talk about what the role is of Hawaiian
culture or the role of Japanese culture, or the role of like, it’s just hard...I feel
like what I need to do and I think what all people need to do, who are in
education, is be sensitive to the multiple ways of knowing and being that all of the
people are coming with for me, I think, being sensitive to all of the ways that
children in particular can be singled out or the ways in which they feel like
outsiders. (Maile)
For those taking on the kuleana of HCBE and other systems of imparting Hawaiian knowledge, we must be careful that we do not further alienate Hawaiians from cultural knowledge while trying to impart it. Ledward (2007) cautions with the following:

There is incredible diversity within the Hawaiian community. Yet oftentimes Hawaiians are imagined to be a homogeneous group… Generations of American influence—and the importation of racial thinking in particular—continue to impact the way Hawaiians are seen and the way we see ourselves. (p. 107)

**Ahikā.**

For geographic areas with tight knit social networks, it is sometimes challenging for those who have been away for extended periods of time to reengage in community exchanges.

*Taking the time to get the information you need that’s really going to be valuable and worthwhile and so I feel that conflict sometimes in my own community. When I go back to Hau‘ula, a lot of people from the community know that I went to school for a long time. When they find out that I’m a doctor, they think I can help with everything from medical conditions to divorce papers. However, when I explain those are not the skills I learned, they think, ‘Why did you go to school for so long and what good is your degree?’ Sometimes formal education creates a non-visual veil. (Hikianalia)*

While Hikianalia may refer to this as a non-visual veil, for many indigenous communities there is an honor that is afforded to the ones that maintain the kuleana of place. While kamaʻāina or kupa may express this Hawaiian sentiment, Tinirau, Gillies,
& Tinirau, (2009) describe this in the Māori context with the honorific title, “ahikā,” afforded to the elder members that have “active participation in residency, land ownership and utilistion” (p. 11). As scholars we are reminded that certain kuleana go with those who attain advanced degrees and certain kuleana go with those who are the ahikā.

**Hierarchy of knowledge.**

Through creation of CCSS in mathematics that give mathematics a preeminent place in all classrooms, Maile recognizes that those who do well in mathematics have an increased opportunity for life success.

*Math opens and closes doors for people and so, just in that…in it being this kind of gatekeeper for whether or not you can do this in life or that in life. It’s political in nature…which means that…it has all of these social connotations and implications…It gets into critical race theory and all that kind of stuff…and…because the people who are successful at math, do things that allow them to be in the upper, you know? I don’t know…but we don’t give kids enough experiences to allow them to succeed…and when there is a history of your culture being denigrated, when you feel like you’re less worthy than other people, you automatically do worse. (Maile)*

Maile supposes that by the very nature of prolonged cultural denigration, Hawaiian students are less inclined to perform well in mathematics.

**Common sense.**

For Kuʻulei, a math learner who progressed through mathematics classes with relative ease, her relationship to struggling mathematics learners was one of empathy.
Math is one of the reasons that I became a teacher. I understand that many students struggle with math learning, and I wanted to help students in this content area. Over the years in my own classroom, I seem to find many more challenges teaching math than I ever did learning math. At times, I am not sure why students do not understand a concept that seems “common sense” to me. Being a teacher has forced me to really dissect my own understanding of math concepts in order to better equip students. (Kuʻulei, 2013)

By “dissecting” her own learning she is able to better equip and engage student learning in mathematics.

**Gender gap.**

Maile recounts her negative experiences as a female, prospective mathematics major in a male dominated field.

*My first and second semesters of calculus went generally well. I think it was because of the multiple representations involved. From there I felt discriminated against as a woman pursuing mathematics, and changed my major from mathematics to education.* (Maile)

“American women are not only given low expectations from the start for success in STEM subjects (science, technology, engineering and mathematics), but also are seldom encouraged, sometimes even discouraged, to pursue higher education in these fields.” (“Women still face gender bias in math, science fields,” n.d.) As an educational community we need to reexamine how we mentor (or not) females in math related fields.
He Punaha'le.

Throughout the teacher participant interviews there was an overwhelming sense that there was one mathematics teacher that had played a special role in fostering a love of mathematics learning for the teachers.

My most memorable mathematics teacher/role model was Mrs. Mary Jane Esera at Kahuku High School. Mrs. Esera instructed me in Algebra II, but more importantly she taught me about life and to always remain firm in my values. She used mathematics as the great equalizer to allow us to find our voices and never be ashamed of them. No matter where we came from, she acknowledged our experiences and backgrounds. Mrs. Esera took the time to listen, learn, and love. Mathematics was the platform for validating our ways of knowing and helping us achieve our personal goals and dreams. (Hikianalia)

I had my most positively memorable math teacher during Grade 10 (for geometry). She was very warm to everyone, but she also seemed to favor me, partly because of the effort I put forth but also likely due to our personal connections (e.g. we had similar sounding first and last names, she was jogging buddies with my track coach with whom I was also close). She could also sense when I was having a bad day and would offer to listen if I wanted to talk about what was bothering me. She always seemed to put her students first. None of my other teachers had been like that. (ʻAlaea)

Let me put it on record then, seventh grade, was my favorite teacher ever, Mr. Higa and after that I hated all five of my next math teachers until I graduated but I did really well in math, I always did well. My lowest grade I ever got was in a
class just because I hated the teacher and it was in math and I knew all the content but I just didn’t want to do her work, was the only C I ever got. (Rovert)

My favorite math teacher was Mr. Ford. He was funny, and presented a lot of real life math applications that helped me make connections. (Kuʻulei)

Eia naʻe, ma ka papa ʻumikūmākahī, ua ʻae ʻia au ma ka papa Hōʻailona Helu II. Na Kumu Jeanne Nelson i aʻo, a nāna au i paipai mai. Ua hoʻi maila ka haʻaheo iaʻu, no ka mea, ma lalo o kona ʻeheu, ua komo hou ka paulele i loko oʻu. “Hiki iaʻu ke hana i kēia. Ua lawa nō koʻu hiki. He keiki akamaʻi au, a ua hoʻolako kūpono ʻia au. ‘Ae, paʻakikī kēia polopolema, akā, ua lawa nō ka manawa, ua lawa nō koʻu ʻike; e noke!” Ua ʻokoʻa ʻo Mrs. Nelson, no ka mea, ua ahuwale kona aloha i kāna hana. Ua ʻimi nō ʻo ia i ala noʻu, a inā nō au i nalowale ai, nāna au i kiʻi, nāna au i alakaʻi, nāna au i aloha. Kaino a he mea naʻau ʻole ka makemakika, he hana helu wale nō; eia kā, ma o ka pilina aloha, a me ka mālama naʻau, i lanakila ai. Nākili maila ka noʻonoʻo oʻu, ʻo ka pilina aloha ke ala e kaʻi ai, i waiwai aʻe ka makemakika i ka haumāna. (Kīholo)

By acknowledging and validating learner backgrounds, these teachers fostered a lasting love of mathematics for these teachers. Gay (2000) suggests,

Culturally responsive teaching can be defined as using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them. It teaches to and through the strengths of these students. It is culturally validating and affirming. (Gay as cited in Strong Makaiau, 2010, p. 29)
I had an Algebra II teacher that scared me to death, in fact she scared everyone and I even tried to switch classes when I was assigned to her. Somehow it did not work and thank goodness because I was meant to be in her class! She was definitely scary, she would literally yell at students, but for some reason I absolutely loved her. I felt like she was the best math teacher in the world because she explained everything so well and ALWAYS provided good examples. It could have also been the fact that I was so scared of her that all I wanted to do was please her so I tried my best, but hey I guess it worked because I learned so much that year, I almost scored a perfect score on my SATs (the math portion of course). (Pualiliia)

This chapter highlighted the complex nature of integrating Hawaiian Culture-Based Education into current mathematics instruction. The initial critical components of HCBE Language, Family and Community, Content, Context, and Assessment and Accountability were each addressed by the teachers within their personal teaching lens. Teacher participants complemented the structure of the current HCBE framework by suggesting additional critical HCBE components. As participants explored their own teaching and learning experiences within their unique contexts, unanticipated themes emerged from the data that contribute to a fuller understanding of HCBE within mathematical educational contexts.
Mokuna VI: Conclusion

Introduction

As articulated in the introduction, this dissertation sought to explore Hawaiian ethnomathematics through multiple lenses by answering the following questions.

1. How can critical analysis of Hawaiian archival texts contribute to an ethnomathematics perspective for teaching mathematics and learning mathematics?

2. How does teacher discourse reflect incorporation of HCBE together with ethnomathematics into the teaching and learning of mathematics?

In this chapter I discussed my impressions and thoughts about the findings of the study as they pertained to its implication for the field and its stated purposes. It is my hope that this research contributes to the larger body of indigenous research by critically engaging with Hawaiian language texts to challenge dominant Discourses in education. It is also hoped that the voices of teachers working to include HCBE and ethnomathematical approaches in their teaching and learning of mathematics will empower other educators to critically engage with their instruction.

Hawaiian Archival Texts

The critical analysis of Hawaiian archival texts allowed for a deeper understanding of the role that western education played in displacing a Hawaiian mathematical worldview within formal education systems. It is imperative that we use these “new” understandings to rethink contemporary mathematics curricula used in Hawaiian educational settings through engaging a critical ethnomathematics approach:

∞ Challenging the Eurocentric narrative in mathematics;
Challenging what counts as knowledge in school mathematics;

Challenging the disconnections between mathematics education and social and political change. (p. 72)

Challenging the Eurocentric narrative in Hawaiian mathematics directs teachers to rethink “universal” and/or “neutral” mathematics instruction in historical and contemporary teaching that have been used to homogenize content in educational systems. The myth of the “Common Core” relies on indoctrinating diverse learners into believing that their people did not have mathematical intelligence and/or the knowledge of their people is not worthy of being taught in contemporary classrooms. By having universal standards for mathematics, the unique ways that different cultural groups perceive their mathematical universe become null. It was important for me that in challenging the Eurocentric narrative that I did not confine my challenges to the Western/Hawaiian dichotomy within existing structures. It is more meaningful for me to explicate how these texts unveil understandings that are completely overlooked in mathematics instruction today.

To challenge what counts as knowledge in school mathematics we look to our written, and cultural practices to elucidate how mathematical intelligences have been purveyed by Hawaiians for Hawaiians. If we believe that education should empower Hawaiian students to articulate their learning through a Hawaiian worldview, education should be done in a way that is supportive of this goal. Strong critiques of the way that knowledge is constructed within school settings and compartmentalized to promote narrow understandings of what knowledge is valuable actually undermines the intent wide sweeping accountability measures by taking a paternalistic approach to education.
The disconnected nature of mathematics education within schools begs the question, “When am I ever going to use this?” For Hawaiian children who are particularly vulnerable to the negative effects of poor education, meaningful learning experiences must include learning opportunities that strengthen their connection to their inherent mathematical knowledge systems. I pay particular attention to the foundations of mathematical knowledge within classrooms that are contrary to Hawaiian epistemological understandings.

**Helu Hawai‘i.**

In examining missionary primers we learn that early missionary-run schools used education to imbue teaching with Christian dogma. Lessons taught to students encouraged them to forsake their traditional (“sinful”) ways, “Pili ka make i ka hewa” (Figure 1) in order to gain everlasting life, “Hele ke ola me ka maikai” (Na Na Misionari i Pai, 1835, p. 9). Other texts went as far as using mathematics to enumerate biblical verses whose ideology was in direct conflict with Hawaiian customary practices. Hawaiian parents had great hope in sending their children into formal education settings. Kanepuu’s own father Maoloha encouraged his son’s formal education with the following.

> E kuu keiki, aole o‘u makemake i ka paani a me ke kaloh, hookahi a‘u mea makemake nui ia oe, o ka mea au e hele la, oia hoi ka imi ana i ka ike mailoko mai o ka wailanahu a ka haole, oia hoi ka imi ana i ka ike i ka palapala. (Charlot, 2005, p. 20)

While Kanepuu was well versed in “ka ike i ka palapala,” his writings also examined examples of native intelligence omitted from formal education settings.
Kanepuu’s (1867) account of the kanaka lawaia employed to fish for the alii demonstrates use of both systems--customary one common for Hawaiians, and the “helu haole” taught in schools. In this first example the alii asks, “Ehia ka nui o na ia?” The fisherman responds “Hookahi lau me ka au eiwa.” When the alii asks again becoming increasingly irritated with the fisherman’s use of helu Hawai‘i, “Ehia ka nui o na ia? The kanaka lawaia then changes his answer to “760 ia.” Kanepuu makes a point of explaining that this fisherman, adept in traditional counting, utilized the counting system of the foreigners to accommodate an increasingly foreign influence on education.

“Hoololi ma ka helu haole e ao mau ia nei ma na kula” (p. 3).

In Kanepuu’s next example, the alii asks “Ehia lau huli?” the kanaka answers “Hookahi tausani me ekolu haneri.” The alii again asks, “Ehia lau?” Being trained in formal schools this kanaka was not well versed in traditional counting, and could not answer the alii. “Aole au i ike i ka helu Hawaii.” This moʻolelo demonstrates that even as early as 1867, concerns were raised with the ones who could not count in the way that their ancestors did.

Similar to contemporary translation efforts, Alexander (1901) explains how early American missionaries used Hawaiian understandings of their number systems to create new words that facilitated the Western counting system.

In the Hawaiian language at least, there was a separate term for 30, kana-kolu, while 40 was kana-ha. Ten forties made a lau, ten lau a māno, ten māno a kini, and ten kini a lehu =400,000. The American missionaries simply extended the use of the prefix kana to other tens, up to 90 inclusive, making kana-lima for 50,
kana-ono for 60, etc. They also introduced the foreign terms haneri for hundred, and tausani for thousand. (p. 203)

If the number base system is the very core of larger mathematical knowledge construction, these translated changes have manipulated the Hawaiian number system to mirror the Western style. While this may not be problematic, the subsequent omission and erasure of these cultural knowledge contributions within schools is.

It is important to note here that for communities that have enjoyed uninterrupted access to their natural resources and traditional customary practices, traditional counting systems continue to flourish. In a recent visit to Wailuanui, Maui, I was fortunate to learn about the communal fishing practices inherent to this place. A school of fish had come in (‘akule, I think), so roles were assigned to the experienced lawai‘a. For some, their kuleana would be to paddle the canoe out to the school, for others, they would need to dive to ensure a good catch. When the nets came, the community came together to open the fish from the nets. Each participant received at least one kaʻau of fish for helping with the effort, for those who had taken on more responsibility like the canoe paddlers or divers, they were given two kaʻau. Special consideration was also given to kūpuna who were not able to physically attend the opening of the nets.

He mea ua maa mau ma na wahi lawaia malolo, anaeholo, amaama, a pela aku, ua helu no lakou ma keia halu [sic] maluna ae nei, e kakaikahi nae ka helu mau ia o ka mano a me ke kini, no ka hiki ole aku o ka nui o na ia ilaila. (Kanepuu, 1867, p. 3)

While we seek to revitalize our Hawaiian language, we must also recognize that our math systems are inextricably linked to our cultural practices. It is counter
productive to focus our sole attention on test preparation for students without engaging these learners in the practical experiences that facilitate “deep learning” nurtured through cultural practice.

**Malama Hawai‘i.**

From birth, Hawaiian children are taught to locate themselves within the arrangement of the Gregorian, Western-style calendar. Through alluring tunes coupled with repetition children commit to memory the progression of Western months that begin with January. These primary teachings obscure cultural understandings, foundational in Hawaiian relationship to time and space. For Hawaiian families a child’s first birthday is particularly significant in that it celebrates their survival during their most vulnerable year. The Hawaiian year and the Western year, however, do not match up. “A year, by Hawai‘i’s lunar reckoning, has gone by and the child is well and strong. Then let the ‘ohana rejoice with a major feast of thanks-giving: Ka ‘Aha ‘Aina Piha Makahiki” (Pukui et al., 1979 p. 37). While the difference of days may not be significant from a Western perspective, for Hawaiians location within space and time during the Malama Hawai‘i determine future well being for the child. Fornander and Thrum (1920) go on to tell us “E like me ka malama hanau, pela no kona ano a me kana hana, ina he waiwai, a ina he ilihune, a ina he punahele” (p. 139).

As we learned from the Gregorian and Hawaiian months by island (*Figure 4*), different islands had their own understandings of which lunar month matched up with Ianuali. By creating a one-to-one correspondence with the cycle of malama Hawai‘i it does not take into account that lunar and solar months do not match up exactly, or that this articulation was different on each island. Tsuha’s (2007) research goes into
meticulous detail of how the Kaulana Mahina manifested on each island, and showcase
an expertise and intricacy worthy of further exploration for classroom use.

Ka Hanau ana o nā Malama (Figure 5) we (re)learn our genealogical connection to the Malama Hawai‘i.

Primary in this mo‘okū‘ahau is our relationship to dark and light, followed by the
stratum and foundation of the earth; these elements as familial connections, sky and the
earth, mountains and their ridges, the great expanses of the ocean, and everything in
between. These interconnections contain critical mo‘okū‘ahau discourses crucial for
developing children’s understandings of their connection to ‘āina in perpetuity.
“Different orientations toward time and space, different positioning within time and space, and different systems of language for making space and time ‘real’ underpin notions of past and present, of place and of relationships to the land” (L. T. Smith, 1999, p. 55). These different orientations have manifested in the creation of translated vocabulary to accommodate foreign understandings of space and time, taken as Hawaiian truths.

ʻAole pau ka ʻike i ka hālau hoʻokahi.

All knowledge is not taught in one school. By extension all mathematical knowledge is not found within the purview of Western educative standards alone. While theoretically possible to engage learners in multiple understandings of number systems, formal education has privileged dominant knowledge systems and demonstrated hegemonic rather than collaborative relationships within Hawaiʻi’s school settings.

Through analysis of the archival texts, I have found examples of the comingling of the systems and an appreciation for learning new knowledge while not forsaking customary understandings.

Memmi (1991) recognizes the difficulty for colonized peoples to accommodate the acquisition of colonial knowledge while maintaining their own cultural knowledges with the following, “Indeed a man straddling two cultures is rarely well seated, and the colonized does not always find the right pose” (p. 168). However, early archival texts do substantiate the hope that Hawaiians felt embracing new literacy while remaining steadfast in their culture, they are also critical of dominant Discourse within formal schooling. “Heaha ko oukou mea i haalele ai i ka helu kahiko o ko kakou aina, kainoa e hana no oukou ma ka helu hou, a e hana no ma ka helu kahiko” (Kanepuu, 1867).
A particular example of the Hawaiian mathematical hybrid was evident in examining the market prices (*Figure 11*). Anana, iwilei and muku are used alongside Western money (keneta) and weight systems (pauna). This example is indicative of multiple quantifiable understandings being utilized in a multicultural society. This example also indicates that because the Hawaiian language was still the language of the commerce, foreigners had to engage learning and speaking Hawaiian in order to successfully navigate the exigencies of trade.

**Hawaiian Culture-Based Education + Ethnomathematics =**

The teacher participant discourse supported the use of ethnomathematics together with HCBE for mathematics teaching and leaning depending on their personal teaching strengths and expertise.

There is a wide variety of interpretation by teacher participants of HCBE in the classroom. HCBE, while explicated through it central tenets may be heavily dependent on the person exacting it, guided by their own knowledge expertise within their content area.

Through collaborative construction of the HCBE frameworks “research developments add to the growing base of knowledge and practice that empowers us as a community, providing new perspectives and approaches to aid our journey forward as we seek to strengthen and grow our Hawaiian lāhui” (S. M. Kanaʻiaupuni & Kawaiʻaeʻa, 2008, p. 86). The community of practice, however, must be able to utilize the HCBE framework in a way that is meaningful to their craft.
Language: Recognizing and using native or heritage language.

The participants’ reflections on their use of Hawaiian language for mathematics instruction were diverse. There was universal agreement that Hawaiian language is an important component for HCBE instruction, but less understanding for how this could be done in mathematics, a content area that is strongly textbook driven. For ‘Alaea it felt very natural in her charter school setting to utilize Hawaiian words and phrases with her students. Even though at times she was not teaching students that were within a Hawaiian focused charter school, her rationale was that Hawaiian language is an official language of the state, so her students should recognize this. For the teachers who worked within KPK settings, there was a formal established commitment to using ‘Ōlelo Hawai‘i in their instruction. Their concerns, however, with using Hawaiian language within the classroom were demonstrated in three ways.

First, teacher participants readily acknowledged their second-language (NEO) status, and had concerns about their Hawaiian language competency, particularly in teaching mathematics, a content area that has created its own Discourse. Kuʻulei expressed that she had never had the opportunity to enter into a university course or professional development opportunity in which mathematics and Hawaiian language were engaged simultaneously. This means that many KPK instructors are left to bridge the two content areas for the classroom instruction.

Second, KPK participants acknowledged that there was limited opportunity to engage in formal and informal proficiency evaluations once they left university run Hawaiian language classes. As many KPK schools are located within larger mainstream English settings, it is atypical to find administrators who are able to properly evaluate
Hawaiian language competency of teachers through routine classroom observations implemented by the HIDOE. For some teachers, relying upon school networks of fellow KPK teachers aided with proper languaging. For other teachers, reaching out to former Hawaiian language instructors for guidance has been helpful. Kuʻulei in particular commented on the copious feedback that she received from a university professor who was able to do short term evaluations through an external federal grant. She openly welcomed the experience, and even went as far as to say that she wished that this instructor could be in her classroom everyday to critique, paka, her language instruction.

The last area of concern was highlighted by both Kīholo and Tristan, who as high school math instructors had strong concerns regarding the Hawaiian language of mathematics. While we have already looked at archival texts that differentiated between customary mathematical practices as Helu Kahiko, and contemporary as Helu Hou, these teachers felt that the newer created terms within Māmaka Kaiao did not always personify Hawaiian understandings of a mathematical world. Tristan preferred to rely on vocabulary found in math texts published in the 1800s at Lahainaluna. He refers to these words as “huaʻōlelo kūpuna.” Kīholo also acknowledges both the simplicity and the beauty of vocabulary created by first language speakers of Hawaiian.

These comments elucidate complex issues within the Hawaiian language component of the HCBE. While recognizing that the inclusion of the Hawaiian language is important, it is also imperative for those who wish to utilize the HCBE framework to be critically cognizant of the insidious role that colonization has played on our Native language. In an early article published in Kuokoa Home Rula (1906), shortly after the
ban on Hawaiian language in formal educational institutions, entitled “Mai Haalele i ka Olelo Makuahine” the author warns,

Ehia la o na Hawai‘i opio i hoonaauaoia iloko o na Kulanui o kakou iho nei, a mawaho aku nei hoi o kakou i kuonoono maoli ko lakou ike a me ko lakou makaukau ma ka olelo makuahine o ko lakou aina hanau. Ke ike nei kakou i keia ma la e nee nei, eia na aapo ana a na opio ma ka olelo Beritania a ua nele maoli ko lakou mana o na kula aupuni olelo Hawaii, ua hoopau maoli ia na poo-wai nui e loaa mai ai na auwai o ka ike ma ia olelo in a opio o Hawaii nei. E hoea mai ana ma keia mua aku e lilo ai ka hapanui loa o na huaolelo Hawaii i kamaaina ia kakou i keia wa, i mau huaolelo pohihihi i na opio Hawaii o keia mau mau ae.

Even in 1906, at a time when Hawaiian language was still widespread, articles were still published criticizing the level of language competency of youth, and foretelling of a time when the majority of words that are familiar become confusing to future generations.

“Language is the mediating force of knowledge; but it is also knowledge itself” (Freire, 2000, p. 102).

While current access to Hawaiian language through formal and informal settings paints a hopeful picture for the future of ‘Ōlelo Hawaii‘i, let the warnings of our kūpuna be a reminder that we should never again be complacent about the survival of our mother tongue. While Hawaiians should lead the Hawaiian language revitalization movement, the survival of the Hawaiian language is not a Hawaiian kuleana alone to mālama. All those who wish to reside within the bounty of Kapaakuokahonua lāua ‘o Kapapakuokahonua, should seek to honor this place through speaking the language born of this place. The KPK, Hawaiian Charter Schools, in addition to Hawaiian language
courses cannot function as our language “safety zones” and cannot carry this kuleana without the larger support of the Hawai‘i collective. Hawaiian language revitalization is a shared kuleana.

Participants in Hawaiian language revitalization need to recognize that nationalized NCLB accountability measures aim to create standardized approaches to educational reform for our children’s benefit, and yet these standards are not indicative of the knowledge systems our kūpuna held dear. These laws need to be “interrogated” in order to fully understand the potential impact of these reforms on Hawaiian language in the same way that historical legislation has.

Act 57, Section 30 is often sited as the impetus for near language extinction in Hawai‘i.

**Figure 12. Act 57, sec. 30**

Treasonous Sanford B. Dole, through implementation of this legislation, set the Hawaiian language on a trajectory for extinction. By effectively banning ‘Ōlelo Hawai‘i from classroom instruction, and subsequent corporal punishments inflicted on children caught speaking their mother tongue English became the de facto language of Hawai‘i.
Settler colonialist, Ken Conklin feels, however, that these punishments were (and may still be) justified.

And yes, if granny spoke Hawaiian in school as a little girl she might have been punished by the teacher, just as the little Japanese girl was punished for speaking Japanese. But even at home, granny as a little girl might have been punished by her own parents for speaking Hawaiian in the home, because the parents recognized that the path to social and economic success would be through English. (Conklin, n.d.)

ʻOhana & community.

For families and communities that have been disenfranchised by mainstream education it is important to reengage learners by valuing their participation and contributions to contemporary education. Participants’ experiences with implementing this occurred in three primary ways.

For Rovert, having the educational experiences of students parallel their home learning environments was critical. This meant that when he invited family and community into the formal school setting, he was ready to engage with parents, families, and communities in a way that was acceptable to them. He did not confine their invitation to sharing about mathematics, but their articulation of expertise, be it fishing or tree trimming. In his manaʻo the checks and balance of working within a Hawaiian focused charter school committed to developing ʻohana and communities must engage them in a way that is not limited to the “boxes” of education.

Like Rovert, Kīholo’s school has encouraged participation from ʻohana and communities by inviting them for “Pō Makemakika.” While this was a fun way to
facilitate student learning, she was more concerned with reengineering positive mathematics learning experiences for families, so that these would pass on to their children.

Lastly, Hikianalia has expanded her mathematics course teaching to include insight from community, cultural experts of land and sea well versed in mathematical practice outside the formal walls of education. Through relocating her sphere of learning she validates authentic opportunities to develop mathematical understandings of the natural environment, challenging the math textbook status quo. A complementary challenge issued to her students was reconceptualizing “mathematician,” expanding the parameters to include colloquial practitioners like aunties that sew, and uncles that fish.

In expanding on this idea we have also learned in Mokuna IV about the ancestral relationships that Hawaiians shared with their natural environment.

We, as Native Hawaiians, must continue to unveil the knowledge of our ancestors. Let us interpret for ourselves who our ancestors are, how they thought, and why they made certain decisions. In the process, we treat them with honor, dignity, love, and respect—whether they be akua, ali‘i, or kānaka—because they are our ʻohana, our family. (Kanahele, 2011, xv)

Context

He lālā au no kuʻu kumu. In examining the context of structuring learning environments in culturally appropriate ways there were three main themes that emerged from the data. First, those that spoke positively about their HCBE teaching context felt responsible and able to participate in co-construction of the vision and/or mission of the
school setting. Next, positive learning experiences for their students began with teacher modeling of kuleana.

In creating a context of learning that was structured in culturally appropriate ways, the charter-school teachers, more than the other participants, used direct quotes from their school mission statements. These school visions and missions provided living documents co-created by teachers and the school that aligned with personal teaching philosophies. Their statements were not contrived but negotiated understandings and fidelity to articulate stated purposes within their classrooms. Kīholo felt empowered and supported by her administration to seek out meaningful personal professional development opportunities for the betterment of her teaching practice rather than continue generic approaches to professional development. She also went on to talk about the namesake of her school in that she feels a personal responsibility to model learning excellence because of the school’s relationship with his descendants.

‘Alaea, and Rovert spoke about the kuleana that they have to model positive behavior, outside of the classroom. For ‘Alaea this meant modeling ‘aipono and participation in community service events outside of regular school hours. For Rovert this manifested in living in the community in which he teaches.

Assessment & accountability, content.

In this section Assessment and Accountability has been combined with Content as many teachers spoke of external accountability measures that were driving their curricular choices. Recognizing that content should be inextricably linked to assessment and the concern for participants working within K-12 institutions, there was extreme frustration with “the test” that they felt began to lead, thus having a somewhat controlling
effect, on their instruction. There was also internal conflict when teachers were deciding what they wanted their students to learn versus nationalized curriculum dictated what they should know. While some participants felt that by tweaking their instruction short term to pass the test could ultimately lead to greater teaching autonomy, they also recognized that the instruments of assessment also change so that students that schools that may pass one year may fail the next.

Interestingly, Rovert’s thoughts on the colonial “boxes of education” are affirmed by D’Ambrosio with the following,

Metaphorically, we may think of disciplines as cages; it is not possible to leave the cage because the codes (the bars) prevent it. The search for knowledge is limited to what is inside the cage. Creativity is restricted by the bars of the cage. (Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009, p. x)

Little room is left for teacher creativity within the teaching. Shall our schools be the site for cultural and linguistic revitalization facilitated by teacher creativity?

While teachers had many productive and creative ideas regarding the assessment of their students, there was an overwhelming discontent with dominant assessment and accountability systems under NCLB. Teachers felt extreme pressure to have their students perform well on the high stakes testing measures in order to facilitate decreased scrutiny upon their educational institution. This lack of assessment autonomy of teachers decreases the likelihood that teachers will venture outside of the cage.

ʻĀina and relationships, ʻāina relationships

In discussing the inclusion of additional components tin the HCBE framework, participants felt that ʻāina, and ʻāina relationships were so important that the HCBE
framework may be incomplete without it. “For a colonized people the most essential value, because the most concrete, is first and foremost the land: the land which will bring them bread and, above all, dignity” (Fanon, 2004, p. 9). These ideas of connection to ʻāina as central to contemporary school instruction is sporadically articulated within formal instruction, and then only as long as you can connect it back with the “encaged” disciplines.

Hawaiian educational settings, must increase opportunities for students to strengthen their relationships to ʻāina. Osorio (2006) warns of the irreversible loss of indigenous identity.

With every new generation, a larger and larger number of our young people need to work harder to identify with their ancestors—or even just with other Hawaiians. Brought up in urban environments, far from loʻi (wetland taro patches), and often unfamiliar even with the ocean, reared in the loud emptiness of American popular culture, our young increasingly exist in an isolation that even the children of my generation never knew. Despite the very real successes of Hawaiian language education, the revival of oli (chant), mele (song), and hula, and the ongoing political and social activism, Kānaka Maoli (Native Hawaiians) face a most dangerous time in our history. (p. 19)

To promote education devoid of experiences within the natural environment is to promote further disconnection from ʻāina ancestors.

Teacher participants felt that cultivating relationships was also a necessary component of the HCBE framework. Rovert reflected on strong relationships that he had with other kumu within his school, learning from and learning with them. ʻAlaea spoke
fondly about relationship to knowledge itself. Her relationship with these knowledge systems fosters her ongoing inspiration as a learner first, then teacher.

**Personal Reflections Aʻo i ke koa, e aʻo nō i ka holo.**

**He welo ʻohana.**

Learn how to fight and learn when to fight. The metaphor of battle may be incongruent with principles of engagement within the university community, but in a real sense, universities are theaters of ideological wars. The koa here represent those that take on difficult tasks for the benefit of the larger lāhui. I refer to this as “the struggle”.

For my grandmother, the struggle was survival. She did not contemplate her career working for the tourism industry. She cheerfully guided happy malihini in Waikīkī. For tūtū, this job allowed her food on the table, a luxury that she had not enjoyed as a young, orphaned Hawaiian.

For my mother “the struggle” is actively political. For her entire adult life, my mother has worked to overturn oppressive legal systems that divest native tenants of their ʻāina relations of the rights of access, of their rights to engage in customary and traditional practices.

I believe education is a tool of liberation. Like Perry (2013), I have been taught that “education, higher education in particular, is the tool that we can snatch from the master to lift us up from oppression” (p. 8). When I began my doctoral program, I was married with two children and a happy teacher in a Hawaiian immersion classroom. Fast forward nine years and now I am happily re-married with four children, and now a tenured faculty member within the College of Education. My struggle has been creating space within the university system to develop its relationships to kuleana. I recognize
and greatly appreciate the opportunities I have been afforded to pursue higher education and develop my potential as a Hawaiian, mother, and scholar. I also reflect on the dual nature of my kuleana as both student and teacher as I enter the next chapter of my scholarly life.

**Silence as complicity.**

I would be remiss if I did not also discuss my personal challenges of “complicity” that have occurred while on this research path of “higher” education. Perry (2013) explains the dual nature of being an Indigenous scholar working within a Western institution,

> We are the agents of our own change but may also become agents of our own repression. As agents, we have the ability to lift up our lāhui. We also have the choice to submit to the pressure of Western hegemony. Knowledge is power and can influence great change. However, unbridled power is corrupting and can cause damaging consequences. (p. 8)

How we choose to exert this power while working within the confines of the institution defines us as native scholars. When hired I was groomed to be outspoken, calculating, and merciless when traversing contested spaces. This worked marvelously for many years, but took a toll on my naʻau as I witnessed, and was an accessory by not speaking out, to the damaging consequences of unbridled power. Hewa is hewa, but condoning hewa through complicity is reprehensible.

**Naivete as complicity.**

I entered the doctoral program in January of 2005. I was flattered that I was being encouraged to pursue a Ph. D., and thought that returning to school was my kuleana. I
jumped right in without fully understanding the program or process. When my course work was complete however, I quickly fell into the doldrums of my program. Years passed and although I was taking more and more courses, I was no closer to graduating. Ironically, I was not alone. Many of my Hawaiian colleagues, were right there floundering with me pushing up against graduate school time limits, academic probation, and even dismissal from their academic programs.

While I take full responsibility for the pace of my academic advancement, these past nine years, I would encourage all hopeful Ph.D. candidates to “interrogate” the doctoral program process prior to entry. So much of the program relies on self-directed scholarship that being a “good” student isn’t enough to get you through. On the university side, I would also suggest a doctoral mentorship program outside of individual advisors or coursework. Fostering relationships with “critical others” prior to program entry could mean many years saved in terms of program completion.

**Complicity in the classroom.**

This following is a cautionary story of injury. In spite of major gains that we make as lāhui, there is still much work to be done to combat the racism and sexism that is entrenched in our educational system. The following is a student’s written response to an assigned class reading, *Culture and Educational Policy in Hawai‘i: The Silencing of Native Voices* for an introductory teaching seminar course I was conducting. As an instructor I did my best to create an environment where students felt free to express themselves.

*We’ve all heard the same rhetoric before about the illegal overthrow of the Hawaiian government by US marine backed politicians yada yada*
yada. Personally, I think it grows tiresome. Unfortunately, things happened in the past that cannot be undone or changed. Constantly referring to something we are all aware of I think does nothing to add to a sensible discussion about the real issues and what we can do to CHANGE CURRENT problems. Sure it’s easier to blame the US government for the overthrow and how people have been marginalized. I think in any case though, you are going to find both sides of the coin. I’m sure there are many native Hawaiians who have suffered because of the effects the US has had here on the islands. On the same hand, there are also many who have benefited from it.

PS - This response was written in ENGLISH so that I could contribute to an open “class discussion” that involves ALL class members.

This student’s hostile attitude was not limited to his course papers but continued into class discussions. “Haole go home!” flashed through my mind, and while other students would provide a counterview in class, suggesting that perhaps if he wanted them to translate what they were saying into English, he should be prepared to translate everything he did into Hawaiian. I began to feel a sharp drop in overall morale of the students in my class, especially the Hawaiian-speaking students. As the instructor I felt a great unease in my attempts to deal with his verbal tirades and attacks concerning Hawaiian history, culture, values, and ideas that I considered to be my foundational informational.

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6 An infamous quote from Professor Haunani Kay Trask in response to a Caucasian student’s confrontation. (Essoyan, 1990)
beliefs, beliefs I knew were shared by many students in the classroom. His combative stance made it clear he would resist any and all attempts to influence his thinking, as he aggressively fought to impose his worldview on others in the class. While I understand, as a member of the academy, that universities, of all places, exist foremost to promote the democratic ideal of freedom and individual expression, I find myself, as a Hawaiian, questioning certain aspects of the instructor’s role: How can I promote the free flow of ideas while, in my view, a student is engaging in veiled and not-so-veiled racist attacks? How can I maintain civility in a classroom where such a student behaves overtly, and states explicitly, views that, if adopted, would further marginalize the Hawaiian people and other oppressed peoples? To what extent should the teacher engage an outspoken intransigent? Is it a mere matter of facilitation skills or a possessing a more cunning intellect? As university instructor, but contrary to my Hawaiian values, should I be expected to tolerate a classroom as a toxic battleground for racist sentiments? What role, as teacher, most promotes ideas of a free society while giving voice to and counterbalancing the truth of colonization and oppression in an institution where vestiges of that oppression are still extant? In practice, what is the role of Non-Hawaiian participants in Hawaiian Educational preparation program? Should I be trying to indoctrinate Hawaiians and non-Hawaiians alike? Or should I focus my efforts on supporting students that already share a worldview that is similar? Or perhaps we as a larger cultural group we need to spend more time and resources addressing areas of cultural conflict among the uninitiated.

In frustration I called a friend from Aotearoa whose work focuses on racism in the health field. Describing the circumstances, I asked my friend's opinion as to whether it
was the fact that I was Hawaiian or a woman that led this student to believe that he could be so openly confrontational and disrespectful. Her response was it was both. This student was being forced to confront issues of education and racism that clashed with his own, and for this he was angry.

I wish I could say that this was an isolated incident where a passionate student sought to assert his critique of literature that sets out the history of an oppressed people, but sadly the “get over it” mentality is not uncommon (Hassouneh, 2006). The dearth of indigenous faculty and students at institutions of higher learning is ironic considering that these institutions owe their very physical existence to, and are situated on, Hawaiian Kingdom lands that the U.S. has admitted were illegally stolen from the Hawaiian people in Public Act 103-150, the “Apology Resolution,” their founding costs were underwritten by revenues generated from these lands. The truth of this history is an important story that has worked its way into the soul of virtually every Hawaiian. It is an important story that bears repeating a thousand times over until justice is done. It must neither be suppressed, denied, or silenced because it may be a discomfort to those who benefit but contribute little toward redress. The hostility of the academy has not gone undocumented – all we have to do is look at the enrollment numbers of our students and the percentage of our people who are tenured-track faculty to understand that the academy has worked extremely hard at keeping us out. Justice (2004) argues that

Many of us have been educated to believe that we don’t belong in this place of meaning-making, that we don’t have anything worthwhile to contribute as Native peoples, that the intellectual traditions of our families and communities aren’t powerful understandings of the world and her ways. (p. 102)
Prior to being hired at UH Mānoa (the largest teacher preparation institution in Hawai‘i), there was only one other faculty member within the College of Education that had a Hawaiian language background and was involved in teacher preparation. There was then, and still is a need to increase future classroom teachers’ Hawaiian language fluency so that they can impart a Hawaiian worldview into their teaching. Having the facility to teach courses in both English and Hawaiian, but through the lens of Hawaiian culture helps teacher candidates gain the experience of articulating their educational philosophies and pedagogies, making them more effective teachers.

A Kāuna of Final Recommendations

Educational self-determination.

In April of 2013, thousands of preeminent educators gathered at the annual meeting of the American Educational Research Association in San Francisco. This premier gathering would feature Secretary of Education, Arne Duncan speaking on his agenda for educational reform, high stakes accountability measures, punitive in nature. The session was so well attended that the venue, roughly the size of a football field could not accommodate all of the prospective audience members. Duncan could not have been fully prepared for the reception that he received -- a highly educated, restive crowd, each carrying a sign with the simple message, “NOT IN MY NAME.”

America’s paternalistic approach to educational reform is not well received by America’s own citizenry. For Hawaiians suffering under the ill-effects of prolonged occupation, imposed federal mandates, and subsequent “Common” Core state standards are not reflective of native knowledge systems. As such children disconnected from the
ways of their ancestors are left behind. Reforming educational experiences for Hawai‘i’s children must include the voices of the communities served. NOT IN OUR NAME.

ʻŌlelo

This research project points to the need for teacher-education programs and by extension all educational stakeholders to further engage in Hawaiian language aspects, underrepresented in classroom instruction. Hawai‘i, as a state with two official languages needs to honor the twin challenges of this responsibility. For every science teacher, there should be the kōko‘olua kumu akeakamai, for every music teacher a haku mele, and obviously for every mathematics teacher, a kumu helu kahiko.

Try buy local.

National trends encourage the reduction of carbon footprints by “going-green”, and buying locally-grown, organic foods. These trends however, have been missed by wide-sweeping education movements seeking to import standardized, generic educational reform approaches in Hawai‘i and other states. “Buying local” would redirect Hawai‘i to invest in building local educational capacity within its educational institutions rather than exporting that kuleana to large corporate companies based outside Hawai‘i and with no Hawaiian ‘ike. “Going green” allows for Hawai‘i’s educational leaders to assess and remain accountable for the learning of Hawai‘i’s students, thereby building capacity and teacher buy-in simultaneously.

Poly-math

It is only in concluding this paper that I learn the word polymath. In reflecting upon this term, used to describe “a person of great or varied learning.” I feel with great certainty that this word’s etymological roots have great relevance to Hawaiians and their
intellectual and mathematical.

Kamakau (August 26, 1865: 2) describes kekahi alii akamai i ke kakaolelo, kuauhau, kahunapule, kilo, kuhikuhipuuone, he koa, a he akamai no hoi i ka haku mele ‘a chief knowledgeable in oratory, genealogy, priesthood, stargazing, geomancy, a warrior, and also knowledgeable in chant composition. (Charlot, 2005, p. 125)

The original Quanti-Natives were actually Poly-Maths.

**Future Research**

This study’s focus on archival data coupled with the perspective of teachers utilizing HCBE and ethnomathematics in classrooms unveiled unique challenges within the Hawaiian Educational Settings. It would be interesting in future research to reconstruct this study within the framework of various distinct settings-- Hawaiian Language Immersion, Hawaiian-focused Charter, and Hawaiian Community schools in order to further understand the role that school context plays in the development of a HCBE and Ethnomathematics framework.

Committing to research for community benefit, my next research project will pursue the organization of a hui of classroom teachers committed to designing, (co-)teaching, and sharing HCBE ethnomathematics lessons for wider distribution. Each teacher participant involved in this study was passionate and committed to this important work. It is imperative that all avenues be explored to take this goal to the next level.

Another approach for future study may be to deconstruct knowledges disciplines that accommodate traditional approaches to assessment. I would like to pursue the Papakū Makawalu approach to shift my own educational paradigm to explore what an
educational setting could look like if schools did not depend on the “boxes” of colonialism.

There is a dearth of readily available curriculum materials for Hawaiian language instruction. It is hoped that this dissertation, in examining the integration of Hawaiian language and culture in the mathematics classroom honors this ‘āina and its people and will make a significant contribution to the Hawaiian research agenda.
Appendix A. Teacher Agreement to Participate

Teacher Agreement to Participate in
Study of Hawaiian Culture Integration into Mathematics
Eōmailani K. Kukahiko
Primary Investigator

This research is being conducted as a component of a dissertation for a doctoral degree. The purpose of this project is to learn how teachers integrate Hawaiian culture into the mathematics classroom. This integration of culture and mathematics is often referred to as ethnomathematics.

Participation in the project will involve of two main components.

1. Initial interview – this will be conducted after participant has agreed to participate and signed the written consent form. Questions will include discussions of education, Hawaiian culture, curriculum and mathematics. Each interview will last approximately 30 minutes. Participant will also complete a written survey. This component will ask for general information from each teacher participant as well as ask for a written “math identity” piece. Participants will be identified only by a pseudonym of their choosing throughout the research. No personal identifying information will be included with the research results. Completion of the background data should take no more than 20 minutes.

2. Focus group – After interviews and classroom observations have been completed. I will invite each participant to participate in a focus group that I will facilitate at a non-DOE location. This focus group will take approximately 60-90 minutes and will discuss research themes that have emerged from the math identity stories, interviews, and classroom observations. I will also invite two mathematics teacher educators at the to attend the focus group to add to the richness of the discussion regarding Hawaiian culture in the mathematics classroom. It is my hope that this focus group will facilitate rich conversations with practical suggestions from the group and will be valuable for both classroom teachers and teacher educators.

The investigator believes there is no risk to the teachers participating in this research project.

Participation in this research project will provide teachers an increased opportunity engage with colleagues in conversations of teaching and learning in the mathematics classroom. The results from this project are that the general public will gain a deeper understanding of Hawaiian culture in the mathematics classroom, as well as share in the results of this research.
Research data will be confidential to the extent allowed by law. Agencies with research oversight, such as the UH Committee on Human Studies, have the authority to review research data. All research records will be stored in a locked file in the primary investigators’ office for the duration of the research project. With the exception of the initial written consent form, pseudonyms will be used for each research subjects for each portion of the research project. Data collected will only be identifiable by pseudonym only to researcher and teacher research participant. Audio recordings will be returned to participant immediately following transcription. All other research records will be erased or destroyed upon completion of the project.

Results of this research project will be included in my doctoral dissertation. There are no current plans to publish and/or present but if the opportunity arises, the confidentiality of all teacher research participants will be maintained.

Participation in this research project is completely voluntary. You are free to withdraw from participation at any time during the project.

If you have any questions regarding this research project, please contact the researcher, Eōmailani Kukahiko. If you have any questions regarding your rights as a research participant, please contact the UH Committee on Human Studies at (808) 956-5007 or uhirb@hawaii.edu.

Participant:
I have read and understand the above information, and agree to participate in this research project.

________________________________________________________________________
Name (printed)

________________________________________________________________________
Signature Date

I agree to be audio recorded for this project. (Circle)

YES NO

________________________________________________________________________
Signature Date
Appendix B. Written Consent Form

Written Consent Form

I, ________________________________ have been informed about this study of
the integration of Hawaiian culture into mathematics classrooms. I understand that as a
teacher working in Hawaiian Language Immersion Schools, Hawaiian-Focused Charter
Schools, and/or schools in Hawaiian communities I have been asked to participate. I
agree to participate in this study with the researcher, Eōmailani Kukahiko. I understand
that no harm will come to me. My identity will remain confidential and the information
will be used for educational purposes and may be published. I understand I am free to
withdraw from the study at any point in time.

Participant Signature ___________________________ Date ______________

Researcher Signature ___________________________ Date ______________
Appendix C. Participant Background Information

Research Name Pseudonym ________________________________

Age_______

Check all that Apply:

☐ Hawaiian Language Immersion School (Kula Kaiapuni)
☐ Hawaiian-Focused Charter School
☐ School in Hawaiian Serving Community
☐ Other (Please Explain):_________________________________________

How many years have you been teaching? ____________

How many years have you been teaching math?__________

Everyone has a story about learning mathematics; these are sometimes referred to as math identities. Please share a story regarding your personal math identity.

∞ What was learning math like when you were in a k-20 classroom?
∞ Did you see yourself as good or weak at math? What areas?
∞ Why do you like/dislike mathematics?
∞ Can you describe a memorable math teacher (model) +/-?
∞ Anything else you would like to share?
Appendix D. Interview Questions in English

Interview Questions (English)

1. What is the school’s philosophy and/or focus?
2. Why did you choose to teach at this school?
3. How does your view fit the schools’ philosophy?
4. How does living in (or out) of the community impact your instruction?
5. What is the role of Hawaiian culture and/or language in the curriculum? Math curriculum?
6. How does culture enter into math? How often?
7. What challenges do you face teaching mathematics?
8. Where do you get your teaching ideas/professional development?
9. How do you assess your students?
10. What does a student need to do in your classroom to be seen as successful?
11. What does success in the mathematics classroom mean for your students?
Appendix E. Interview Questions in Hawaiian

Ka Nīnauele (Ka ‘ōlelo Hawai‘i)

1. He aha ka nu‘ukia o kēia kula?
2. He aha ke kumu āu i koho ai i ke a‘o ‘ana ma kēia kula?
3. Pehea ka pilina o kou kālai a‘o i kā ke kula?
4. Inā paha no loko a i ‘ole no waho ‘oe o kēia kaiāulu kula, he aha ka pilina o kēia i ke a‘o ‘ana?
5. He aha ka pilina o ka mo‘omeheu Hawai‘i i ka makemakika?
6. Pehea ke komo ‘ana o ka mo‘omeheu Hawai‘i i ka makemakika? Pehea ka nui o kēia pilina?
7. He aha nā ʻālalina no ke aʻo ‘ana ma kāu papa pili i ka makemakika?
8. Ma hea paha ‘oe e huli ai i kākoʻo ma ka haʻawina makemakika?
9. He aha nā ʻano hana a ke keiki mākaukau ma kau papa?
10. Pehea ‘oe e loiloī ai i ka holomua ma kāu papa?
11. Inā akamai ke keiki i ka makemakika he aha nā pahuhopu nui nona?
Appendix F. HIDOE Application to Conduct Research

May 10, 2013

Ms. Eomailani Kukahiko
1776 University Ave., EH 221
Honolulu, HI 96822

Dear Ms. Kukahiko:

Thank you for your interest in conducting research within the Hawaii State Department of Education (HIDOE). After carefully reviewing your application for the research project “Quanti-Native: Mathematics Teachers’ Perspectives of Culturally Relevant Curricula in Their Classrooms” (Study #201288815651), I regret to inform you that we will not be approving your application.

In your application, you indicate that the purpose of your research project is “to learn how mathematics teachers working in Hawaiian Educational settings (Hawaiian language immersion schools, Hawaiian focused charter schools, and schools in Hawaiian communities) incorporate culture into their classrooms.”

We recognize the potential value of research focused on the impact of culture-based educational practices; however, the content of your application does not provide adequate information about the design, objectives, or impact of your proposed research project for HIDOE to determine whether it aligns with the HIDOE Strategic Plan or if its findings will be meaningful to HIDOE schools, programs, or offices.

Although this application is now closed, you are welcome to submit a new application. Should you still wish to pursue conducting research at HIDOE schools on this topic, we recommend that you consult with your dissertation advisor for guidance.

Should you have any questions, please contact Jennifer Higaki in the Data Governance Office at DOEresearch@notes.k12.hi.us or (808) 440-2854.

Very truly yours,

Kathryn S. Matayoshi
Superintendent

KSM:bk

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