ECO-IDENTITY: SECONDARY SCIENCE TEACHERS' EXPERIENCES THAT

CULTIVATE PLACE-BASED TEACHING IN A HAWAIIAN CULTURAL CONTEXT

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DEDICATION

I'd like to dedicate this dissertation to my dad, Thomas Fitzgerald, who transitioned on Monday, April 30, 2018. I can still hear his voice asking when I was going to finish my "book." I did it, Dad!

What I do know is that this form of scholarship is introspective and time consuming, but highly meaningful and transformative. My dad always kept me grounded by reminding me that getting this Ph.D. would not change the person that I am. I will always be your daughter, Dad.

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ABSTRACT

Eco-Identity: Secondary Science Teachers' Experiences That Cultivate Place-Based Teaching in a Hawaiian Cultural Context

This dissertation documents the lives of six science teachers whose multifaceted identities were influenced over time by Hawaiʻi's unique sociocultural and biogeographical factors. Narrative inquiry was utilized through individual interviews which spanned a five-year period. From *restorying*, identity narratives and maps were co-constructed and unique eco-identities emerged from these science teachers' lived experiences. The process of coming to know what an eco-identity looks like and why it matters unfolded through constructivist grounded theory methodology. The common threads, or narrative, characterizing eco-identity development and shaping as situated in sociocultural and biogeographical contexts of Hawaiʻi were: (a) reflective environmentalism, (b) an evolving science teacher community of practice, (c) bridging knowledge systems, and (d) island biogeography. The grounded theory suggests a dynamic and multifaceted eco-identity situated in Hawaiʻi that supports teachers with navigating the professional landscape, supporting their calling as science teachers. *Biophilia*, Hawaiʻi sense of place, *ʻike Hawaiʻi*, and a mindset of "thinking like an island" revealed eco-identity to be the meaning making processes for teachers negotiating their professional and personal lives. Further study on science teacher eco-identity in Hawaiʻi is needed to better understand how such an awareness can impact teacher practices, curriculum development, and teacher education programs in science.

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CHAPTER 1: INTRODUCTION TO THE STUDY

One can claim that schools limit experience and perception by regulating geographic experiences, schools potentially stunt human development as they help construct our lack of awareness, our lack of connection to, and our lack of appreciation for places. (Gruenewald, 2003b, p. 625)

Teacher of Science, or Science Teacher?

Prior to this journey of entering the Ph.D. program and completing my dissertation in the field of education I had taught in both the public and private secondary school settings on Oʻahu in various subject areas of science. This included life science, Earth and space science, physical science, and teen health. Prior to secondary teacher training I briefly taught general science and health education at an alternative secondary school while living in San Francisco and while taking courses at the graduate level. Upon my return to Hawaiʻi I worked in the summer to teach a general science class to first graders at a private school, which spurred me on to think about where my place was in the world and what my professional calling would be. With an undergraduate background in biology I had a desire to expose others to the wonders of science and to the appreciation of natural spaces in which we live. Where did this interest in "science" come from, and how did I come to pursue a career in secondary science teaching? I initially put the term *science* in quotation marks, as I refer to this system of knowledge from a Western framework. First let me explain the beginnings of my own love for the natural environment and what ecologist E.O. Wilson (1986) calls *biophilia*.

My beginnings of an eco-identity began to take shape when I attended a public university in Washington state to pursue a biology degree with environmental science and ecology courses making up the majority of my science electives. By my sophomore year in college I became disillusioned with the process of studying science content to memorize facts and details that I found irrelevant to learning more about my environment and how I could effect change for the good of all places and all peoples. I wanted to make a difference in the greater community. As an undergraduate my grades dropped and my focus on veterinary school was now in the past. I reflected upon my goals as a college student and why I was continuing to study the sciences from a Western perspective.

I was not finding a true expression of myself in my studies of the biological sciences from a Western science perspective.

I didn't have deep personal connections with what I was learning and unsure of what I was striving to become after completing my undergraduate degree in biology. The humanity was taken out of what I was studying and any connections to the environment were diminishing. During my junior year at the university I enrolled in an organic chemistry class that changed my path to becoming any kind of scientist. Sitting in the office of my male professor, I was met with the challenge of a person of authority who told me point blank: "Women should not be in the field of science." I was struggling in this organic chemistry class and his words disrupted my emerging scientist identity and how I also saw myself as an environmentalist. My remaining year in college was spent not only with a shift in focus with my studies but also with a reconnection to nature. I started hiking again and doing long distance running outside alongside the wheat fields and pasturelands that surrounded the small farming town that I was situated in. I soon realized my inspiration: being immersed in nature.

I returned to Hawai'i after completing four years of schooling out of state and was happy to be home in the Islands. This was a time for me to reconnect with people whom, and places that I grew up with. In a 1996 essay entitled "How my schooling taught me contempt for the Earth," Bigelow, a science educator and published author of science curricula, describes how his education condemned him to 12 years inside a building, which made him careless and ignorant of his own surroundings. Thus, my post-undergraduate years were spent regaining my sense of place in Hawai'i. I still had a lack of focus with respect to a career path and continued to take post-baccalaureate classes at the university and community colleges in the sciences. I also privately tutored in science and math subjects and substitute taught in the public and private schools. This notion of helping others and inspiring them with the wonders of science took hold and became my new career focus. I eventually pursued a master's degree in secondary science education.

As a secondary science teacher, I spent the next five years teaching subjects of life, Earth and space, and physical science in the middle and high school settings. I quickly became disenchanted with the public-school system and the ways in which I was expected to teach science. I reflected upon what excited me about learning science in my middle and high school years and even in college.

I realized that over time I had been experiencing a slow disconnection to people and places and my natural environment. Disruptions to my scientist, environmentalist, and teacher identities ensued throughout my five years of teaching at the secondary level.

I questioned my roles as a science teacher, scientist, and environmentalist. I came to realize the disparities between these identities of a science teacher and scientist. Was I having an early teacher burn out? J. Palmer (1998) proposes that we need to accept the dark times often associated with deep stress and also combine that with the positive and reaffirming experiences of teaching in order to sustain ourselves in terms of commitment and passion. At that time, I felt constrained by the Western framework with science teaching in our public-school system. I was not able to afford my students the kind of experiential learning that would help them better connect with where they lived and become aware of the issues in our local environments.

In 2004 I left secondary science teaching and took a job as an instructor at the university level in the area of teacher education. I welcomed the changes: more flexibility with teaching and selecting resources and making use of my time each day; teaching methods courses in the classroom; being in the field with students doing service projects at various Hawaiian cultural sites on Oʻahu; and mentoring student teachers as they completed their practicums. I taught the methods courses for pre-service undergraduate and in-service graduate students in education and quickly witnessed internal struggles that both pre- and in-service teachers were challenged with as they pursued their education. These were the same struggles that I was challenged with in terms of finding and developing my teacher identity while maintaining other identities as a scientist and environmentalist.

My teachings at the college level brought on more questions and doubts of my roles as a "science teacher," and as a "teacher of science." Likewise, I had witnessed such challenges in my pre-service and in-service teachers whom I worked with in the education program and in their classrooms. What I had witnessed in the pre-service teachers in the secondary science program was the negotiation of multiple identities, as they came from a background in the sciences and were now being trained to become teachers. New to the profession of teaching, the pre-service teachers had to reflect back on their own experiences with learning science.

They drew from their lived experiences as K-12 students to negotiate this new identity as a science teacher and then act upon what they believed to be their expected roles in this community of practice. For the in-service teachers whom I worked with at the college level there were still such dilemmas with understanding their roles as science teachers and as scientists. Over time, these veteran science teachers were able to address challenges to their existing schemata as part of the science teacher community of practice. I saw how it was not so dissimilar to my own experiences. As a former secondary science teacher and now a college instructor for pre-service teacher training and in-service teacher professional development, I wanted to better understand the development and shaping of multiple identities of secondary science teachers. I also wanted to understand what kept science teachers going, despite an array of challenges at the personal, classroom, schoolwide, and institutional levels. This interest and continued passion for supporting science teachers were impetuses for entering the Ph.D. program at the University of Hawaiʻi at Mānoa.

Pilot Studies on Teacher Identities and Place Connections

Pre-Service Teachers' Transformative Learning in Environmental Education

In two pilot studies spanning 2005 to 2006 and 2006 to 2007, I examined pre-service teachers' learning experiences through an environmental education course. In this course I was able to gain a better understanding of the beginnings of teacher identity development through critical self-reflection and transformative learning (Mezirow, 1985, 1991, 2009) based upon lived experiences of individuals as they interacted with others and the environment over time and space. Over the course of two years (four semesters) I gathered information on initial attitudes and values of pre-service teachers in the environmental education course utilizing principles of place-based education in a Hawaiian cultural context.

At the end of each semester I gathered the same information using a questionnaire with Likert scale ratings and open-ended questions. I followed up with eight former students (undergraduate and graduate) each semester thereafter and conducted individual interviews to discuss the impacts of the course on their development as teachers. For some, there were emergent, *eco-centric* worldviews of understanding how human beings are a part of nature and not separate and/or above it. Through these interviews I gained insights on the developing multiple identities of teachers in training and how such a methods course on place-based science education could potentially impact their ways of knowing and practicing as future educators.

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Gee (2001) purports that the "kind of person" one is recognized as "being," at a given time and place, can change from context to context, can be ambiguous or unstable, and that multiple identities make up a person's sense of self that is not connected to an internal state but instead to performances in society (p. 99).

I felt a personal connection with my former students and continued to stay in touch with many of them. To this day (spring 2018) I have come into contact with several of my former students in the field as they bring their own students to work at the fishpond and to the wetland and upland areas on Oʻahu. This relationship building was as meaningful for me as it was for them as practicing teachers. The process of participating in service-learning projects over the semesters had not only impacted my students (the majority of whom were pre-service elementary school teachers) in terms of development of an eco-centric worldview, but it had also helped to develop and refine my own ways of viewing and connecting with the Earth. The acts of doing with service learning and being immersed in natural, local environments helped them to better understand places through multiple lenses. This occurred not only through the scientific lens of observations and research but also through learning about the natural history of these places and how this was tied to the Hawaiian culture and other cultures over time. I was witnessing what Thomashow (2002) describes as a place-based perceptual ecology, where "by virtue of doing (juxtaposing scale and perspective) you learn how to explore the spatial and temporal dimensions of environmental change and thereby cultivate the ability to perceive the biosphere" (p. 5).

Included in this kind of ecological consciousness were the affective connections to place (place attachment) and the cognitive associations to where one lives (place meaning). Together, place meaning and place attachment make up the notion of *sense of place*. What I had found through these questionnaires and interviews with pre-service teachers in the environmental education course was that: (a) those individuals who already had a strong sense of place in Hawaiʻi also had deeper levels of an ecological consciousness; and (b) for those who may have started the course with less connections and meanings toward natural places there was a slight shift towards building connections to local places and an emergent ecological awareness by the end of the semester. The conversations revealed positive shifts in values about their natural surroundings, towards teaching science and the subject of science itself, and how they perceived their environments through the practice of place-based perceptual ecology.

Secondary Science Teachers Negotiating Multiple Identities

My continued interest in science teacher development, the development of a sense of place, and science teacher ecological consciousness prompted me to conduct the next pilot study from 2008 to 2009. This second pilot study focused on two secondary science teachers who were former students of mine and part of the Teach for America (TFA) program. They taught secondary science at different public schools located along the Leeward coastline of Oʻahu. This qualitative study included the following methods:

- interviews with each teacher separately and together,
- several classroom observations over the two semesters within a school year,
- seventh and ninth grade student surveys on attitudes towards learning science and the usefulness of the subject of science in everyday life, and
- one focus group interview with ninth grade students from the high school science teacher's class.

What emerged from the teacher interviews were marked difference in attitudes toward teaching science and teaching students of diverse backgrounds. The teacher originally from the East coast of the continental U.S. talked about positive connections that he made with his students through the use of relevant examples and practical, place-based experiences for students in his ninth-grade physical science classroom. This teacher shared an open-mindedness towards multiple perspectives for understanding and making sense of the world and for solving problems in the environment. He also lived in a district near the school and hiked and surfed in the area where he had lived and taught. He would often ride his bicycle to school. As a high school science teacher, this individual was able to realize his potential as an agent of change in the classroom. Despite his Western-focused educational background he was able to develop an environmental identity with an eco-centric worldview that revealed deep connections and dialogs between the places where he lived and practiced and with his students' cultural and socioeconomic backgrounds. What emerged after a year of teaching in this ninth-grade classroom can be described as a successful science classroom whereby a teacher has found ways for students to identify with an emergent community of science learners and a culture of science that acknowledges multiple epistemologies (Seiler, 2011).

The other teacher was born and raised in Hawaiʻi, attended private school for the majority of his K-12 schooling, and lived outside of the district where he had taught seventh grade life science. His connection to any particular place in his school's community and/or outside of it was not mentioned. Like the other ninth grade science teacher, this individual was schooled from a Western perspective and both were now being trained as teachers under the same framework of the national TFA program. What was different for this seventh-grade teacher was his view of teaching science. It was a structured practice driven by a Western perspective: empirical, reductionist, and positivistic.

Seiler (2011) describes what I had witnessed with this seventh-grade science teacher as being already enculturated in dominant, Western ways of knowing and doing that supported an identity that was an influential power in the educational system at the time. In addition, the enactment of *No Child Left Behind* (NCLB) (USDOE, 2002) and the expectations and accountability focused on test-taking and standards that all teachers in the U.S. were faced with at the time put demands on this teacher to negotiate his own identities (Upadhyay, 2009). In an era of high stakes testing this teacher was strongly influenced by demands put upon him by the administration, especially at his school, where the majority of the students were Hawaiian or part-Hawaiian.

During my final interview with both individuals the seventh-grade life science teacher shared how in teaching he would have to make the material "basic" for his students in order to address key concepts in science. This deficit model approach to teaching science was something I had witnessed during several observations in his seventh-grade life science classroom. This teacher maintained an authoritarian stance throughout the school year, teaching mainly through lectures and administering quizzes and tests based upon recall of factual knowledge in life science. From a Western perspective of science education and the imposition of high stakes testing by NCLB, this teacher felt that it was his duty to prepare students for such exams through repetition and focus on lower level skills in science.

In contrast, what the ninth-grade physical science teacher did for his students was integrate their local knowledge system with Western science by taking them outdoors—the classroom was situated close to the back of campus where there was access to the beach—and making the learning of science relevant for them.

Topics and laboratory exercises included studying waves and relating this to surfing and bodyboarding, which students could identify with in this physical science class. In addition to feeling the need to prepare his students for the high stakes exams, he also exuded concerns not only for environmental issues in the local environment and the world but also a kind of care for students' emotional well-being as he navigated the required test taking component in ninth-grade physical science.

Through this pilot study I was able to do a short-term comparative study of two individuals with varied backgrounds and attitudes towards teaching science and towards the diverse students they worked with on the Leeward coast of Oʻahu. As a former secondary science teacher and now educator supporting pre- and in-service teachers, it was my beginning of a postmodern approach to conceptualizing science teacher identity. I was coming to know that all people, and not just teachers, have multiple identities connected to their internal states and also to their performances in society (Gee, 2001). Moreover, forming a science teacher identity is not a static process. It is a continuous interplay of history, culture, and power while learning to teach, which can be a challenge for emerging and veteran teachers alike. With these individuals whom I've been fortunate to study over a span of three years for both pilot studies, what was evident were the "breaks and discontinuities with one's multiple identities while learning to become a science teacher and meeting the expectations of a teacher education program rooted in a Western framework" (Seiler, 2011, p. 349).

Rationale Behind My Current Research

Conceptualizing Teacher Identity and Science Teacher Identity

These initial experiences as a university instructor and an educational researcher prompted me to further question science teacher identity, place identity, and notions of sense of place and ecological consciousness in science teacher development. I examined the development of these secondary science teacher characteristics and attitudes and how they saw themselves as not only "teachers of science" and "science teachers," but also in many other ways where professional and personal views of self are not as distinct. In science education the term "identity" has been used in a general sense to describe "who we think we must be to engage in science" (Calabrese Barton, 1998, p. 379). Beauchamp and Thomas (2009) maintain that defining teacher identity in general is a challenge with respect to understanding the concept of a professional identity and how this can influence teachers' learning and their work.

They note three recurring characterizations of teacher identity: the multiplicity of identity, the discontinuity of identity, and the social nature of identity (Beauchamp & Thomas, 2009).

Rather than focusing on studying teacher identities merely as the "acquisition of assets," my research attempts to understand how science teachers themselves make sense of their teaching practice, beyond development pertaining to predefined professional standards (Akkerman & Meijer, 2011). The dynamic and dialogic processes that take place both internally and externally are critical components to the meaning making of developing, negotiating, and sustaining multiple identities. In Hawai'i, external factors can include interactions with other people and places which may be unique to living and practicing in the Islands. The sociocultural contexts of Hawai'i can thus add to the multiplicity of science teacher identities.

Science Teacher Community of Practice: Agency and Social Structure

A critical social context influencing the development and maintenance of a complex teacher identity with the added multiplicity that science teachers bring to the profession is the science teacher *community of practice*. With fragmented and multiple social worlds, science teachers are always participating simultaneously in different social communities, with emphasis on social interdependence and meaningful discourse (Gergen, 1991) that becomes the basis of being a science teacher. In a science teacher community of practice situated in Hawai'i sociocultural factors are diverse and interactive and can further shape identities in ways that adhere to both structure with what is expected to become a science teacher and the process of mastery learning that is situated (Lave & Wenger, 1991) in a particular profession of science teaching. The individual is initially a peripheral participant who is introduced to particular ways of thinking, speaking, and acting as s/he works to become a contributing member to this community of practice. The structural perspective defines identity by the requirements, norms, and expectations imposed on individuals as a result of their membership and position within a social group, but Sewell (1992) argues that this conceptualization is too rigid and that there is an adaptive process to these normative practices.

Does a science teacher community of practice also account for individual science teacher identities and a sense of agency, if the identity comes to depend upon on those we associate with and the groups we participate in? Recent scholars have moved away from this debate of agency versus structure to the acknowledgement of the existence of an interplay between both.

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Sewell (1992) argues that "structures shape people's practices, but it is also people's practices that constitute (and reproduce) structures. In this view of things, human agency and structure, far from being opposed, in fact presuppose each other" (p. 4). If this is the case, then what might such a science teacher identity look like, if there such an interaction between structure and agency within this community of practice? Is this community of practice evolving and can it still have a relatively stable structure in terms of rules and goals while also adapting to institutional changes in science education? Can science teacher identity influence practices and activities as part of a collective repertoire in the community of practice?

Place- and Culture-Based Education in an Era of Post-No Child Left Behind (NCLB)

What is unclear today in Hawaiʻi is how evolving roles and expectations for science teachers are involved with (re)constructing not only multiple professional identities that include teacher and scientist identities, but personal cultural, ethnic, and social identities. In science teacher communities a large number of individuals bring with them a Western scientific background to the practice (through post-high school science education), which adds to the contested and challenging nature of negotiated and multifaceted identities. Moreover, in an era of post-NCLB, student expectations and teacher accountability are no longer heavily focused on high-stakes testing and strict standards-based curricula.

While place-based and culture-based education models are not new to the U.S. system, pedagogical practices of cultural relevancy. Responsiveness, and eco-justice are not as mainstream in the science classroom setting. Ladson-Billings (2014) developed her theory of culturally relevant pedagogy in 1995 and since its use and misuse for over 25 years, she now argues for a "remix" of her original theory: *culturally sustaining pedagogy*. Environmental education and the understandings of what it means to be ecologically literate are continuously being shaped and re-imagined in secondary science education. In addition, the divide between environmental education (EE) and education for sustainable development (ESD) (Barnhardt & Kawagley, 2005; Bowers, 2001; Kopnina, 2013, 2014; Kronlid & Öhman, 2013; UNESCO, 2009) has prompted local communities and Indigenous populations to interject themselves into the equation of conservation and environmental activism.

In Hawaiʻi, conservation education appeared to have its local roots in the 19th century and the damaging effects of uncontrolled grazing by feral animals and the introduction of invasive plants and animals were dealt with in a protective and utilitarian philosophy toward native forest conservation (Gagné & Gill, 1998). In the 1970s and 1980s environmental education was approached through non-governmental organizations such as the local Sierra Club chapter, the Hawaiʻi Nature Center in Makiki, the Bernice Pauahi Bishop Museum, and the Moanalua Gardens Foundation. Even in 1998, Gagné and Gill noted that there was "little interaction with the DOE and public school teachers" and Oʻahu-based organizations had a strong urban emphasis with little impact on the neighbor islands or even rural Oʻahu, "where the attitudes of students toward natural areas" were "strongly exploitative" (p. 180).

Notions of place and place-conscious education (Gruenewald, 2003b) have been brought forward in school reform in the 1990s and up until the present times. In a changing educational landscape today, school reform in a new era of the national *Every Student Succeeds Act* (ESSA) (USDOE, 2015) is supporting states with moving away from the focus on segregated skills and outcomes that are individualistic, quantifiable, and statistically comparable. In Hawaiʻi's public, charter, private, and Hawaiian immersion schools today there is a shift toward pedagogies and accountability methods that are culturally relevant and sustaining and progressing outward toward places. With such a connection to the natural environment, place-based and culture-based models in a Hawaiian cultural context have become a part of the educational model during school hours.

The acknowledgement of Indigenous Knowledge Systems (IKS) and Traditional Ecological Knowledge (TEK) as integral parts of science education today has resulted in the bridging of two knowledge systems: Hawaiian ways of knowing and Western science. Science education today has become politicized and culturally responsive and science teachers are becoming increasingly challenged with understanding what is appropriate content and how their students can be engaged with learning that is intentional, applicable, and relevant to their lives. Thus, the changing landscape of Hawaiʻi's educational system today adds another layer of complexity to the development and negotiation of multiple identities for science teachers.

Significance of Research

My research thus seeks to better define and describe the processes of identity making for secondary science teachers as they traverse the professional and personal landscapes over time. Situated on an island ecosystem where the cultures are diverse, I also proposed to examine the multiple factors influencing identity development and shaping specific to science teachers in Hawaiʻi. As a former science teacher I have wondered about how the negotiation of multiple identities over time and space has been able to influence a science teacher community of practice that addresses current local and global issues in our environment today. I also wanted to know if teachers receiving training in place- and Hawaiian culture-based education would be influenced to take on pro-environmental behaviors that became transformative and contributing to a dynamic science teacher identity. In sum, I sought to understand the contextualized nature (i.e. social, cultural, historical, political, and economic factors) surrounding science teacher identity development and shaping.

In an era of globalization there is the push for STEM (Science, Technology, Engineering, and Mathematics) initiatives and the Federal and State mandates for standardization in education from a Western perspective. The challenges that science teachers face in Hawaiʻi today can seem insurmountable. Is there a unique, collective identity that exists which embodies an understanding of one's role as a science teacher and one having a sense of place and deep connection to the natural environment? Is this what Thomashow (1995) refers to as an *ecological identity*? If so, what might such an identity look like and how does it relate to how one practices in Hawaiʻi? For the purpose of my research, I will refer to ecological identity as *eco-identity* from this point forward.

In this study it was essential for me to include the place-based and place-conscious education framework rooted in the Hawaiian cultural context and also to utilize the theory of a critical pedagogy of place when focusing in on science teacher eco-identity development. A sense of place and the mindset of teaching for ecological and social justice in science education have become essential innovations for contemporary times and imperatives for science education reform.

Focusing Research Question

As a secondary science teacher in Hawai‘i what does it mean to have an eco-identity and why might this be important?

Related Sub-Question

- How do secondary science teachers negotiate their eco-identities over time and space and how does this impact their practices as situated in the sociocultural contexts of Hawai‘i?

Definition of Key Terms

Community of Practice. Lave and Wenger (1991) define this perspective as learning that is situated in the community, whereby the connections between learners and the communities in which they are immersed and in which they seek membership is central. Through legitimate peripheral participation and interaction, newcomers engage in a mastery learning process that allows them to become a contributing member with a specific role in the community to which they belong and aspire to belong. What we learn transforms who we are and defines our roles in society, and these defined roles and who we are, in turn, transform what we continue to learn in this community (Lave &Wenger, 1991, p. 29).

Critical Pedagogy of Place. Place-based education in science that encompasses stewardship in cultural, historical, political, and economic contexts to address ecological and social crises, both locally and globally (Gruenewald, 2003a, 2008). It is an education promoting transformative learning through critical participatory action and critical self-reflection on the human-nature relationships, with implications for addressing real life concerns and worldwide insecurities of today.

Culturally Relevant Pedagogy. A theory that posits an effective process that not only addresses student achievement, but also helps students to affirm their cultural identity while developing critical perspectives that challenge inequities in schools and the greater community (Ladson-Billings, 2005).

Culturally Sustaining Pedagogy. Beyond culturally relevant and responsive pedagogies, culturally sustaining pedagogy is a stance that seeks to "perpetuate and foster—to sustain—linguistic, literate, and cultural pluralism as part of the democratic project of schooling" (Paris & Alim, 2014). A culturally sustaining approach to upholding a democratic form of education ensures the valuing and maintenance of a multiethnic and multilingual society in today's demographically changing schools and communities. Culturally sustainable practices takes on an asset approach to teaching, whereby once marginalized communities become important resources in the classroom.

Culture-Based Education (CBE). Grounding instruction and student learning in shared ways of being, knowing, and doing. CBE pedagogy places importance on Native language; place-based, project-based, and experiential learning; cultural identity; holistic well-being; and personal connections and belonging to family, community, and ancestors (Castagno & Brayboy, 2008; Kanaʻiaupuni, 2007).

Ecological Identity. How people perceive themselves in reference to nature, as living and breathing beings connected to the rhythms and cycles of the Earth, and to the expansive and complex diversity of ecosystems. An ecological identity emerges from an ecological worldview that may lead to new ways of understanding personal identity in a socially mediated framework of the human-nature relationship (Thomashow, 1995). An ecological identity is having a sense of place, which incorporates place identity, place attachment, and place meaning, while also having a sense of deep ecology that embodies an eco-centric worldview supporting a sense of personal agency at various societal and ecological system levels (Gedzune & Gedzune, 2011).

Eco-Justice Pedagogy. A model for critically questioning existing school foundations and challenging students to rethink and re-examine the traditions and practices of their society that are threats to all life and communities and sustainability in a broad sense (Bowers, 2008). Eco-justice pedagogy is an education that orients students toward preparing to support and achieve diverse, democratic, and sustainable societies, with the understanding of the need to restore cultural and environmental commons (Martusewicz, Edmundson, & Lupinacci, 2011).

Ecological Consciousness. Consciousness is shown to be key to understanding personhood, and it enables human beings to be open to others and the world (human-nature connection). Ecological consciousness is the situating of human beings into the ecosystem, as embodied creatures in continuum with the world, implicating co-relatedness, co-dependence, and co-consciousness (Morris, 2010).

Environmental Identity. Social roles and responsibilities ascribed to an identity of how we orient ourselves to the natural world. An environmental identity prescribes a course of action that compatible with individual's sense of who they are (Clayton & Opotow, 2003). Environmental identity involves a dynamic interplay between what is perceived as central and as peripheral, with social and environmental orientations encroaching on and redefining each other.

'Ike Hawai'i. Hawaiian knowledge and understanding. Understanding Hawaiian culture as an interconnected system of beliefs, knowledge, and shared practices that which connects humans to the natural environment, and the spiritual realm (Kamehameha Schools, 2009). The ancestral Hawaiians were keen observers of the natural world, and knowledge, or 'ike, was held important and sacred, and considered very powerful, especially among the professional experts (*kahuna*). "'Ike enabled the early Hawaiians not only to function and survive in their island environment, but to excel in their featherwork, canoe making, fishpond building, irrigation engineering, heiau construction, and agricultural farming practices—to name a few of their significant achievements" (Burrows, 1998, p. 205).

Land Education. Indigenous cosmologies in practices that offer a more critical look into place- and community-centered teachings, with central focus on historical and current contexts of colonization in the education on and in relation to land (Tuck, McKenzie, & McCoy, 2014). The concerns with place-based and environmental education programs today are that they purport themselves to be culturally or politically neutral while perpetuating forms of European universalism and settler colonialism. Educator and Indigenous scholar Manulani Meyer writes, "Learn from the land and not simply about the land. We can learn from the land as Native peoples whereby it is more than just the *'āina that which feeds*, but also includes studying ecosystems with humans as part of nature" (2004, p. 8).

Place Attachment. Emotional attachment (affective bond) of individuals and groups to a particular place or environmental setting of key familiar characteristics (Semken & Freeman, 2008). Environmental psychologists describe place attachment as the emotional intensity of the human-place bond (Altman & Low, 1992).

Place-Based Education. Place-based science education is a Western construct that encompasses John Dewey's ideals of experiential learning that is relevant, problem-based, and situated in local environments. Place-based education goals are to promote connectedness with surroundings (human/social, natural, and man-made) and hence a strengthened sense of place, and to eventually achieve local, ecological and cultural, sustainability (Woodhouse & Knapp, 2000).

Place Meaning. A cognitive construct, embodying ways in which people know and experience the physical space, be it through aesthetic, ceremonial, economic, familial, historical, political, spiritual, and/or scientific means (Semken & Freeman, 2008). Place meaning can also include the evaluative beliefs of individuals and community groups, reflecting the values and significance of certain settings in terms of functionality (i.e. resources) (Wynveen, Kyle, & Sutton, 2012).

Sense of Place. This term has been liberally, and often in various humanistic, sociological, geographic, and educational discourses to encapsulate the connections among people and places. In their study of sense of place in place-based science teaching, Semken and Freeman (2008) define sense of place as a combined set of place meanings and place attachments, held by a person or a group, that is highly contextualized and evolving due to the changing landscapes, boundaries, and socially mediated nature of its meaning. A person's cognitive (ways of knowing), affective, and embodied understandings of a place, cultivated through a living ecological relationship with a place can thus be defined as a sense of place (Lim & Barton, 2010). In the Hawaiian context, natural and cultural resources are valued in ways to that have developed for over hundreds of generations into an evolving attachment that can be called a sense of place (Maly, 2001).

Situated Learning. Theoretical perspective of learning and knowing that is contextualized, whereby interaction and influences of the physical environment and community play a critical role to the eventual acquisition of knowledge and skills to serve the greater good of society (Lave & Wenger, 1991).

Traditional Ecological Knowledge (TEK). Indigenous science whereby humans are viewed as intricately and spiritually connected with nature. It is a representation of the descriptive and explanatory knowledge about nature transmitted across generations, mainly through oral traditions. TEK is the understanding of the interconnectedness with nature on intellectual, emotional, social, and spiritual levels, and how it is applied (technology) in everyday life contexts. Time-tested practices of TEK for preserving fertility, controlling pests, and conserving biological diversity are approaches that foster sustainability and environmental integrity (Glasson et al., 2006; Snively & Corsiglia, 2001).

CHAPTER 2: REVIEW OF THE LITERATURE

This chapter continues my story as a scientist, a reflective environmentalist, and a teacher of science. I demonstrate that fostering a strong sense of science teacher identity supports a strong commitment to the profession of teaching. Next, I examine how culture-based education, land education, and island biogeography relate to secondary science teacher education in Hawai'i. Finally, I review narrative inquiry as an effective tool for studying teacher professional development and its choice for my methodology to co-construct understandings of science teacher eco-identities as negotiated across time and place.

Contextualizing the Study: My Journey as a Science Teacher

As a secondary science teacher, I was trained in an era of high stakes testing and the enactment of No Child Left Behind (NCLB) in 2002 (USDOE). Knowledge was presented as information conveyed through the rationale of standards reform and accountability. NCLB's definition of student "success" as high test scores in reading and in math and graduation rates resulted in a narrowing of curriculum (Darling-Hammond, Bae, Cook Harvey, Lam, Mercer, Podolsky, & Stosich, 2016). While I wanted to instill a more place-conscious type of education that connected students to real life and local, environmental, and social issues (Gruenewald, 2003b), I was met with the dominant paradigm of the standards-and-testing model and the focus on Science, Technology, Engineering, and Mathematics (STEM). Episodes of overwhelming stress and frustration consumed me and I turned within to better understand where my passions and life's calling lay.

After five years of teaching at the secondary science level, I moved on to teaching adults entering the profession. While I didn't remain in the classroom working directly with students, I still saw myself as a science teacher and also as a teacher educator. Early in my college teaching career I was given the task to revise an environmental education course for pre- and in-service teachers. The design of the course enabled me to take my students on field trips to all parts of O'ahu to participate in service-learning projects involving clean-up and restoration of places that held significant connections to the Hawaiian culture. This approach to learning felt right to me. I wanted to instill a passion for restoration and conservation of *wahi pana* (special, sacred places) and help future and current teachers understand the connection of ecosystems to teachers' own cultures in the Hawaiian cultural context.

These natural places mattered and the histories of these places mattered. I found connections to these spaces on intellectual, cultural, emotional, and spiritual levels essential to regaining my own sense of place. As a teacher educator, I wanted to learn about the impacts of colonization on the Hawaiian people and the land which they knew and respected on multiple levels. By learning about the sustainable practices and mindsets of ancient and modern-day Hawaiians, I could integrate such ways of knowing into the science education curriculum. The kind of identity that I was now developing was one that included my scientist, environmentalist, and science teacher identities. Through direct connection with my environment and the negotiation of multiple identities emerged a broader *meaning making* process of developing an eco-identity. I found it essential to behave in ways that strengthened my sense of place and supported my role as a science educator in Hawai'i.

Thus, as a former secondary science teacher I wanted to help pre-service and in-service science teachers better understand their own multifaceted identities and what I refer to as an eco-identity. Eco-identity as a meaning making process as currently situated in the sociocultural contexts of Hawai'i and living on an island ecosystem became the focus of my research.

Sociocultural Theory

Sociocultural theory purports that human cognition and the acquisition of knowledge and skills cannot happen in a vacuum (Vygotsky, 1978). Human development and learning, and more importantly the development of individual identities, occur within social and cultural contexts over time and space. According to sociocultural theory there is an interactive, inner dialog within oneself that is connected to the outer social world of history, experiences, and politics. Change and evolution of one's own theorizing and thinking are not static, and social institutions like schools can influence and be influenced by such processes (Vygotsky, 1978). Under the broad framework of sociocultural theory I also refer to the ecological theory of human development (Bronfenbrenner, 1994) whereby human development encompasses the entire ecological system in which growth takes place. The social and cultural influences on human development and learning within the entire ecological system thus serve as external forces dynamically shaping and reshaping teacher identity.

A growing body of psychological research examining individual belief systems (within cultures) and the degree to which an individual is part of the natural environment has accumulated over the past 40 years.

Constructs borrowed from social psychology include attitude theory in its many forms, values, persuasion, risk communication, and norm activation (Bruni & Shultz, 2010). Environmental psychology, and what is now called "ecopsychology," establishes the validity of a humans-as-part-of-nature concept that stresses that humans are not isolated beings but connected to all of nature (Kahn & Hasbach, 2012; Rozak, Gomes, & Kanner, 1995).

Sociocultural theory and ecopsychology offered a way to interpret social elements interacting with teachers' lives. These identified social elements as well as inputs from culture influenced practices and development of eco-identities. The development of such an identity is part of this meaning making process of learning to become a teacher and growing further through lived experiences (Akkerman & Meijer, 2011). Rethinking education and identity development in the ecological sense and critically considering the interdependent and dynamic settings in which a person lives, and the larger contexts in which such settings are embedded, is thus an essential framework for this study on science teacher eco-identity.

Part I: Complexity of Teacher Identity Development

Bloomfield's (2010) case study of a professional experience for a graduating teacher entering a pre-service school-based experience, and a plethora of case studies studying pre-service and novice teacher development of identity (Alsup, 2006; Clandinin & Connelly, 1995; Watkins-Goffman, 2006) are indicative of the complexity of teacher identity development and the existence of multiple and dynamic identities over time and space. Induction of a new teacher to the profession is seen as complex, ambiguous, and full of contextual specificities that can create persistent dilemmas and produce common narratives (Alsup, 2006; Clandinin & Connelly, 1995). Bloomfield (2010) draws upon the work of Deborah Britzman (1991), spanning the past two decades, with particular attention to three dimensions of teacher voice: biography, emotion, and institutional structures. Bloomfield (2010) focused on these dimensions of voice to understand this process of developing a professional identity as a "struggle for voice," which can be uncomfortable aspects of pre-service teacher meaning making (p. 221). Britzman's work identified both the complexity and the contested nature of teacher education and pre-service teachers' experiences that "shape the contradictory realities of learning to teach" (1991, p. 8).

In multicultural education, Macedo (2000) makes a distinction between "giving voice" to those marginalized in society (which perpetuates the dehumanizing and oppressive relationship between colonizer and colonized) with "coming to voice" as a democratic human right not given to the colonized. Pre-service, novice, and veteran teachers of all cultural and ethnic backgrounds and from multiple contexts, have often felt disempowered and conflicted in terms of their own professional identities in this struggle with coming to voice (Macedo, 2000). Moreover, teachers working in communities of poor urban students and minority students experience transformations of their identities over extended periods of time, as they negotiate, renegotiate, and accommodate their identities to adapt to the current sociocultural and political contexts (Upadhyay, 2009).

Akkerman and Meijer (2011) take a dialogical approach to conceptualizing teacher identity. They purport that teacher identity is both unitary and multiple, both continuous and discontinuous, and both individual and social (p. 309). While other studies of teacher development (Alsup, 2006; Meijer, Korthhagen, & Vasalos, 2009) do discuss teacher identity development and maintenance as narrative and dynamic processes, they do not explicitly present nor discuss a dialogical approach to teacher identity (Akkerman & Meijer, 2011). Dialogical Self Theory therefore addresses the notion of identity with "self" referring to the self-as-knower and "identity" referring to the self-as-known (Akkerman & Meijer, 2011). In the presence of others identity can be re-conceptualized, and the "Cartesian dualistic conception of self-versus-other is surpassed and the self is extended to the environment" (p. 314). Hence, teacher identity is multifaceted and fluid and cannot be defined in terms of distinct parts of one's sense of being that do not interact.

Negotiating Scientist and Science Teacher Identities

Secondary science teachers have additional dilemmas with respect to coming to voice and realizing their calling as educators, scientists, and environmentalists. Kovan and Dirkx (2003) write about a vocation or calling exemplified by environmentalists building deep interconnections between the meaningfulness of their lives with the meaningfulness of their work. Vocation has historically meant "to be addressed by a voice" (Storr, 1984) or what P. Palmer (1998) describes as "something I can't not do, for reasons I'm unable to explain to anyone else and don't fully understand myself but that are nonetheless compelling" (p.25).

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Eco-identity development in science teachers is a meaning making and transformative process that is shaped and reshaped by knowledge, beliefs, values and the contexts of work. Generative causes of variation in the professional identity of new teachers includes the socio-political and historical contexts in which teachers experienced prior to entering the field were explored by Leonard and Roberts (2014). What the researchers found was that as early as late adolescence and up through early adulthood, individuals situated in the socio-political contexts of the time were already being influenced with respect to teacher professional identity development. In addition, in-service teachers can experience identity transformation when confronted with a multitude of resources (Tan & Barton, 2008; Upadhyay, 2009) being introduced in neoliberal education reform.

Environmental Education and Education for Sustainable Development

An era of globalization and STEM initiatives professing to promote scientific literacy add to the struggles of science teachers coming to voice. With the ending of *No Child Left Behind* (NCLB) Act of 2001 and with shifts in educational policy discourse to address local and global environmental changes, discussions of science teacher education reveal that preparing secondary science teachers is a complex task (Aydeniz & Kirbulut, 2014; Calabrese Barton & Berchini, 2013; Capps & Crawford, 2013; Kerkham & Comber, 2007; Meijers, Lengelle, & Kopnina, 2016; Quinn, Castéra, & Clément, 2015). For the past 20 years there have been evolving socio-historical and political contexts, and Leonard and Roberts (2014) argue that effective school reform "requires an understanding of the complex ways teachers interact with the drivers of change" (p. 303). Resulting neoliberal education reform that is associated with the global economy and a free market have influenced environmental education (EE) models worldwide, prompting the development of education for sustainable development (ESD) programs (Meijers et al., 2016; Quinn et al., 2015).

In turn, educational reforms in science and the debates over models of EE and ESD have prompted researchers to look critically at the multiple perspectives of people worldwide in order to understand and characterize how humans, and science teachers in particular, relate to the natural world (Kopnina, 2013; Thomashow, 1995, 2002). The United Nations (UN) Decade of Education for Sustainable Development (DESD) employs teachers with a key role in developing and "securing sustainable life chances, aspirations, and futures for young people" (UNESCO, 2009).

What teachers of science have been expected to do in this time of local and global environmental change is negotiate the sometimes conflicting goals of EE and ESD. Environmental education (EE) as defined by J. Palmer (1998) is:

> The process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture, and his biophysical surroundings. Environmental education also entails practice in decision making and self-formulation of a code of behaviour about issues concerning environmental quality. (p.5)

The goal of EE is promoting positive change in human relationships with nature (Kopnina, 2012) that supports an *eco-centric worldview*. As opposed to the *anthropocentric worldview*, an eco-centric one describes human beings are part of nature and act for the good of other species in order to protect the biotic community (Dunlap & Van Liere, 1978). In EE curricula, environmental valuing and upholding a land ethic (Leopold, 1949) recognizes Indigenous communities' ways of relating to nature and fosters environmental learning without formal regulations or standardized curricula (Barnhardt & Kawagley, 2005).

With globalization and the modernization of once considered third world countries, a neoliberal education attempts to address issues of sustainability in three areas: economics, social systems, and natural resources (Kopnina, 2012). ESD conceives the environment as a "resource for economic development or shared resource for sustainable living" (Sauvé in Kopnina, 2012, p. 34). Hence, critics of ESD curricula argue that the dominant Western worldview is further emphasized, whereby humans as part of the natural system is acknowledged but the moral imperative to address non-human needs is rarely part of this paradigm (Kopnina, 2012, 2013). Instead, an anthropocentric, human-centered, worldview is perpetuated through such curricula.

Eco-Justice Education

A continuum, rather than a dichotomy, has been set up with EE and ESD curriculum development and the assumption of the existence of universal aspects of environmental and sustainability education (ESD) principles. For educators and education policy makers today, the dilemma thus arises with the cultural contexts of environmental values and how teachers in particular must negotiate multiple ethical values for the environment when teaching science (Sund & Ohman, 2014).

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According to Bowers (2001), a social justice discourse that attempts to address social injustices in the schools is still lacking in that it comes from a critical humanist perspective that ignores eco-justice issues. The expanded perspective of an *eco-justice education* (Bowers, 1995, 2001) as a broader framework from which social justice discourse takes place is not to be confused with environmental education (EE) and education for sustainable development (ESD) which may often support anthropocentric worldviews and not focus on root causes of social and environmental injustices.

Eco-justice education as part of neoliberal education reform purports to take a critical look at not only teaching for ethical practices in and toward the environment, but also the rights and traditional practices of humans with respect to local, sustainable living practices and development in a changing and global-minded world (Bowers, 2001). In the 2004 article linking discourses on ecology and sustainability with social justice discourse, Furman and Gruenewald (2004) draw upon the literatures on eco-justice education and critical pedagogies of place (e.g. Bowers, 2001; Gruenewald, 2003a; Smith, 2002; Sobel, 2004) to argue that pedagogy is the primary vehicle through which socio-ecological justice can rightfully be addressed in schools today. Furman and Gruenewald (2004) make clear that environmental crises are not separate from socioeconomic crises and that this need to advocate for social and environmental justice perspectives in the schools can only happen with extensive changes in the educational systems.

Likewise, Thomashow (2002), a professor of environmental studies for over 25 years, stresses the importance of individuals understanding issues of global environmental change (ecological principles) and also the societal, economic, cultural, and spiritual practices and perspectives through which one perceives the biosphere. Thomashow (2002) and other eco-justice educators note that the best way to understand ecological principals and human impacts on the environment and to learn how to perceive the biosphere is by playing close attention to where you live. Eco-justice pedagogy therefore supports the development of place connections and awareness of the socio-political and ecological injustices impacting communities and natural environments. The issues of antagonistic goals and anthropocentrism with respect to EE and ESD are therefore resolved with an eco-justice framework for teaching and learning.

Hence, in order for effective school reform in science education such as the implementation of an eco-justice model to take place, teacher professional identity, and more specifically eco-identity, is essential as a discourse tool interacting with evolving socio-political and historical contexts (Leonard & Roberts, 2014).

Science Teacher Community of Practice.

The socio-historical and political arenas and globalization initiatives supporting neoliberal education reform today also impact science teacher *community of practice*. Community of practice (Kimble, Hildreth, & Bourdon, 2008; Lave & Wenger, 1991; Wenger, 1998) consists of a collective of professionals, such as educators, placing social rules and conventions on learning and practices. The group shares common concerns and passions for what they do and as they regularly interact they learn how to do their tasks better (Wenger, 1998). For science teachers this kind of community of practice can also influence how teachers come to know their professional selves as educators and also as scientists. Wenger (1998) argues that the learning that most individuals find transformative takes place through collaborative membership in communities of practice such as teaching. Within a science teacher community of practice, structure and power relations may encourage and/or prevent legitimate participation for individuals and the promoted science identities may not be attainable to or desired by all (Shanahan, 2009). Structure refers to the underlying principles that shape the normative patterns within social groups (Sewell, 1992). From a structural perspective, science teacher identity is defined by the requirements, norms, and expectations imposed upon individuals as a result of their membership and position within the group.

Science teacher community of practice is just one component influencing the development of multifaceted identities within K-12 science education. Adding to the complexity of a collective professional identity is the personal identity and sense of individual agency.

Akkerman and Meijer (2011) discuss the negotiation process of understanding oneself and how one feels s/he is perceived in the teaching community:

> A way to come to an understanding of this complexity is to look more carefully at the doubts, dilemmas, and uncertainties that teachers experience, implicitly within their normal work routines, or perhaps more explicitly when faced by educational innovations or career transitions. In a similar vein, teachers' self-dialogues might be studied to reveal the individual identity struggles and challenges teachers face, in taking up a teacher career, or as a consequence of changes in their working lives. (p. 318)

In addition to structure and adaptive structure, individual agency becomes part of the dialectic in a community of practice. Sewell (1992) argues for the interactive nature of structure and individual agency as an adaptation to the existing structure within a teacher community of practice because they presuppose each other. Nieto (1996) argues that in order to achieve transformation in schools and schooling, teachers must establish a community of critical friends who debate, critique, and challenge one another to go beyond their current ideas and practices. Science teachers benefit tremendously from membership in teaching learning communities that promote teacher reflection and transformation (Saka, Southerland, & Brooks, 2009; Tan & Barton, 2008; Upadhyay, 2009). Teacher dialog, self-dialog, lived experiences, and reflections within a community of practice all influence transformative learning that in turn impacts identity development and shaping.

Teacher Accountability in an Era of Post-No Child Left Behind (NCLB). In the post-NCLB era, expectations and teacher accountability for student "success" are no longer heavily focused on high stakes testing. The *Every Student Succeeds Act* (ESSA) (USDOE) was signed into law in December 2015, surpassing NCLB. Science teachers, like their contemporaries in the elementary and secondary school levels, have been impacted in terms of what success looks like.

In their 2016 report, Darling-Hammond et al. examine options with redefining accountability systems at the state level, and note:

> ESSA marks an important move toward a more holistic approach to accountability by encouraging multiple measures of school and student success. This shift creates new opportunities for local innovation by giving states the opportunity to create new approaches to accountability and improvement. The law also gives state leaders the challenging responsibility of designing systems that can address enduring inequalities in student learning opportunities and outcomes. (p. 1)

With the passage of ESSA in 2015, the overarching goal of achieving an equitable school system now supports accountability strategies that lead to more meaningful, culturally relevant, and engaging learning opportunities for all students. In terms of curriculum design, access to materials and resources, and educator development, science teachers are now expected to think and act in ways that are holistic in terms of what defines student "success" and achievement in science.

In addition to the expectations put upon teachers with ESSA, there is a national shift with respect to science teaching and the adoption of the Next Generation Science Standards (NGSS). The National Academy of Sciences (NAS) publication (2015) has shed some light on science teachers' learning, and their beliefs about teaching and their instructional practices. From a Western framework for learning and teaching science and how teachers have been indoctrinated into the career of science teaching, the report found that there were gaps between the vision of what science teachers reported doing in their classrooms and what actually has transpired (based on student feedback and observations of classroom practices). The student-led inquiry process, hands-on learning with laboratory activities, and the use of evidence/data to support claims are what the recently adopted national NGSS purports. On the contrary, this has not been the case as many K-12 science teachers have shown to be struggling with this shift in mindset (NAS, 2015).

Defining student success and achievement in science is still highly debated, even in the current era of ESSA and reformed national science standards (NGSS).

The goals of NGSS promote science education as "central to the lives of all Americans" and the website states:

> A high-quality science education means that students will develop an in-depth understanding of content and develop key skills—communication, collaboration, inquiry, problem solving, and flexibility—that will serve them throughout their educational and professional lives. (Retrieved from https://www.nextgenscience.org/)

In the current environment of K-12 science education there still exists the mismatch between national science learning goals and mandated test-oriented goals, creating political and cultural challenges for teachers (Anderson, 1996). Upadhyay's (2009) case study of a science teacher of minority students in an atmosphere of high-stakes testing highlights the contested nature of teacher identities while teaching science:

> For teachers political challenge stems from high-stakes testing environment where academic success has been directly correlated to students' test scores. Thus, political challenge creates tensions between teachers and other stakeholders such as school administrators and parents. Cultural challenge creates tension between teachers' epistemology and the purpose of schooling for the students. Therefore, teachers have to strategically renegotiate their own identities and beliefs about teaching science in order to stave off political and cultural challenges and to ensure student's success in the high-stakes tests. (p. 571)

In addition, institutional accountability and this kind of discourse oftentimes subsumes the educational discourse of collaboration in a science teacher community of practice. Gruenewald (2003b) writes about having an "accountability to place," whereby having a place-conscious framework demands a new set of educational objectives and a new set of indicators whereby schools and communities are held accountable. Lipman (2002) elaborates on the politics influencing curricula and educational practices:

> Accountability policies not only regulate educational practice but also are a form of symbolic politics…They shape the public definition of education, explain educational failure, and organize consciousness around shared understandings of what constitutes classroom knowledge, educational practice, and valorized social identities. (p. 394)

What is unclear today in Hawai'i is how evolving roles and expectations for science teachers are involved with (re)constructing this professional identity.

In science teacher communities a large number of individuals bring with them a Western scientific background to the practice (through post-high school science education), which adds to the contested and challenging nature of multifaceted identities. With identity development as a meaning making process teachers will negotiate their multiple senses of selves and utilize the community of practitioners and expected roles to confirm, challenge, or rethink what it means to be a science teacher in Hawaiʻi. Science teacher identity in Hawaiʻi is further impacted by the sociocultural contexts of *ʻike Hawaiʻi* and other epistemologies, including the educational philosophies driving Western science.

Conceptualizing Eco-Identity

Distinguishing Environmental Identity from Ecological Identity

The concept of an *eco-identity* was introduced in 1971 by community psychologist James G. Kelly as a metaphor for an ecological perspective for learning about and being involved in a community as a researcher. This perspective transcends the narrow role of a professional and outside interventionist in research. Kelly (1971) purports that in order to have a comprehensive appreciation of the local context, one must have an eco-identity whereby the community psychologist's own identity should be related to the natural community s/he is working with. Knowing and being immersed in the community with parallel goals and identities, can aid the research process to make the outcomes mutually beneficial for all parties (Ryerson Espino & Trickett, 2008). Eco-identity as defined by Kelly is more of a metaphor to consider the natural community (as an interdependent ecosystem) collaborating with researchers to make changes and share information in ways that are mutually beneficial. The notion of reciprocity in defining this kind of eco-identity involves a "relationship where there is self-consciousness and care about the reciprocal exchange of resources" (Kelly, 1986) for all contributing participants.

Moving beyond this notion of reciprocity in research and having an ecological perspective as an educator, Meijers, Lengelle, and Kopnina (2016) discuss how developing more sustainable relationships with the environment involves moral principles and valuing natural resources as part of the meaning making process of developing an identity in the context of environmental education. An *environmental identity* is based upon values (especially altruism) which can influence beliefs, which in turn can influence the creation of "personal moral norms" that can then characterize predispositions to pro-environmental behavior (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000; Van Petegem & Blieck, 2006).

The revised New Ecological Paradigm (NEP) Scale (Dunlap et al., 2000) is a widely used measure of people's shifting worldviews from a human-centered one of anthropocentrism, to an ecological one of eco-centrism, with humans as part of nature. With such an environmental identity, individuals hold self-meanings as "representations of who they are, how they feel, and what they value" (Meijers et al., 2016, p. 4).

Distinguished from an environmental identity, an *ecological identity* stems from the understanding of ecology: the relationships of organisms to one another and to their physical surroundings. An ecological identity therefore, includes humans as living organisms interacting with other organisms and their physical surroundings in an interdependent manner. An environmental identity, on the other hand, focuses on humans' relationships and orientation to their surroundings as being separate from nature (Clayton & Opotow, 2003). While many studies focus on behavioral and attitudinal aspects contributing to environmental degradation, the human-nature relationship is often conceptualized as a disinterested one in economic and practical terms and less so in affective terms (Clayton & Opotow). Sociocultural theory supports self-meanings of an ecological identity that one acts out and sustains (Stets & Biga 2003) through identifying oneself as part of nature. Ecological identity thus becomes the process of identity development and shaping involving the interaction of individuals with their environments as they develop connections with nature (Meijers et al., 2016). Stets and Biga (2003) bring identity theory into the area of environmental sociological research in order to explain pro-environmental behaviors. Their study revealed that individual agency is important in influencing environmentally responsive behavior but that this kind agency is largely mediated through the identity making process, rather than through an attitudinal process (Stets & Biga, 2003, p. 398).

An ecological identity as defined by Thomashow (1995) takes into account the complex notion of identity and all the different ways people construe themselves in social relationships, as manifested in personality, values, actions, and sense of self. It also takes into account the broad understanding of *ecology* as the scientific study of the interaction of organisms with their environment, including the physical environment and other organisms living in it. Thomashow (1995) goes on to note that an eco-centric worldview embedded in this kind of ecological identity may therefore lead to new ways of understanding personal identity.

For science teachers, both personal and professional identities need to be considered, with respect to the human-nature relationship and to the development of an ecological identity capable of impacting human-environment attitudes and relationships. Identity work and identity awareness in the areas of environmental education (EE) and education for sustainable development (ESD) are essential for both moral development and developing pro-environmental behaviors (Meijers et al., 2016).

In utilizing Thomashow's (1995) broad definition of an ecological identity and applying it to secondary science teachers I approached my study through a sociocultural lens of *situated learning*, where identity formation and shaping are meaning making processes that take place in specific environments (Lave & Wenger, 1991). Situated learning as a perspective for science education has been explored with respect to how social issues with conceptual and procedural connections to science (known as socio-scientific issues) are experienced (Houser, 2009; Sadler, 2009). Learning to perceive global environmental change, notes Thomashow (2002), is about having a place-based perceptual ecology characteristic of "learning how to observe, witness, and interpret the ecological patterns of the place where you live" (p.6). Individuals can therefore develop what I will refer to as an *eco-identity*, through which personal interpretations and reflections on life experiences transcend cultural and social interactions as professionals in the field of education.

Becoming a Reflective Environmentalist

Teachers' experiences with being in nature and eventually transforming themselves into *reflective environmentalists* (Thomashow, 1995) is a process of identity making and evolution with respect to how one not only has values and beliefs that respect and sustain the environment, but also by taking action. Through activities grounded in the professional practice of teaching, teacher education programs that aim to create opportunities for critical reflection, *transformative learning* can take place (Mezirow & Associates, 2000) and pro-environmental behaviors are enacted. Kovan and Dirkx (2003) contend that Mezirow's (1991) theory of transformative learning "relies heavily on cognitive, rational formulations of this process" and that it "understates the role of the broader sociocultural context of learning experiences and how emotions, imagination, and spirituality are actively involved in and central to this form of learning" (p. 102).

In their study of transformative learning in the lives of environmental activists they note the importance of also understanding the emotional and spiritual dimensions associated with finding one's calling (Kovan & Dirkx, 2003, p. 102).

Quinn et al. (2015) studied teachers' conceptions of the environment as an attempt to prevent the worsening of environmental problems on Earth with multiple understandings of what nature and sustainability mean and how this can impact contemporary school curricula development and implementation in Australia. From the review of literature of environmental ethics and eco-philosophy and subsequent responses of pre- and in-service teachers on a questionnaire, these researchers discovered a range of anthropocentric and eco-centric conceptions of the environment. Teacher worldviews were revealed to be along the continuum of anthropocentric (human-centered) ideologies and eco-centric (human-as-part-of-nature) ideologies, illuminating the consistently contrasting findings on attitudes toward nature and the environment (Quinn et al., 2015, p. 13). What is further noted is how the top-down promotion of knowledges, ways of thinking, and attitudes toward the environment from a sustainability perspective is perpetuated in the Australian Curriculum. The authors contend that the science curriculum dealing with living things and an ecological system, as opposed to the geography curriculum, lacks "expressions of sustainability that relates directly to any intrinsic value of non-human life or ecosystems" (p. 13). Quinn et al. (2015) conclude their study with implications and issues for teacher education programs in Australia and how varied conceptualizations of sustainability (primarily anthropocentric with negative attitudes toward nature) will influence how science teachers interact with and enact curricula (p.17).

These arguments foreground the potential role of teachers in providing nature experiences that may not otherwise be available for some students and especially those living in urban settings. Hence pre-service science teacher education can play an important part in equipping teachers with the necessary knowledge, skills, and mindsets of a reflective environmentalist. In policies relating to pre-service teacher education in EE and even less so in more recent moves of neoliberal education with ESD, the place-conscious components supporting human experiences with nature and places in general is lacking (Quinn et al., 2015).

In what Houser (2009) calls an "ecological democracy," he argues for a synthesis of ecological thought and citizenship education that would include the emotional and spiritual values attributed to all people and all environments. In the literature of deep ecology, Capra (1996) observes the following mindset that is a key characteristic of being a reflective environmentalist:

> The view that values are inherent in all of living nature is grounded in the deep ecological, or spiritual, experience that nature and self are one. This expansion of the self all the way to the identification with nature is the grounding of deep ecology. (pp. 11-12)

The nature of eco-identity development and the possible transformations that an individual will have over time and space includes value-laden constructs of the person's connections to the Earth, perceptions of the ecosystem, and critical self-reflections on direct experiences of nature (Houser, 2009; Naess, 1973; Thomashow, 1995).

Part II: Contexts of Secondary Science Teacher Education in Hawai'i

The second area of my literature review focuses on the specific sociocultural contexts of living and practicing in Hawai'i. Science teacher identity has been presented thus far as fluid, dynamic, and continuously evolving, but also uniform and discontinuous (Akkerman & Meijer, 2011; Beauchamp & Thomas, 2009). Teacher identity development is further complicated for secondary science teachers who, in a world of global environmental change, science education reform, and continued accountability measures are at times struggling with *coming to voice* (Macedo, 2000). Socio-political and historical contexts can also create dilemmas for teachers, creating spaces of negotiation and renegotiation that can appear to produce common identity narratives (Alsup, 2006; Clandinin & Connelly, 1995). Meaning making and coming to voice with eco-identity work are influenced by the factors of:

- biography—lived experiences;
- emotion—values and beliefs, place connections; and
- institutional structures—teacher education programs, science teacher community of practice, and neoliberal reform in environmental education (EE), education for sustainable development (ESD), and eco-justice pedagogy. (Bloomfield, 2010)

The specificities of living on an island ecosystem with the socio-scientific and political issues of the time can also impact how science teachers in Hawai'i see themselves not only as science teachers (scientists), but also as teachers of science (educators first).

Further influence on science teacher eco-identity arises within contexts of culture-based education including Hawaiian ways of knowing, or ʻike Hawaiʻi, land education, and island biogeography. Thus, a science teacher who takes on an eco-justice pedagogy approach is taking a critical look at not only ethical teaching practices in and toward the environment, but also the rights and Native ways of knowing with respect to local, sustainable living practices and development in a global-minded society (Bowers, 2001; Furman & Gruenewald, 2004).

Culture-Based Education and Science Teacher Identity

After the publication of *A Nation at Risk* report in 1983, science education models focused heavily on the goals and expected outcomes of STEM learning through test taking and performances in science that were void of cultural relevance (Bang & Medin, 2010). In the post-NCLB era, subsequent initiatives such as the *Race to the Top* 2009 program gave states like Hawaiʻi the opportunity to obtain grants to change school systems to prepare students for success in an information- and innovation-driven job market. While boasting successes for all students, these initiatives have not explicitly addressed the importance of culture, multiple epistemologies, and connections of local places to the global arena (Bang & Medin, 2010; Cajete, 2000; Gruenewald, 2003a; Woodhouse & Knapp, 2000).

Bang and Medin (2010) describe a conceptual framework that focuses on culturally based epistemological orientations of Native American communities and their relation to cultural practices associated with science instruction. What they and other researchers have shown is the efficacy of community-based science education that shifts the orientation in current science education to supporting the navigation of multiple epistemologies (Luehmann & Markowitz, 2007; Meichtry & Smith, 2007). Under the *Every Student Succeeds Act* (ESSA) (USDOE, 2015) the de-emphasizing of high-stakes testing and the deficit model approach to teaching students from non-dominant cultural and ethnic groups (Darling-Hammond et al., 2016) are a part of this neoliberal education reform.

Cultural relevance and the inclusion of *Indigenous Knowledge Systems* (IKS) which are locally situated cultural and social processes and skills by which knowledge is transmitted, acquired, and utilized with respect to the environment (Barnhardt & Kawagley, 2005; Berkes, 1999; Feinstein, 2004) have been cited as critical factors toward promoting transformative learning in students of all ages (K-12 and college).

Likewise, transformative learning as a process of identity development and shaping, implicates the importance of science teachers coming to know and understand how cultural relevance and IKS can inform and serve as a bridge to Western science education.

    Culturally Relevant and Sustaining Pedagogies. Today, school reform in the U.S. is focusing on cultural responsiveness and learning communities that facilitate place-conscious teaching and learning (Gruenewald, 2003b). Shifts in thinking more about how students and teachers learn science, and how a science identity can be successfully nurtured through *culturally relevant pedagogy* have been emphasized through the seminal work of Ladson-Billings (1995, 2014). In pursuit of making pedagogical changes, Ladson-Billings challenged the deficit model of what was lacking in African American learners and adopted the position of cultural relevancy that attempted to promote a new generation of teachers who would bring an appreciation of students' assets to the classrooms. Culturally relevant pedagogy as a framework for teacher training in multicultural education and implementation in schools across the U.S. has been used and misused since inception in 1995 (Bang & Medin, 2010; Ladson-Billings, 2014; Milner IV, 2008; Patchen & Cox-Petersen, 2008; Young, 2010). Young (2010) noted that the widespread application of culturally relevant pedagogy in research and practice was not always commonly understood as a viable conceptual framework advocating for academic success, cultural competence, and sociopolitical consciousness.

    Patchen and Cox-Petersen (2008) studied culturally relevant pedagogy (CRP) as a mechanism for diminishing disparities in science education and found practical possibilities for increasing marginalized students' access to science and technological fields (p. 994). Through CRP, issues of power, race, class, and gender were addressed through the redistribution of authority in the contexts of the classroom (Ladson-Billings, 1995). In the science classroom in particular, teacher instruction with CRP became a scaffolding of "teacher explicit" to "student-exploratory" continuum that "establishes and cultivates the redistribution of authority" (Patchen & Cox-Petersen, 2008, p. 996). CRP therefore prompted science teachers to think further about their own epistemologies and what it means to know and do in science. Science teachers utilizing CRP began to include multiple perspectives as valid practices and knowledge systems to learn from—an assets approach to teaching was utilized over a deficit model.

Reflecting on "Toward a Theory of Culturally Relevant Pedagogy" (Ladson-Billings, 1995), Paris and Alim (2014) questioned the terms "relevant" and "responsive." In exploring whether culturally relevant and responsive pedagogies went far enough to ensure the valuing and maintenance of our multiethnic and multilingual societies, Paris offered the conceptual stance of *culturally sustaining pedagogy*. "Culturally sustaining pedagogy seeks to perpetuate and foster—to sustain—linguistic, literate, and cultural pluralism as part of the democratic project of schooling" (Paris & Alim, 2014, p. 93).

Defining and redefining "sustainability." In addition to thinking more critically about culturally relevant and responsive education, a culturally sustaining pedagogy defines the term "sustain" from a sociocultural perspective. For over the past two decades, Western science education has defined the term "sustainability" from a dominant, anthropocentric worldview taken from political and economic vantage points whereby ecosystem management is generalized, prescriptive in nature, and inflexible with respect to local contexts (Crate, 2006) and void of cultural connections to these places (Brandt, 2008; Sund & Öhman, 2014). Borg, Gericke, Höglund & Bergman (2014) surveyed upper secondary school teachers in Sweden by subject areas on their conceptual understanding of sustainable development. While all teachers had an awareness of integrating economic, ecological, and social dimensions of sustainable development, each group understood this concept from their own subject traditions. The misunderstandings with and the lack of multicultural and Indigenous perspectives with sustainability initiatives today warrants a need to address understanding the concept of sustainability and education for sustainable development (ESD) from holistic, pluralistic perspectives (Borg et al., 2014). Educators as curriculum designers and enactors must therefore understand the risk taking processes in high-stakes times (Clayton, 2007). According to Kopnina (2017) teachers must know how to link unsustainable consumption to the structures and processes shaping consumer capitalism, in order to "teach for environmental sustainability" (p. 130).

In a more culturally responsive sense stemming from what Indigenous scholars and cultural practitioners profess, the interpretation of what it means to be sustainable, ecologically sustainable, and also *eco-literate*, can be explained by Orr (1994) as a relationship between human beings and the world, and sustainability is a process by which systemic and patient effort is put into restoring and preserving the traditional knowledge of the land and its functions.

Orr (2005) discusses the importance of being eco-literate, and contends that, "All education is environmental education…by what is included or excluded we teach the young that they are part of or apart from the natural world" (p. xi). Hence, such knowledge is specific to physical place and climate and also to history and cultural practices that work in each particular setting. The Hawaiian culture also incorporates the sustainable science concept through Indigenous ways of knowing and practices ('ike Hawai'i). This kind of valuing and knowing would be seen as *kuleana*, or right, obligation, or responsibility.

Consequently, culture-based education (CBE) goes beyond just being culturally relevant and responsive, but also sustaining and holistic in that it is inclusive of pluralistic perspectives of what it means to be sustainable—economically, culturally, and ecologically. Teacher education programs have had to go beyond implementing multicultural education courses in order to prepare future teachers (many of whom are not local or Indigenous to where they are assigned to teach) for culturally responsive teaching that also helps educators and students alike to develop a sense of place and place-consciousness (Au, Lefcourt, & Kawakami, 2008; Gay, 2002; Maaka, 1999; Nelson-Barber & Lipka, 2008).

Science Teacher Identity and 'Ike Hawai'i

Hawai'i, with its distant pre-colonial past, comprised a rich oral tradition grounding the Indigenous knowledge system that functioned to be practical, utilitarian, aesthetically pleasing, and spiritual. In her writings on Hawaiian epistemology Manulani Aluli Meyer (2004) describes the characteristics of 'ike Hawai'i as knowing something as it encompasses history, intention, and function. Meyer writes:

> The belief that meaning was tied to learning was not something hidden or subtle for Hawaiians. It is the core of why we do things—it must have a function for information to become knowledge and knowledge to become understanding. (As cited in Meyer, 2004, p. 56)

In the 1998 book, *Conservation Biology in Hawai'i* , Charles Kekuewa Pe'ape'a Makawalu Burrows (Doc Burrows, as he is commonly known today) shares how 'ike Hawai'i, an Indigenous knowledge system, was an integral part of the prehistoric Hawaiian conservation values and concepts in the Hawaiian culture.

Burrows (1998) defines 'ike Hawai'i as embodying cultural values, skills, and knowledge:

> Ancestral Hawaiians were keen observers of the natural world and were able to use their intimate knowledge of nature to sail on long-distance voyages and manage the natural resources of the sea and land for farming, and other uses. (p. 205)

Colonization and the arrival of missionaries with their negative stereotypes of Hawaiians influenced the educational system in Hawai'i after the overthrow of the monarchy in the late 1800s. Meyer (2004) discusses the disparities with an educational system of progressive reform taking place in North America and how classism and racism played out in Hawai'i, where Hawaiian language and culture were banned from the public school system during the standard English school movement. What remains today of the public educational system is still strongly influenced by a Western philosophy dominated by measurements and testing.

As an environmentalist and eco-justice educator, Burrows (1998) implores the integration of 'ike Hawai'i with Western science to address conservation and management issues in our State today. The associated Hawaiian conservation values and concepts of the past are just as valid in our present day, in order to reduce environmental pollution, conserve our natural resources, and sustain endangered plant species here and elsewhere, notes Burrows. Doc Burrows states:

> We must use the Hawaiian conservation values such as *'Ike*, *Lōkahi*, *'Āina*, *Mālama*, *Mana*, and *Kapu* to guide us in our decision-making when questions arise in economics, recreation, and land development that have a bearing on critical biological habitats. It is essential for modern man to accept the ecologist's and the primal Hawaiian's views of nature and life: that man is neither apart from nor a conqueror of nature but is one with nature and the divine force or mana that permeates the universe. (Burrows, 1998, p. 212)

Likewise, Meyer (2004) discusses the importance of a Hawaiian knowledge system, or 'ike Hawai'i, that is at the center of educating our youth today, including in science. She states that "knowledge that holds function at its center moves our students into action and better understanding of the roles of history and intention" (p. 57) and writes:

> Science makes sense when mo'olelo synergizes with water salinity and coral growth patterns in the places you wish to heal. Botany, astronomy, geology all makes sense when there is purpose, meaning, and function to the knowledge that is gained. (Meyer, 2004, p. 57)

Ramsay Remigius Mahealani Taum, educator, businessman, and promoter of Hawaiian cultural stewardship, shares the importance of bringing the Hawaiian knowledge system ('ike Hawai'i) to our Western-focused classrooms today. He shares that the Native Hawaiians had many schools of knowledge, and that modern scientists are only now becoming aware of this. In his recollection during a talk story session with Aunty Pilahi Paki, a well-known teacher and advocate of Hawaiian language, Taum reiterates the need to include Native ways of knowing in the mainstream teaching of sustainability principles as applied to agriculture:

> As I read about the advances in renewable energy technologies and accessing wave energy as a preferred source of energy in the future, I recalled a particular day when I asked her [Aunty Pilahi Paki] about na pōhaku (the stones) that were around her hale (home). "These are my pōhaku lolo...my brain rocks," she said. "They are like my encyclopedia. Each stone contains the 'ike (knowledge) of our kūpuna (elders). Whenever I need information regardless of whether it is about agriculture, aquaculture, or astronomy, all I have to do is pick up and hold one of these pōhaku in my lap." (Taum, in Chirico & Farley, 2015, p. vii)

Within Native ways of knowing, authors Mack, Augare, Cloud-Jones, Davíd, Gaddie, Honey, Kawagley, Plume-Weatherwax, Lone Fight, Meier, Pete, Rattling Leaf, Returns From Scout, Sachatello-Sawyer, Shibata, Valdez, and Wippert (2012) outline effective practices for using Native ways of knowing to strengthen informal science education programs. Since cultures around the world have different ways of looking at, experiencing, and relating to their environment, their knowledge systems (ways of knowing) will differ (Berkes, 1999). The authors (Mack et al., 2012) contend that entire knowledge systems that develop out of different cultures can have fundamental differences (i.e. linear versus cyclical views of the nature of time) and therefore have a strong effect on teacher practice (p. 52). From interviewing experts involved in informal Indigenous science education programs across the U.S., including Hawai'i and Alaska, the researchers arrived at three effective practices for successful informal science education programs grounded in Native ways of knowing.

Effective practices grounded in Native ways of knowing were confirmed as:

- creating hands-on, inquiry-based lessons reflective of the culture and people in their aboriginal homeland;

- utilizing the community as an integral resource for curriculum development and instruction; and

- using the local Native language to both facilitate instruction and in understanding the local Native worldview. (Mack et al., 2012, pp. 60-61)

These practices were shown to promote sustainability of culture and language through informal science education while also supporting the assets approach to bringing in the local, Native worldview (Mack et al., 2012).

In Hawai'i, Native ways of knowing is embodied in 'ike Hawai'i and the Hawaiian language, inextricably connecting culture with traditional ecological knowledge (TEK) and Western science. Science education today has become politicized and culturally responsive and science teachers are becoming increasingly challenged with understanding what is appropriate content and how their students can be engaged with learning that is intentional, applicable, and relevant to their lives. Thus, if the knowledge system of Hawaiians is still essential to learning and growth of students through environmental education programs in the global marketplace, then it is necessary to rethink what it means to be successful in science while sustaining the Hawaiian culture, its language, and traditional ecological knowledge.

Culture-Based Education in Hawai'i

In Hawai'i, Indigenous and non-Indigenous educational researchers and scholars have utilized this ideology of culturally responsive education to study examples of place- and community-based learning at the K-12 and college settings. Numerous culture-based education studies in Hawai'i have been completed by researchers and Indigenous scholars (Aikenhead, Calabrese Barton, & Chinn, 2006; Au, Lefcourt, & Kawakami, 2008; Chinn, 2006; Maaka, 1999; Meyer, 2004; Serna, 2006) and PhD candidates (Feinstein, 2002; Kanahele-Mossman, 2011; Hoof-Kuwahara, 2010). Research focused on student learning of science in the Hawaiian cultural context utilizing Indigenous knowledge revealed that a culturally responsive and sustaining curriculum can positively impact the learning of students from all cultural and ethnic backgrounds, and at all levels of schooling.

In Waiʻanae, on the island of Oʻahu, the Hawaiian Studies Program (HSP) at Waiʻanae High School adopted four core elements:

- contextualization of instruction with students' home and school backgrounds;
- joint projects and activities among teachers, students, and community members; and
- "de-tracking" of students; and
- team teaching and looping process for the HSP. (Yamauchi & Purcell, 2009)

Since its inception in 1995 by teachers and community members, the HSP at Waiʻanae High School has worked to decrease the high dropout rate and low achievement of youth in the area, many of whom were of Native Hawaiian ancestry. The development of community achievement and building of a community of collaborative and agentive practitioners (Wenger, 1998) was shown to be critical to this culturally responsive program. Retention, engagement and motivation, civic responsibility, and a sense of belonging among students, teachers, and community members in Waiʻanae have been achieved over the years (Yamauchi & Purcell, 2009).

Again, from a Hawaiian culture-based perspective, a case study by Kelling and Schonleber (2011) documented the bridging of two knowledge systems, one based on the practices, beliefs, and pedagogical practices of the Hawaiian culture and the other based on Euro-centered (Western) scientific perspectives and pedagogy. Through the use of the *Kumulipo*, a Hawaiian creation chant, an integrated unit plan was implemented with K-6 teacher and students at a Hawaiian language immersion school, or a *Kula Kaiapuni*. The authors based their premise on research suggesting that early exposure to a culturally responsive science curriculum is important (Aikenhead, 2001; Kanaʻiaupuni & Kawaiʻaeʻa, 2008). In this study, the impacts on teacher practices and how they viewed themselves as science teachers resulted in four key findings that has implications for depth of pedagogical and content knowledge in both Indigenous and Western science systems.

Four themes emerged from teachers' descriptions about what they had learned from this project:

- an increase in their perceived ability to bridge two worlds,

- an increased sense of success in their ability to teach science,

- a perceived increase in their willingness and ability to follow the interests of their students, and

- an awareness that this curriculum allowed families to connect more deeply with their own ancestors. (Kelling & Schonleber, 2011, p. 244)

In a 2010 study entitled "Hawaiian Cultural Influences in Education (HCIE)," Kanaʻiaupuni, Ledward, and Jensen found a set of relationships linking the use of culture-based educational strategies by teachers and by schools to student educational outcomes. The positive impacts of culture-based education (CBE) on high school students' socio-emotional well-being, and math and reading test scores for all students and especially those with low socio-emotional development were noted across private, public, and public charter schools. CBE programs in these high schools included engagement with *wahi pana* (sacred places) and other outdoor learning experiences where science experiments involved assessing the successes of methods to revive endangered endemic species or water resources. Utilizing a survey to measure three standards of effective pedagogy identified by the Center for Research on Education, Diversity, and Excellence (CREDE) in different school settings, teachers in charter schools reported the greatest use of both CBE strategies and CREDE standards, relative to those in the DOE and Kamehameha Schools.

With respect to culturally relevant strategies reported by teachers as being most helpful to their practices in this large scale empirical study (Kanaʻiaupuni et al., 2010), the resulting themes reiterate the importance of preparing science teachers in Hawaiʻi with training and professional development in pedagogical and content knowledge that bridges ʻike Hawaiʻi, a Hawaiian knowledge system, with Western science. With such education and training, science teachers in Hawaiʻi can better understand how their personal epistemologies and those of Western scientists, which influence eco-identity development, can be bridged with ʻike Hawaiʻi. Findings in the 2010 report from Kanaʻiaupuni et al. with respect to teacher best practices in CBE have implications for science teacher education programs supporting eco-identity awareness.

Kanaʻiaupuni et al. (2010) note that while Hawaiian culture- and language-based schools are quick to adopt CBE, it is not limited to Hawaiian teachers and that across all school types (public, private, charter), teachers who regularly use these strategies consider these culturally relevant and sustaining approaches to be best practices. They recommend that:

> Rather than CBE being divergent from best practices, the data suggest a "double win" for children in culture-based environments. Specifically, the data suggest that in culture-rich environments, teachers go above and beyond conventional best practice to achieve relevance and rigor, delivering highly relevant education via culture-based strategies *in addition to* the research-based body of teaching strategies known as best practices. In effect, principles such as contextualization and joint productive activity are most often achieved by teachers using culturally relevant strategies. (p. 11)

In further support of culture-based education for all students in Hawaiʻi, the Kamehameha Schools World-Class Hawaiian Culture-Based Education (WCHCBE) guiding statement purports that:

> World-class Hawaiian culture-based education leverages cultural strengths to the benefit of *haumāna* [students] in order to effectively prepare them to make meaningful and practical community and socio-political contributions locally and globally. (Alcantara, Keahiolalo & Pierce, 2016, p.10)

Nā Hopena Aʻo and Culturally Relevant and Sustaining Pedagogies. In addition to the initiatives and programs of the Kamehameha Schools serving Native Hawaiian and non-Hawaiian students and promoting WCHCBE for all students across the State today, the Hawaiʻi Department of Education (HIDOE) introduced Nā Hopena Aʻo (HĀ) in 2015. The Hawaiʻi Board of Education, with a team of educators and researchers, Hawaiian cultural and language practitioners, and the Office of Hawaiian Education arrived at a mission to address six fundamental outcomes for the entire public school system: **B**elonging, **R**esponsibility, **E**xcellence, **A**loha, **T**otal well-being, and **H**awaiʻi (**BREATH**). The HĀ framework strives to "develop in its employees and students the skills, behaviors, and dispositions that are reminiscent of Hawaiʻi's unique context and to honor the qualities and values of the Indigenous language and culture of Hawaiʻi" (Qinaʻau, 2016).

Competencies that strengthen a sense of belonging, responsibility, excellence, aloha, total well-being, and Hawaiʻi (the HĀ, or "Breath") in ourselves, students, and others, describe Nā Hopena Aʻo (Qinaʻau, 2016). HĀ, with its foundation in Hawaiian values, language, culture, and history, supports an inclusive learning environment where students and their teachers can feel acknowledged, with respect to their unique identities in the sociocultural contexts of Hawaiʻi. In year one of Nā Hopena Aʻo (June 2017) a pilot launch focused on building the foundations to create a strong base from within the HIDOE that creates an environment that strengthens the HĀ framework. As a result of year one implementation is the understanding of the context and visualization of a future HĀ state allowing for flexibility and the responsibility to allow for "multiple stories and multiple definitions of success within HIDOE" (Qinaʻau & Worchel, 2017, p. 3). Opposed to a top-down approach in policy making and redefining the culture of the HIDOE, HĀ emphasized a collaborative implementation which promoted systemic shifts in the following areas:

- the power of the collective and allowing for multiple perspectives to contribute to multiple definitions of success within the current contexts of the updated HIDOE Strategic Plan and the ESSA plan;

- through the empowerment model, individuals shared what is known and felt about HĀ from their moʻolelo (story), and unique perspectives to inform the iterative process and greater narrative;

- HĀ supports the movement back to a gifts-based education system of an assets model where each person shares this gift and contributes to the collective good;

- shifting the system so that all gifts are celebrated and that community ready is just as, if not more, important as college and career ready; and

- a focus on the learning environment is a focus on the learning conditions that are optimal for leading up to strengthened outcomes of BREATH (HĀ). (Qinaʻau & Worchel, 2017, pp. 3-4)

In conjunction with a revised HIDOE strategic plan, the WCHCBE programs of Kamehameha Schools, and the national ESSA, the HĀ implementation serves as another means for science teachers in Hawaiʻi to feel supported with bridging Hawaiian culture-based education that includes ʻike Hawaiʻi, with Western science.

With local and global environmental changes taking place, science teachers are confronted with the potential to address not only environmental crises of the time but also sociocultural, political, and economic issues. Culture-based education that is responsive supports ecological and cultural sustainability and can therefore impact how science teachers view their roles and how they enact curricula. Science teacher identity development therefore becomes an intricate part of the process of reform in science education.

Place-Based Education and Critical Pedagogies of Place

Place-based education has its roots in experiential education that was advocated by progressive educator John Dewey whereby relevancy, student-centered approaches to teaching and learning, and learning in local environments were understood and practiced for over 100 years. This concept of place-based education encompasses Dewey's ideals of allowing students to learn in their local environments, to become connected with their surroundings— both the natural environment and the people who have lived in a sustainable manner for many years—and to eventually achieve local, ecological and cultural, sustainability (Woodhouse & Knapp, 2000). Underlying place- and community-based education are the tenets of experiential, constructivist (building of knowledge through experience), sustainable science, and outdoor education.

Davidson-Hunt and Berkes (2003) define social and ecological resilience as having a deep connection with the land, and the ability to deal with change in the environment through adaptive, dynamic learning. Indigenous peoples such as the Native Hawaiians and Anishinaabe people in Canada studied by Davidson-Hunt and Berkes (2003), have been practitioners of sustainable science for hundreds of years; the terms place-based education and sustainability science are modern, Westernized terms used to identify such practices by Native peoples. As already noted, the term sustainability is rooted in multiple conceptual understandings, and Martusewicz, Edmundson, and Lupinacci (2011) note that while the word "sustainable" can mean many different things, a commonly used pedagogical approach to the current Earth environmental crisis, called "education for sustainability," can actually challenge the existing educational paradigm of the 21st century. By using the conceptual understandings of sustainability to mean a "transformation to put environmental concerns at the center of a critical, participatory education," (p. 13) this kind of educational approach can then become a powerful tool for addressing ecological and social crises and worldwide insecurities today.

Critical Pedagogy of Place. Place-based and community-based education in science that encompasses stewardship contextualized culturally, historically/temporally, politically, and economically, can become what Gruenewald (2003a) calls a *critical pedagogy of place*. Place-based education that involves both understanding of multicultural and Indigenous knowledge systems and support for critical analyses of current social, political, economic, and environmental issues in a region combined, can challenge students and educators alike to reflect upon the relationships humans have with nature (Gruenewald, 2003a). Moreover, a critical pedagogy of place program engenders multiple layers of understanding of the interdependent relationships among community and ecology while also addressing causes of poverty, the creation of wealth at the community level, and threats to sustainability of both Indigenous cultures and natural resources (Bowers, 2001).

Hence, a critical pedagogy of place (Gruenewald, 2003a) can address two key objectives of decolonization and "re-inhabitation"/"re-indigenization" (Barnhardt & Kawagley, 2005; Maaka, 1999; Meyer, 2004; Nelson, 2008; Smith, 2002) in Native communities and all other educational settings. Many Indigenous scholars will argue that in order for such programs supportive of evidence-based science practices can be most effective only when taught through Indigenous languages (Maaka, 1999; Macedo,1994, 2000; McKinley, 2005; Smith, 2002). Educational researchers have concluded that in diverse, multicultural classrooms today, there can be place- and community-based programs taught with critical pedagogic principles and rigorous scientific precepts in mind, that are also equitable and responsive to the needs of all students (Nelson-Barber & Lipka, 2008; Pewewardy & Hammer, 2003; Yamauchi, 1998).

Sense of place. Tied to a critical pedagogy of place and culture-based education is the notion of *sense of place*. During this twentieth century, the human community with all of its technologies, scientific discoveries and advances, and globalization of economies, has lost its universal connection to specific places and time (local bioregions) (Harwell & Reynolds, 2006). Sense of place invokes human intellect, emotions, and creativity to create a deep inner intimacy and physical connection to the natural world. Spiritual leader Wendell Berry (in Harwell & Reynolds, 2006) observed this growing disconnect between our human culture and the natural world in which we are a part of, by stating: "You can't know who you are until you know where you are" (p. 7).

Semken and Freeman (2008) note the difficulty with defining the term sense of place, as it is highly contextualized, it incorporates a combined set of place meanings and place attachments specific to a person or a group of people, and that it is situated in changing and evolving landscapes and boundaries. They purport a highly adaptive and socially negotiated nature for the meaning of sense of place, whereby the cognitive domain (i.e. ways of knowing) including the ways in which people know and experience a physical space, combines with an affective bond developed by individuals and groups through emotional attachments to place. Hence, a combined set of place meanings and place attachments held by a person or a group constitutes a working definition of a sense of place (Semken & Freeman, 2008).

Notions of place and place-conscious education (Gruenewald, 2003b) have been brought forward in the 1990s. In the Hawaiian context natural and cultural resources are valued in ways that have developed for over hundreds of generations into an evolving attachment that can be called a sense of place (Maly, 2001). Calabrese Barton and Berchini (2013) purport that "place, in the urban classroom, accounts not only for the physical spaces of the community but also for the historical and sociocultural dimensions that play out as people interact with and in place" (p. 21). Cultural historian Kepā Maly (2001) notes the interconnectedness between nature and culture and how these attachments to the natural, physical, and spiritual realms help to shape beliefs, practices, and identity of a people. With today's expansion of cities the ecological place meanings and place connections associated with science teacher identity are also nurtured through direct experiences with the urban environment and the sociocultural interactions within their teaching communities of practice (Russ & Peters, 2015).

Land Education

In more recent empirical and conceptual studies focusing on the considerations and practices of *land education*, the criticality of place in relation to historical and current contexts of colonization in education and the role of Indigenous cosmologies have prompted the building upon place-based education and critical pedagogies of place (Tuck, McKenzie, & McCoy, 2014). Across the U.S., and in Canada, Australia, and Africa, possibilities of land education relating to particular disciplinary domains, in both formal and informal K-16 education, exist. Tuck et al. (2014) note the "challenging but necessary task" of "bridging fields and considerations of settler colonial studies, Indigenous studies, and environmental education" (p. 2) through land education.

Calderon (2014) describes land education as the intersections of environmentalism and Indigenous rights being articulated by Indigenous communities, scholars, activists, and allies, along with recent global social movements demanding a broader discussion on how to better account for the history, present, and future. This is accomplished by attending to embedded issues of colonialism and Indigenous rights and sovereignty. Thus, land education builds upon recent place-based work (Gruenewald, 2003b) with the emphasis on "decolonization" and "reinhabitation" to take up what "place-based education fails to consider" (Calderon, 2014, p. 33). The current socio-scientific realities of today (i.e. climate change and biodiversity loss) that are shaping the land and the lives on the land necessitates a transformation of Western science education through "desettling dynamics of settler colonialism" (Bang, Curley, Kessel, Marin, Suzukovich III, & Strack, 2014, p. 39).

Bang et al. (2014) developed theoretical precepts and practical tools to collaborate with Native youth, families, and community members in relation to urban science and environmental learning environments in order to (re)story Chicago as Indigenous lands (p.39). The researchers worked at the grassroots level with teachers and community members to develop an environmental science education program with land-based perspectives that "enabled epistemological and ontological centering that significantly impacted learning, agency, and resilience" (p. 37) for all stakeholders.

In a study by Engel-Di Mauro and Carroll (2014), they propose an African-centered approach to land education. They contend that critical pedagogy and place-based education is an attempt to rectify the social underpinnings of what constitutes the environment in an already institutionalized system of schooling. Mauro and Caroll argue for the need to have a land education program that critically addresses powers in a capitalist system today and the historical struggles between the colonizer and the colonized. They propose college level courses in Africana Studies and Geography rooted in land education as a means for facilitating people's reconnection to places and the environment/lands they inhabit. As a model for adult education, land education has implications for teacher education programs as well.

Land Education in Hawai'i. In Hawai'i the bridging of the Indigenous knowledge system of 'ike Hawai'i with the Western framework for science education, along with a sense of place in the Islands and the understanding and acknowledgement of multiple epistemologies are essential components of land education.

Through culture-based education that critically addresses multiple epistemologies and historical aspects of places, such programs have been shown to be successful with raising student self-esteem, self-confidence, cultural awareness, and resilience (Kanaʻiaupuni et al., 2010). Model programs in Hawaiʻi are indeed addressing the need to make these paradigm shifts with regard to understanding what is important to know and be able to do in science education today to address local issues of ecological and social injustices with careful attention to cultures and histories of specific places.

Indigenous scholar and educator, Manulani Aluli Meyer (2014) offers two vivid snapshots of what land education looks like in action in Hawaiʻi today, with the understanding that transformative learning that influences and reshapes eco-identity in teachers and students can take place with a land education model. The first view is of lava rock terraces of wetland taro (*loʻi kalo*) in a specific place of Limahuli Valley on the island of Kauaʻi. Meyer explains specific ahupuaʻa where Native Hawaiians cultivated taro, and how the place of Limahuli means, "'turning hands,' and infers a quality of work ethic needed to sustain this kind of intensive wetland cultivation" (2014, p. 98).

Meyer (2014) gives the second snapshot of MAʻO Farm of Waiʻanae Oʻahu whereby it was a community effort to secure tracts of unused land, to grow food crops to nourish the people, and sustain the Hawaiian culture. With both examples, Meyer describes the food sovereignty movement in Hawaiʻi that is not only about environmental and sustainability education but also about perpetuating Hawaiian values and knowledge through education and practice. This brings to light the need to consider how to better prepare science educators in teacher education programs for land education approach in the secondary school setting that addresses social, historical, and cultural connections to the natural world. This can be connected to sovereignty issues— ahupuaʻa studies, when approached critically, are Hawaiian land issues.

Island Biogeography

Land education in Hawaiʻi, as shared by Meyer (2014) has been shown to address not only environmental issues associated with living on an island ecosystem, but also takes a critical look at sovereignty issues and perpetuating Hawaiian values and its knowledge system. Concepts of *island biogeography* are connected to land education in Hawaiʻi. While not a new theory, island biogeography is not widely known by lay persons.

This theory purports that flora and fauna on islands are unique species that are geographically distributed due to adaptations over time and that the repopulation of new species can occur due to competition for limited resources on the island (MacArthur & Wilson, 1967). Ecologists today utilize this theory of island biogeography to study "island" effects with the understanding that increasing the biodiversity of a habitat is a function of area, or as a balance between rates of colonization of species and local extinction (MacArthur & Wilson, 1967).

In New Zealand marine reserves based upon island biogeography concepts related to enclosed marine systems were first established in 1977 and have been successful ever since (Ballantine, 2014). When marine reserves were established their ecology began to change, due to cessation of fishing and other previous manipulations by humans. With an understanding of the negative impacts of fishing and other human activities on isolated areas in New Zealand, these marine reserves became models for conservation and sustainability of resources worldwide. In sharp contrast to what is known as marine protected areas (MPAs), New Zealand and a few other countries including the U.S. and Australia have developed this concept of marine reserves where no disturbance is allowed (Ballantine, 2014). One allowance that is encouraged is for "people to view, appreciate, study, and publicize the results of this protection" (p. 299). Thus, with the understanding of island biogeography comes the understanding of how as human numbers increase, so will the intensity of exploitation which can lead to extinction of marine life.

In 2017 it was noted by Patiño and colleagues that it was the 50th anniversary of the publication of the seminal book *The Theory of Island Biogeography* (1967), by Robert H. MacArthur and Edward O. Wilson. What Patiño et al. (2017) arrived at was a roadmap for the continued study of island biogeographical effects in order to address current issues of global environmental change, conservation and management policies, invasive and alien species, and biodiversity loss. What island biogeography and the understanding of the past, present, and future island ecosystems continues to do today is become that springboard for research of biological communities, with particular reference to marine island systems, but also extending out to island-like systems (Patiño et al., 2017, p. 965).

This theory of island biogeography suggests a unique way of thinking related to living on an island ecosystem: global environmental changes can impact sustainability in Hawai'i on a larger scale due to biogeographical isolation.

Chirico and Farley (2015) note how ancient Hawaiians practiced what we now call "sustainability," and suggest that "thinking like an island" embodies the knowledge system of ʻike Hawaiʻi. Handy, Handy, and Pukui (1991) note that for ancient Hawaiians two aspects of life are fundamental: to breed and perpetuate oneself through interpersonal relationships, and to survive through feeding, adaptations to the environment, and building connections with the land. Moreover, Hawaiians were more closely tied to the land and the cultivation of the soil (through practices of systemic agriculture) than other oceanic peoples in Polynesia (Handy et al.). The term *honua* is a more general term for the Earth, and ʻ*āina* is a more specific term meaning land, which also conveys a sense of arable land, and "that which feeds" or "the feeder" (Handy et al., 1991, p. 45). Chirico and Farley (2015) purport that we must develop the mindset of thinking like an island in Hawaiʻi in response to local and global environmental changes to navigate a sustainable future in Hawaiʻi. As discussed by editors of their timely conception, we need to view sustainability in places like Hawaiʻi from a systems perspective where everything is interconnected and everything is interdependent.

Addressing Local Environmental Issues with Cross-Cultural Communications. Living in Hawaiʻi and being geographically isolated in the Pacific Ocean, issues of conservation, climate change, and sustainability in our Islands can promote an eco-centric worldview of thinking like an island. For people living in Pacific countries and island systems like Hawaiʻi climate change and issues of sustainability are of serious concern. Science teachers can see the urgency with providing their students with the right tools and understandings for addressing the host of challenges of sustaining one's livelihood over the long term. Pre- and in-service teacher attitudes toward nature and the environment, and interactions with mandated curricula have been shown to be varied and at differing states along a continuum in terms of their worldviews—both anthropocentric and eco-centric (Quinn et al., 2015).

McNamara (2013) argues that it is critical for communities, in this case communities of science teachers in Hawaiʻi, to make local sense of issues like climate change in an ever-changing world where knowledge is continuously expanding and changing. In the Hawaiʻi, fishing practices provide for a rich cultural context, involving the ahupuaʻa with which it is associated.

Environmental managers like the state's Department of Land and Natural Resources and Division of Aquatic Resources, there is often the focus on sustainable practices that ensures access to all peoples to meet the needs while considering the economy, fisheries stocks (quotas), and resource replenishment. Hence, with environmental management issues in Hawai'i and the need to understand ancient and current Hawaiian cultural and sustainability practices begets a need for genuine understanding of 'ike Hawai'i and TEK (traditional ecological knowledge). In turn, science teachers play a critical role with how they see themselves as part of the solution and how they will provide for such learning experiences for students that promote a thinking like an island mindset.

Sustainability Science Supporting Concepts of Island Biogeography. In the fifth/sixth grade classroom in Ontario, Canada, Caswell and Bielaczyc (2001) explored the use of a computer program designed to support knowledge building communication and to foster critical thinking skills in science. The paper examined the knowledge transforming discourse that took place as children worked to understand the evolution of the Komodo Dragon during an investigation of island ecosystems and island biogeography. A shift in pedagogy by the teacher with the use of a communal database was shown to impact how students view scientific knowledge and what it means to learn science and build theories in science through inquiry and discourse (p. 285). With a complex theory of island biogeography guiding the unit, the fifth/sixth grade teacher was able to create an environment of inquiry and discourse that engaged students with wondering about the flora and fauna of islands and how species came to islands. Over the course of the Komodo Dragon discussions and debates, along with the computer-aided access to scientific information, both teacher and students were able to shift in their views of who does science and who can make contributions to this body of knowledge.

This study by Caswell and Bielaczyc (2001) was one example of how a science teacher in the elementary classroom setting utilized this understanding of island biogeography to show how shifts in thinking about how science is taught, experienced, and learned can take place when structures in a classroom practice are altered. What is lacking in the literature today in K-12 environmental education is the teaching and experiencing of this theory of island biogeography and how this can be successfully implemented in secondary environmental education programs.

In my view, on an island ecosystem such as Hawai'i, principles of sustainability, conservation, island biogeography, and global environmental change are topics that when introduced in science teacher education program and in the K-12 classrooms, will positively impact the development of a thinking like an island mindset.

Existing sustainability science education programs in Hawai'i have encompassed the understanding of fundamental interactions between nature and humans within systems: systems of bioregional places connecting the mountains to the sea in an *ahupua'a* system (Kaneshiro, Chinn, Duin, Hood, Maly, & Wilcox, 2005). Moreover, sustainability science curricula that are situated to specific regions (bioregions), have been shown to promote better attitudes of students from diverse backgrounds toward the subject of science, and can help in the process of individuals gaining a sense of belonging and attachment to their immediate environment (Woodhouse & Knapp, 2000; Yamauchi & Purcell, 2009).

Kaneshiro et al. (2005) noted this importance of place and the interactions humans have with nature as a basis for sustainability science programs. The traditional *ahupua'a system* encompassing cultural and ecological stewardship within a bioregion (mountain-to-sea connection) may not be as well-practiced or understood in today's global economy, but what is being attempted in schools statewide are programs fostering these principles of sustainability science, with particular attention to place. An ahupua'a system of land division in Hawai'i usually extends from the uplands down to the sea (Pukui & Elbert, 1986). In Hawai'i, more so than in any other state in the U.S., about 86 percent of the place names are in the Hawaiian language (Pukui, Elbert, & Mookini, 1974), thus reiterating the need for place-based sustainability science programs that value specific bioregions.

Cultural practitioners, policy makers, health practitioners, the general public, and science educators and researchers have come together over the past two decades to focus on such place-based sustainability science programs in public schools, all with critical, eco-justice pedagogy and environmental stewardship (based upon the TEK of Native Hawaiians) frameworks in mind. Kaneshiro et al. (2005) note two, U.S. DOE funded educational programs started in 2000, in support of place-based sustainability science: the *Mālama I ka 'Āina* and the *Pīkoi Ke Kaula Kualena* programs.

These model programs were developed to provide professional development for K-12 teachers on sustainability science, enabling them to write curricular materials integrating Hawaiian TEK and cultural narratives rooted in place, while addressing the Hawai'i [State] and Content Performance Standards (HCPS). In these two seminal programs, teachers' lessons recognized the relationships that humans have with nature in the context of the ahupua'a ecosystems approach to interacting with the environment.

In the study by Sylva, Chinn and Kinoshita (2010), a Hawaiian culture-based agricultural and environmental science professional development course was taught over three years and transformed each time, to hone in on content driven toward improving pedagogy. A key objective of this course was to make the agriculture and/or environmental curriculum more relevant to the students, their community, and their geographical locales. At the teacher education level, this study revealed the need to consider how to best prepare science teachers in Hawai'i, by integrating 'ike Hawai'i into their existing curricula and practicing in ways that have real-life meanings for students and the greater community. These kinds of experiences, as with a transformed science-culture-curriculum framework for teacher professional development (Sylva et al., 2010), not only embody Hawaiian practices of learning and doing, but are also similar to Lave and Wegner's concept of situated learning in a community of practice (Wenger, 1998). Science teacher community of practice and identity development and shaping are situated in a Hawaiian cultural context and an island ecosystem.

The mindset of thinking like an island is a pro-environmental attitude that in turn can influence individuals to "act like an island" (Chirico & Farley, 2015). Sustainability science programs in Hawai'i can therefore support this kind of thinking and pro-environmental behaviors that are transformative for teachers and students. These types of programs include experiences in nature, be it exploratory and/or service-oriented. Adopting a thinking like an island mindset requires more than deeper understandings of ecological principles and traditional practices of the host culture with respect to living on an island ecosystem. Sustainability science programs with a thinking like an island mindset will support the development of non-anthropocentric perspectives, as shown by an ahupua'a ecosystems approach (Kaneshiro et al., 2005; Sylva et al., 2010).

Professional development experiences can help teachers and students develop the ecological literacy necessary to understand the diversity and interrelatedness of nature, the extent of human dependence on non-human nature, and ultimately the folly of human-centeredness (Quinn et al., 2015).

Part III: Narrative Inquiry and Understanding Science Teacher Identities

The final section of the literature review presents research in support of narrative inquiry research as a tool for understanding science teacher identities. Conceptualizing teacher identity through the narrative process has been extensively researched over the last two decades (Ackerman & Meijer, 2011; Alsup, 2006; Clandinin & Connelly, 1995, 2000; Jessop & Penny, 1999; P. Palmer, 1998). More recent studies have focused on science teacher identities within varying contexts of gender, culture, ethnicity, socioeconomics, and geographies (Brandt, 2008; Calabrese Barton, & Berchini, 2013; Calderon, 2014; Lloyd & Boyd, 2014; Meijers et al., 2016; Russ & Peters, 2015; Trumper, 2010; Tytler, Symington, Darby, Malcom, & Kirkwood, 2011). McAdams and Olson (2010) define *narrative identity* as a self-making process that is an internal dialog that is an evolving life story where one continuously adapts and changes in practices of positioning. For Chase (2005), narrative identity is "an amalgam of interdisciplinary analytic lenses, diverse disciplinary approaches, and both traditional and innovative methods—all revolving around interest in biographical particulars as narrated by the one who lives them" (p. 651).

Foundations of Narrative Inquiry Research

Narrative inquiry research has its roots in sociological research. Life story (autobiographical) and life history (biographical) in both oral and written forms, and the narrative descriptions collectively, in a narrative configuration, can reveal human activities as purposeful engagement in the world (Chase, 2005; Hatch & Wisniewski, 1995). Narrative research in the study of teacher stories, advanced by Clandinin and Connelly (1992, 1995), moves through several analytic lenses.

When approaching the information/data found in the narrative, the investigator considers:

- a distinct form of discourse with retrospective meaning making in mind,

- verbal action as doing or accomplishing something,

- stories viewed as both enabled and constrained by a range of social resources and circumstances,

- socially situated interactive performances, and

- researchers themselves as narrators. (Chase, 2005)

The investigator approaches the information/data to include: a distinct form of discourse with retrospective meaning making in mind, verbal action (as doing or accomplishing something), stories viewed as both enabled and constrained by a range of social resources and circumstances, socially situated interactive performances, and researchers themselves as narrators (Chase, 2005). In order to capture these stories, these lived experiences, the narrative inquiry process most accurately and authentically captures a person's voice (Connelly & Clandinin, 1990, 1999). The meaning making processes are elucidated through the experiences involving interactions with others and with nature, which in turn influence identity development.

Naturalistic Processes in a Post-Positivistic Era

In qualitative case study and ethnographic research, narrative inquiry is often a primary method for collection of primary sources of data that are "teacher stories" and "stories of teachers" (Clandinin & Connelly, 1995). The nature of such data is frequently subject to its concerns about trustworthiness. The *naturalistic process* studying teacher identity formation and development assumes the added notion of how values (of both the researcher and those being studied) can feed into this inquiry process (Guba & Lincoln, 2005; Lincoln & Guba, 1985). In their book *Naturalistic Inquiry*, Lincoln and Guba (1985) speak of a paradigm shift in behavioral research in a post-positivist era. Positivistic ideologies (developed in the early 1800s and based upon scientific principles) are mechanistic, reductionist, and based upon assumptions of naïve realism and a universal scientific language.

Conversely, the naturalistic paradigm assumes several, key contrasting axioms:

- realities are multiple, constructed, and holistic (ontological);
- the knower and the known are interactive and inseparable (epistemological);
- generalizations are temporal and contextual only;
- it is impossible to distinguish causal linkages (cause-and-effect); and
- inquiry is value-bound. (Lincoln & Guba, 1985)

Guba and Lincoln (2005) note that with these alternative existing paradigms in qualitative research, there are overlaps in assumptions, but more importantly there are contradictions, controversies, and confluences among these genres of behavioral research today. In Western forms of social science research, the ideas, beliefs, and theories about the social world and the development of the human "self" are assumed to be based upon social relationships and membership in cultural groups, suggesting that development and learning and shaping of identities is causal and can be predicted (Smith, 1999). When Linda Tuhiwai Smith (1999) writes about recovering the stories of the past for Indigenous peoples, this process is inextricably bound to a recovery of language and epistemological foundations.

Narrative Inquiry as a Method of Data Analysis

Narrative inquiry is not only a way to collect data on storied experiences (social phenomena) of teachers, it is also a method of data analysis referred to as *storying* (Clandinin & Connelly, 2000). In the comprehensive process of *restorying*, Liu and Xu (2011) worked through mini-stories from narratives and deconstructed, constructed, and reconstructed social meanings in ways that created an educational landscape of reflection and shared experiences (with the researcher and person being researched). With the restorying process of narrative inquiry, telling and retelling of these lived experiences affords researcher and participants the space to co-construct meaning. Storytelling can also be a *reiterative narrative* process whereby the narratives follow a cyclical pattern and while seemingly repetitive, the key values and beliefs associated with these events can reveal common themes (Ewing, 2016).

Watkins-Goffman (2006) notes how the first-person singular narrative approach can provide a "rich template through which to observe human interaction and behavior" (p. 4). A narrative written in third person can also give an authentic picture of evolving identity and shifting perspectives in a multicultural world. Individuals are creating narratives as we live our daily lives.

Choices made in the present will inevitably affect the future, and individuals can also revise their stories retrospectively, by re-ordering or selectively forgetting past experiences (Watkins-Goffman, 2006). Hence, the reiterative narrative process with restorying can provide for layered, and complex stories, or what Jessop and Penny (1999) refer to as a "story behind a story." What distinguishes narrative inquiry from thematic analysis that involves open and axial coding (Huberman & Miles, 2002) is the restorying process. The goal of narrative research in case study and ethnographic forms of research is to analyze and document these stories in a systematic way and "not to produce generalizable data, but a rich and nuanced understanding" (Liu & Xu, 2011) of teacher identity formation.

Narrative Inquiry as a Tool for Critical Identity Studies

   Complexity and Heterogeneity of Teacher Voices. Studies by Sfard and Prusak (2005) and Aydeniz and Hodge (2011) equated identity with "the stories that individuals tell, in this case, about their teaching and the expectations that they must meet in order to be successful as professionals" (Ayendiz & Hodge, 2011, p. 168). The value of the narrative inquiry approach is to discover the relationships between individuals' stories and their movement through different situations. Aydeniz and Hodge (2011) used identity formation as a lens through which to advance their understanding of a college professor's agency, and his subsequent participation in science teaching. With the process of narrative inquiry, they were able to discern emergent and sometimes competing identities of being a scientist and also being a university professor, which in turn influenced his practices. They explored dual identities assumed by a college science professor from a naturalistic inquiry perspective (Lincoln & Guba, 1985) with the goal of "reaching an informed construction negotiated by respondents who are involved in the inquiry process" (Ayendiz & Hodge, 2011, p. 168).

   In examining the complexity of identity formation within contexts of place, space, and time, Liu and Xu (2011) reveal through narrative inquiry how teachers need to reconstruct their identity to cope with new challenges in the workplace. The overarching aim of their inquiry was to "understand, interpret and critically interrogate, in the sense that the context of educational reforms is diversified, complex and fluid, and resulting in both opportunities and constraints for learning" (p. 590). Clandinin and Connelly (2000) argue that central to narrative inquiry is the focus on understanding teachers' lived experiences and the practical knowledge gained in the process, which is expressed through teacher identity.

In short, Connelly and Clandinin's work "implicitly links narrative inquiry with teachers' identity through the concept of 'stories to live by'" (1999, p.4).

Through narrative inquiry, many studies (i.e. Brandt, 2008; Calabrese Barton, & Berchini, 2013; Calderon, 2014; Lloyd & Boyd, 2014; Meijers et al., 2016; Russ & Peters, 2015; Trumper, 2010; Tytler et al., 2011) have elucidated on what it means to become a teacher and how to negotiate multiple identities associated with personal and collective roles in the community of practice. Seiler's study (2009) focused on the experiences of science teachers who were outside of the dominant, White, mainstream group who were experiencing a sense of *diaspora*, the sense of being taken away from what knows and values. By documenting and exploring the feelings of identification and dis-identification with science and science teaching, Seiler (2011) generated a "creolized approach to science teaching":

> Teachers create possibilities for greater student identification with science in school,
> which in turn has potential for changing the face of who does science and of science
> itself. (p. 13)

In utilizing cultural toolkits, teachers construct identities from an array of spaces and cultures relating to various groups and communities to which they belong, including participation and interactions in school, the scientific community, home, family, and social, religious and other groups.

With a qualitative case study approach Seiler (2011) appropriately utilized narrative inquiry to analyze and document the lived experiences of a small sample of science teachers. Settlage, Southerland, Smith, and Ceglie (2009), however, supplemented their large scale quantitative study measuring pre-service science teacher self-efficacy with individual interviews in order to inform the quantitative measures. By examining the changes of science teaching self-efficacy beliefs for pre-service teachers over time as they completed their teacher education program, Settlage et al. (2009) attributed the process of examining the teacher interviews as critical to finding uniformity with teacher responses of "no discernable influences on teacher candidates' perceptions of science teaching selves that could be attributed to the demographics of their field placements" (p. 102). The interview protocol was designed to investigate pre-service teachers' attitudes toward teaching science in diverse settings and allowed for an invitation of responses rather than directing responses and explicitly asking them to comment on perceived identities.

Hence, findings from a larger scale quantitative study on pre-service science teacher identity development was significantly validated with the use of interviews and narrative inquiry and analysis (Seiler, 2011).

In a study on the development of an ecological place meaning in New York City, researchers utilized narrative research with educators and students in environmental education programs in the Bronx. They found that teachers are in fact cultivating ecological place meaning nurtured through direct experiences with the urban environment (Russ, Peters, Kransy, & Stedman, 2015). With the understanding that narrative research is the study of "experience as story" (Connelly & Clandinin, 1999), the authors of this urban environmental education study contend that the use of this method is consistent with the restorying process:

> The exploratory nature of this study and its potential to contribute to theory, and with our goal to elicit participants' deep reflections on their experiences and the meanings they attribute to their environmental education practice. (Russ et al., 2015, p 75)

In their narrative research interviews were viewed as a way to organize and communicate co-constructed stories told through the sharing of events and actions by nine educators and six students participating in urban environmental education programs. Russ et al. (2015) contend that instead of focusing on causal relationships, narrative research uses an interpretive framework that can produce meaningful findings in the form of discoveries, theory-making, and generating hypotheses (p. 76). Through the narratives they were able to "uncover the value of ecological place meaning and articulate how this meaning is being nurtured" (p. 76).

Cameo Analysis as an Additional Tool in Narrative Inquiry

Jessop and Penny (1999) developed strategies for making sense of teacher narratives in their contextualized study in rural post-Apartheid South Africa. As they began their work issues of researcher positions and problems of narrative and voice emerged. They realized the dilemmas of not being that "objective, all-seeing eye, but as a re-presenter from 'somewhere'" (Jessop & Penny, 1999, p. 213). Narrative studies are intersections of lived experiences that are personal, social, cultural, political, and historical that can create tensions with respect to text, historical contexts, and the intentionality of researchers (Goodson, 1992). Narrative research utilizing inquiry in the form of interviews and restorying as a means for analyzing the data may claim to articulate the voices of the marginalized.

This approach can in fact perpetuate conditions of subjection by operating in what the researcher considers to be "neutral" space outside of time, history, context, and intentionality (Denzin, 1991, pp. 2-3).

Within the context of rural post-Apartheid South Africa where tensions exist between the radical teacher's union (to which many teachers in general belong to) and the more conservative sister associations (to which many rural teachers belong), the study by Jessop and Penny (1999) attempted to provide narratives to shed light on the ways in which professional and personal lives meet and oftentimes clash. The researchers argued for the credibility of narrative research as they utilized *dialogical interviewing* that sought to minimize the differential between researcher and researched (Siraj-Blatchford, 1995). In the processes of analyzing the teacher narratives through coding, categorizing, and writing analytic memos, Jessop and Penny went through several iterations of making sense of these teachers' stories, using several strategies for re-telling and restorying. By the end of their work, they identified a multidimensional representation of four-quadrant matrices. This template contained one circle of three different sizes in each quadrant to represent tensions and areas of ambivalence or contradiction with respect to common themes emerging from the stories. Using what they call *cameo analysis*, they provided an alternative way of seeing the narratives:

> Teacher-as-person, in an individual case, was represented. This enabled the reader to engage at a deeper level with one teacher's life history, his or her story, and the tensions and contradictions within it. At the same time, individual cameos were placed within the context of a broader study of the narratives of rural primary teachers and thus, the stories could be read and interpreted as part of the same 'social horizon' as other teachers within the sample interviewed. (Jessop & Penny, 1999, p. 225)

Utilizing this kind of cameo analysis alongside the re-telling of teachers' stories provided an alternative medium to interpret teachers' stories. The implications for understanding "stories within stories" and imparting the view that connected to teachers' voices are "an enormous sea of social issues" (Behar in Jessop & Penny, 1999, p. 228) became a valid method bridging teacher training and development with educational policy-making (Jessop & Penny, 1999).

Studying Science Teacher Eco-Identity in Hawai'i

This literature review sets the foundation for my focus on secondary science teacher eco-identity in Hawai'i. By discussing the complexity of teacher identity development, shaping, and sustainment I was able to demonstrate connections of a strong eco-identity to supporting science teachers to remain committed in the profession. Culture-based education that includes 'ike Hawai'i, a critical pedagogy of place, and land education were revealed to be critical components of effective science education reform. In addition to the sociocultural, political, and historical contexts of Hawai'i, island biogeography is also important to understand as an influencing factor on teacher learning and growth. Lastly, narrative inquiry was discussed as an appropriate tool for authentically capturing teachers' voices and studying the meaning making process of a multifaceted and dynamic eco-identity.

In Chapter 3 I will reiterate my research questions and detail the methods of data collection and analysis. Under the theoretical framework of sociocultural theory I was able to focus on studying eco-identity with the understanding that identity development is co-constructed and contextualized, and negotiated across time and place.

CHAPTER 3: METHODOLOGY

Research Questions

Focusing Research Question

As a secondary science teacher in Hawaiʻi what does it mean to have an eco-identity and why might this be important?

Related Sub-Question

- How do secondary science teachers negotiate their eco-identities over time and space and how does this impact their practices as situated in the sociocultural contexts of Hawaiʻi?

Theoretical Framework

Sociocultural Theory

In the 1970s, qualitative researchers in the field of education advocated for a paradigm shift that acknowledges the interaction of multiple perspectives and worldviews of the researcher and research subjects and the importance to emphasize the views of the participants in a study (Creswell, 2008; Denzin & Lincoln, 2005; Lincoln & Guba, 1985). My approach for this dissertation was grounded in the sociocultural theory with the understanding that while my role as a researcher was interactionist and directing a co-construction process of meaning making with each subject, this framework supported a dialogic process implicating social and cultural influences with the formation of identities (Bakhtin, 1981). Teacher perspectives were emphasized and upheld throughout the research process with the constructivist grounded theory methodology that I will shortly explain.

My qualitative study was guided by the sociocultural theory ideology that posits learning and growth (transformation) as continuous, emergent and unfolding, and mediated both externally and internally. Learning and growth are based upon social, cultural, historical, and environmental factors experienced over time (Bandura, 1986, 2001; Bronfenbrenner, 1994; Bruner, 1991). From a sociocultural perspective I considered the interactive nature of external factors in the arena of professional spaces of science teachers, both in and outside of the classroom, while also observing and noting the internal, reflective dialogs of these individuals (Vygotsky, 1978).

Teacher identities are not only constructed from the procedural and emotional aspects of teaching and their personal lives (Acker, 1999; Ball and Goodson, 1985), but also "as the result of an interaction between the personal experiences of teachers and the social, cultural, and institutional environment in which they function on a daily basis" (Sleegers & Kelchtermans, as cited in Day, Kington, Stobart, & Sammons, 2006, p. 603).

Through lived experiences, a teacher navigates what Clandinin and Connelly (1995) refer to as the teacher's professional knowledge landscape, which is not static but fluid and dynamic (Juzwik & Ives, 2010; Lasky, 2005). Cognitive processing, then, is highly contextualized and based upon interactions with the outer social world of history, experience, culture, and politics (Vygotsky, 1978). To gain a better understanding of the dialogic nature of identity development for science teachers it was necessary to acknowledge the influencing factors of socially constructed identity-making: what it means to perform as a scientist and as a science teacher (Shanahan, 2009).

The development of science teacher identity, and more specifically what I refer to as an eco-identity (Houser, 2009), is influenced by social, political, cultural, historical, and economic factors. Mezirow (1991, 2009) adds that transformative learning with respect to eco-identity development, is multifaceted involves a change in frame of reference (encompassing cognitive and emotional components) based upon inclusive, discriminatory, integrative, and self-reflective of experiences as science teachers. Under the broad framework of sociocultural theory, I focused on studying eco-identity in selected science teachers in Hawaii, and the role that sociocultural contexts played in its development.

Constructivist Grounded Theory as a Methodology

Classic Grounded Theory

To honor teachers' voices and their perspectives within the sociocultural theory framework, I adopted the interpretive and interactionist stances of constructivist grounded theory for analyzing their stories. Classic grounded theory with its "no preconceptions" methodology guided my research. Barney Glaser and Anselm Strauss introduced grounded theory in their 1967 book, *The Discovery of Grounded Theory*. Criticism and praise followed both discoverers of grounded theory since its inception. As such, researchers in the positivistic fields of the natural and physical sciences viewed this approach as going against the canons of empirical research.

As noted by Glaser and Strauss (1967) and reiterated by Piantanida, Tananis, and Grubs (2004), grounded theory is not a step-by-step approach but a methodology that aims to keep the discussions and research open-minded and flexible by using tools of theoretical sampling, coding, constant comparative analysis, memo writing, and theoretical sensitivity. Strauss (1987) wrote on grounded theory as a process of qualitative analysis:

> So, it is not really a specific method or technique. Rather, it is a style of doing qualitative analysis that includes a number of distinct features, such as theoretical sampling, and certain methodological guidelines, such as the making of constant comparisons and the use of a coding paradigm, to ensure conceptual development and density. (p. 5)

Grounded theory involves the discovery of theory from data systematically obtained and analyzed in social research, whereby concepts, themes, and hypotheses become relevant to the areas in which one is researching (Glaser & Strauss, 1967). The generation of theory without *a priori* assumptions nor the use of logic and deductive reasoning can be a challenging, with the processes seemingly elusive (Piantanida, Tananis, & Grubs, 2004). Glaser and Strauss were adamant about the ability of grounded theory methodology traversing both the qualitative and quantitative research arenas, thereby offering procedures and processes that supported positivistic approaches mirroring the scientific method (Bryant & Charmaz, 2007). Glaser and Strauss' positivistic approach in classic grounded theory can therefore seem counterintuitive to qualitative methodology by today's standards in sociological research.

While Glaser and Strauss (1967) moved away from the common scientific process of deductive reasoning and approached research inductively, their approach to analyzing data objectively removed researcher influence and social and environmental interaction from the processes of analysis. Classic grounded theory promoted emphasis on the *constant comparative method* that focused on studying segments of data that became fractured incidents; and then comparing and contrasting these fragments to extrapolate patterns from the data to achieve conceptual generality (Glaser, 1978; Glaser, 2016). Glaser and Strauss' focus on the constant comparative method ensured that the emergent concepts were grounded in the patterns and abstract of time, place, and people (Glaser, 2016). They emphasized the role of researchers as "unbiased observers" conducting research "grounded in the data" through making comparisons among incidents and emerging categories while continually asking questions of the data (Glaser, 1992).

Rationale for a Constructivist Grounded Theory

An expansion and interpretive approach to the grounded theory perspective emerged when Strauss and Corbin (1998) emphasized the role of *symbolic interactionism* in conducting qualitative inquiry. This shifted the focus away from the unbiased and objective approaches of the constant comparative method of classic grounded theory and emphasized the researcher's role of getting out into the field to find relevance of theory as a basis for social action. Symbolic interactionism is based upon the understanding that people act on the basis of meaning, and that meaning is defined and redefined through interaction (Strauss & Corbin, 1998). The understanding that identity is a complex and variable meaning making process is further supported by this notion of symbolic interaction, whereby dialogic actions (both internal and external) of science teacher eco-identity in my study were continually negotiated over time and space.

Further discrepancy arose between classic grounded theory methodology and my purpose of conducting research: which was to gather the rich stories of science teachers to better understand what an eco-identity may look like and how this could impact their practices. The strict adherence to an inductive approach in this methodology with classic grounded theory proved to be limiting with respect to how I analyzed the data inductively and also brought in elements of deduction. Bryant & Charmaz (2007) contend that classic grounded theory, with "its strain towards parsimony and subsequent reductionism, the beliefs in discovery and distanced observation, all become problematic" (p. 52). To counter this dilemma, I used an *abductive reasoning* process to analyze the narratives which made up my data. As described by Strauss and Corbin (1998) abductive reasoning is a distinct form of inferencing that not only focuses on observed frequencies or statistics from the research data, but also acknowledges the logical explanations associated within the contexts of events (Douven, 2017). My research data which included highly contextualized stories of teacher identity narratives required analysis through multiple forms of reasoning. Subsequently, I approached my study using an expanded form of classic grounded theory:

> (1) studying individual cases inductively; (2) conceptualizing them; and (3) checking these conceptions through further data gathering, to arrive at logical explanations that could best support theory. (Bryant & Charmaz, 2007)

In 2006 Kathy Charmaz published *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*, considered a "variation" or "evolution" of classic grounded theory. Charmaz and other critics of classic grounded theory argue that Glaser and Strauss' original conception contains the positivistic and objectivist mindsets of scientific research. Charmaz aptly characterized these suggestions for improvement of classic grounded theory as constructivist grounded theory. Constructivist grounded theory revisits the classic underpinnings of grounded theory in the past century and re-examines them through a methodological lens of present day, making this process valid and rigorous in both qualitative and quantitative research (Charmaz, 2006). In constructivist grounded theory, methods are not seen as prescriptions or packages, nor are they inflexible rules, recipes, and requirements.

A constructivist grounded theory methodology that purports learning and knowledge building as experiential and reflective is appropriate for discovering the *personal realities* of science teachers. Personal realities are associated with how teachers view themselves which are recognized by their identities: "self-as-knower" and "self-as-known by others" (Akkerman & Meijer, 2011). Furthermore, Akkerman and Meijer note that identities are not just viewed as unified, continuous, and individual; but also changing, discontinuous, and social. Constructivist grounded theory was an approach to analysis that appropriately supported the building of knowledge and personal realities through lived experiences and the dialogic processes of identity formation.

Unlike most qualitative methodologies, the grounded theory approach claims to produce testable outcomes which may lead to traditional experimental and quantitative designs of study for the future (Taber, 2000). While Western science frameworks have dictated quantitative, positivist studies, science education researchers including Taber (2000) recognize that studying more subtle and complex sociocultural interactions in science learning also requires an interpretive stance characteristic of constructivist grounded theory. By adopting the expanded perspectives of Strauss and Corbin (1998) and Charmaz and Bryant (2007) while still adhering to the underlying principles of classic grounded theory (Glaser & Strauss, 1967), I adopted the constructivist grounded theory methodology for my research.

Research Design: Qualitative Case Study

Case study as a research design in qualitative inquiry, while not a new approach in educational research, is a justified means to studying a particular case in what can be seen as humanistic and also credible in that descriptions and explanations are continuously made throughout the period of study (Stake, 2005). A qualitative case study involves the examination of a "case" bounded in time and/or place. My research was bounded by both time and place since I studied the lived experiences of teachers as retold and reflected upon during the interview process. The case studies of *purposefully selected* science teachers were examined closely with contextual details of the places and lived experiences and included artifacts that added more depth and richness to the narratives and to the meaning making processes involved with identity work. To address concerns about qualitative data trustworthiness, Liu and Xu (2011) recommend:

- securing high quality data through building trust and rapport with participants so that the "stories are told with fidelity", and
- analyzing the data in a systematic way with documented processes of data analysis "so that it is open to scrutiny and critique. (p. 591)

My choice for a case study design is distinguished from an ethnographic approach. Ethnographic research involves describing, analyzing, and interpreting a culture-sharing group's shared patterns of behaviors, beliefs, and language development over a lengthy period of time (longitudinal) (Creswell, 2008). In contrast, a case study approach from sociocultural and historical perspectives explores individuals' multiple contexts and landscapes (Stake, 2005). Utilizing the constructivist grounded theory methodology, I used the interpretive approach (Charmaz, 2002, 2006) to acknowledge personal realities associated with these case studies of the science teachers. Case study as a methodology in educational settings is useful because although teachers, students, and school settings share similarities, they also are unique and complex, as realized by studies on teacher epistemologies and multiple influences on student learning (Saka, Southerland, & Brooks, 2009; Sleeter, 2009; Young, 2010). Reality and identities for each teacher are therefore multiple, dynamic, and unique, and they are temporally and spatially influenced.

In case study design, interviewing is commonly used for gathering stories to better understand participants lived experiences and their beliefs, attitudes, and actions.

While graduate research in areas of the natural and physical sciences employ experimentalism informed by behaviorism to conduct empirical studies, the educational and social sciences fields utilize singular or multiple case studies where in-depth interviews are the primary method for investigation (Seidman, 2013). Use of the in-depth interview alone, done with skill and ethical mindsets, notes Seidman, can avoid tensions that sometimes arise when researchers utilize a triangulation method. Gathering data using multiple data sources assumes that a weakness in one method will be compensated by another. Vygotsky (1978) noted how words spoken during interviews are critical in the storytelling process, as they are at the depths of consciousness. Dialog and discourse are critical in the meaning making process of identity learning (Hermans & Hermans-Konopka, 2010) which are supported by in-depth interviewing and a multiple case studies research design. In order to account for participant attrition in a study, multiple case studies were preferred over a single or two case studies (Creswell, 2007). Again, my research took on a more subjective and interpretive stance typified in education research using multiple case studies (Stake, 2005) and following the methodology of constructivist grounded theory (Bryant & Charmaz, 2007; Charmaz, 2006).

Research Procedures

Approval

In the fall of 2012 my original proposal to conduct research was approved by the University of Hawai'i at Mānoa (UHM) Internal Review Board (IRB) (see Appendix A for UHM IRB approval). Following approval from the university to conduct my qualitative research I applied to the Hawai'i State Department of Education (HIDOE) with the request to work with potential secondary science teachers who were in the public school system, to serve as a participant-observer in their classrooms. While waiting for the HIDOE approval to conduct my study I moved ahead and sought out potential participants in the late fall of 2012.

In early spring of 2013 I revised my research title and research questions and extended my data collection time frame, which was also approved by the UHM IRB (see Appendices B and C). At the same time, I was unable to obtain approval from the HIDOE for observation and participation in the public school classrooms of the teachers to be studied. Subsequently my IRB revision and research approach focused on the inquiry component of gathering stories *outside* of the classroom setting.

With a multiple case studies design I concentrated on the in-depth interviews to better understand science teacher identities with sufficient detail and contextualization for each case presented (Creswell, 2007).

Purposeful Sampling in Case Study Design

Prior to agreeing to participate in my study, I met with each teacher to conduct pre-interviews and explain the focus of my research, with limited definitions of what characterizes an eco-identity. Since I was approaching this study with a "no preconceptions" methodology of grounded theory (Glaser, 2016), I didn't have any answers or theories nor hypotheses to share with potential participants. When better understanding what the goals and objectives of my study on eco-identity were, participants reviewed the consent form to agree upon the terms and conditions (see Appendix D for the adult consent form). In case study design, *purposeful sampling* is generally used to carefully select cases that while not necessarily representative of the population, the sample does provide a range of lived experiences, situations, and outcomes of (Merriam, 1998). The small sample size provided an opportunity for detailed accounts of each participant while also allowing for cross-case comparisons (Creswell, 2007).

Teacher Attrition and Retention. The process of teacher identity development is dynamic and ongoing. Studies reveal how beginning teachers negotiate new identities and either develop new strategies to survive within changing contexts or fail to negotiate these emerging identities and leave the profession (Clandinin, Downey, & Huber, 2009). Since my research focused on studying the existence of an eco-identity in science teachers, it was essential that the sample selected were science teachers who successfully "compose lives that work in the shifting landscapes in which they find themselves" (Leonard and Roberts, 2014). Thus, the criterion of a teacher practicing in the field for five or more years became a key factor for purposeful sampling.

On the national level, the National Center for Educational Statistics (NCES) studies K-12 public and private school teacher attrition and mobility. In the 2012-2013 NCES report Goldring, Taie, and Riddles (2014) utilized a teacher characteristic of teaching experience in the ranges of one to three years, four to nine years, and 20 years or more to discuss attrition and mobility percentages of K-12 teachers over the school year. Research on teacher retention suggests that keeping good teachers is the most important determinant of student achievement (Darling-Hammond, 2003).

With one-third of new teachers leaving the profession within five years, it is essential to recognized that what keeps good teachers in the profession is their ability to surpass a steep learning curve (Darling-Hammond, 2003; Wilson, Floden, & Ferrini-Mundi, 2001). This period of learning and the development of self-efficacy includes the negotiation of new and multiple identities within evolving sociocultural and political contexts. Based on this research about teacher retention and attrition, I purposefully selected science teachers who have taught for five years or more and have successfully navigated this professional landscape and produced "stories to live by" (Connelly & Clandinin, 1999).

   Sociocultural Contexts of Hawai'i. In order to better understand eco-identity development and how this may impact practice, I also considered the lived experiences of these science teachers as they traverse the professional and personal landscapes of teaching, both here in Hawai'i and in other places. Research on teacher identity development reveals how the knowledge of self, both self-as-known and self-as-known by others (Akkerman & Meijer, 2011), is a crucial element in the way "teachers construe and construct the nature of their work" (Kelchtermans, 1993). The interrelationships of professional and personal lives have been found to be intimately linked to the multifaceted identities of teachers (Sleegers & Kelchtermans, 1999) and therefore the interview discussions focused on how the selected teachers saw themselves and made sense of their lived experiences. In order to conceptualize their eco-identities in the present moment, I needed to contextualize the stories as they were situated in diverse social and cultural settings from the past and up through their lives today. My purpose was to study identity development over time and space which entails evolving processes of the construction and reconstruction of meaning making stories over time.

   Social, political, and historical contexts. Science teacher identities are further complicated by a community of practice that includes the negotiation of socio-scientific issues Sadler (2009) and the historical, cultural and political issues associated with time and place (Bang & Medin, 2010; Saka et al., 2009). Community of practice (Lave & Wenger, 1991; Wenger, 1998) involves the negotiation of teacher knowledge and values and beliefs toward achieving shared goals in the profession. Responsiveness and the "practical risk taking as learning in high-stakes times" can thus become processes of meaning making which influence identity development (Clayton, 2007).

I purposefully selected my participants and adhered to the small sample size I was to be working with, while also being able to acknowledge multiple realities and sociocultural backgrounds of each, along with past and current contexts of practice. Multiple realities of science teachers can influence identity development. Gee (2001) notes that the complexity and fluid nature of identities at a given time and place:

> [Identity] can change from moment to moment in the interaction, can change from context to context, and of course, can be ambiguous or unstable…all people have multiple identities connected not to their "internal state" but to their performances in society. (p. 99)

Hawaiian cultural context. A criterion within the sociocultural contexts of Hawai'i also included selecting teachers (at least two) of Hawaiian ancestry, as my research focused on individuals living and practicing (or once practicing) in Hawai'i. I wanted to better understand how being Hawaiian or part-Hawaiian could influence and shape the development of an eco-identity. What life experiences and Hawaiian cultural influences impact the meaning making processes of developing an eco-identity? Does it matter if a teacher is of Hawaiian ancestry or not, and how might a multicultural society in Hawai'i potentially impact how one views his or her multiple roles as a science teacher? The cultural historian Kepā Maly describes the Hawaiian cultural landscape whereby Hawaiian culture does not dileneate between where culture ends and where nature begins, and how values are assigned to specific places:

> In the Hawaiian context, these values—the "sense of place"—have developed over hudreds of generations of evolving "cultural attachement" to the natural, physical, and spiritual environments...one must understand that Hawaiian culture evolved in close partnership with its natural environment. (Maly, 2001, p. 1)

Today, as a result of the cultural diversity in our Island communities and therefore in our teacher community of practice, it is expected that these unique sociocultural factors will influence how science teachers look at and apply different values to their natural and cutlural environments (Maly, 2001). I therefore included this criterion of being of Hawaiian ancestry for at least two participants, with the understanding that Hawaiian culture and other cultures may influence shaping eco-identity development.

Reciprocity in Research

Community psychologist James Kelly (1986) purports that involving citizens as contributing participants throughout the research enterprise takes on an *ecological perspective*. Research findings and emergent understandings are generated from the community. As argued by Kelly this approach provides a reciprocal exchange of resources and complementary benefits to all parties. An ecological perspective upholds my research methodology of constructivist grounded theory. An ecological perspective contributes to a manner of collecting data and contributing to providing practical benefits to the community that is being studied. Kelly's viewpoint therefore supports my approach to the co-construction of knowledge through narrative inquiry:

> I am arguing that if we can develop a unique research style that is community based, we can generate topics that are of the community. The practical benefits of the research then will be more apparent because the connection between research and practice will be joined as the data are authentic to the locale…Constructs are generated from the community. (1986, p. 582)

As a former secondary science teacher now conducting research in science education, I applied this notion of reciprocity involving immersion and participation with the understanding that the research would benefit all parties involved. Taking on an ecological perspective aided my data collection and constructivist grounded theory processes by situating myself in positions of observation and participation. With constructivist grounded theory I needed to go beyond the empirical research methods of a scientist as a neutral and objective observer. Instead, I embedded myself back into the community of practice of science teachers in order to study the phenomenon of eco-identity development and authentically capture and represent their voices in my research. Having a pre-existing relationship and further developing trust with each teacher thus became an important criterion for participant selection.

Teacher Selection Criteria

Criterion Sampling. With a multiple case studies research design and with purposeful sampling, I looked for the following qualities of secondary science teachers as they would serve to address my research topic and questions. Moreover, the multiple case studies format was designed to sample valid representations of multiple realities and diverse sociocultural backgrounds.

With *criterion sampling* (Patton, 2002) as part of the sampling process, I adhered to the following demographics for recruiting potential participants in order to ensure that I obtained a range of teachers from diverse sociocultural backgrounds and lived experiences:

- years of teaching (five years and beyond),
- current/past use of place-based education practices,
- practicing in Hawai'i in the same place (i.e. school, district) for at least five years,
- range of secondary school types (i.e. private, public, charter),
- having full or part-Hawaiian ancestry (at least two teachers), and
- having an existing professional and/or personal relationship with the researcher.

I initially sought to obtain six to eight secondary science teachers currently living and practicing in Hawai'i. I was challenged with finding individuals whom I had already built a professional relationship and/or mentorship with, as some were unavailable at times throughout the school years due to travel (i.e. being a crewmember on the voyaging canoe Hōkūle'a). While I had many contacts with science teachers, some did not meet the specific criterion of being a secondary science classroom teacher and instead were science educators working in informal and after school settings outside of the traditional classroom. In line with a case study design I wanted the opportunity to work with these teachers in their classrooms throughout the school year but I was not approved access by the Hawai'i State DOE Data Governance Office in the spring of 2013. The notion of reciprocity from an ecological perspective (Kelly, 1986) I had intended to uphold was compromised and adjustments were made to ensure that I was still able to immerse myself into the worlds of these science teachers.

In order to uphold this notion of reciprocity with my research and gain the confidence of the science teachers whom I was to be conducting in-depth interviews with, I purposefully sampled the population with a criterion checklist described in Table 3.1 (p.75) in the following ways:

- colleagues whom I've taught alongside with in secondary science,
- others whom I was referred to by other educators, and
- those cooperating/mentor teachers whom I've met through my work as a university supervisor.

By the end of June in 2013 I secured six secondary science teachers who were able and willing to commit to a multi-year project involving the exploration of their professional and personal lives to explore this notion of an eco-identity. Together we each reviewed the expectations of my research and once agreed upon, each teacher signed the adult consent form (see Appendix D). Table 3.1 depicts the purposeful selection method with criteria based upon my research foci on studying secondary science teachers' eco-identity in Hawai'i.

Table 3.1

Secondary Science Teacher Selection Criteria

Research Factors	Purposeful Sampling Criterion	Met/Not Met
Multiple case studies research design	• Six to eight (maximum) case studies	Met
Negotiating multiple identities	• Secondary science teacher—middle or high school	Met
Place connection and meaning in Hawai'i	• Teaching science for at least five years in Hawai'i (MHI) (see note)	Partially Met: Five of six teachers
Teacher retention and commitment to the field	• Overall ranges of teaching experience as of spring 2013: (a) five to 15 years and (b) 16 years or more	Met
Teacher connections to students and community	• Practicing in the same school or district in Hawai'i for at least five years	Met
Institutional Identities	• Range of secondary school types: public, public charter, private/parochial	Met
Science teacher community of practice	• Currently or previously servicing secondary school students with place- and/or culture-based science lessons and projects	Met
Hawaiian cultural context	• Two to three teachers of Hawaiian ancestry (partial or full)	Met: Two teachers
Ecological perspective and reciprocity	• Having a pre-existing professional relationship and/or mentorship connection with the researcher	Partially Met: Four of six teachers

Note. (1) For one teacher (Lynne), she adopted a new role in administration in her fifth year at the charter school. (2) MHI = Main Hawaiian Islands.

Demographic Data

  The six individuals participating in my study came from diverse sociocultural backgrounds and teaching experiences. Three of them had each taught for 20-plus years in the formal classroom setting and have since retired but continue to practice in and outside of school settings as mentors, coaches, and educational program managers. One teacher transitioned from the classroom setting to a role as vice-principal overseeing curriculum and instruction at the same school where she previously taught high school science for four years. Years of teaching ranged dramatically from nine years to forty-three years of service, formal and informal. Two out of the six teachers were born outside of the state of Hawaiʻi and each came from varied ethnic and cultural backgrounds.

  Table 3.2 to follow (p. 77) describes the demographics of six participating teachers in order of least number of years of teaching to the greatest. The demographic data gave my research rich contexts and served to support the potential existence of an eco-identity development within each of them with the understanding that identity is characterized as meaning making and transformative learning processes. In a multiple case studies design with a small sample size, this purposeful selection became the foundation for better understanding the variety of sociocultural contexts and lived experiences which these teachers have spatially and temporally traversed. I assigned aliases to two of the six teachers at their request to uphold confidentiality that was agreed upon in the adult consent forms. See Appendix D for a copy of this adult consent form to participate in my research.

Table 3.2
Secondary Science Teacher Demographic Data

Name/Alias Place(s) of Birth/Childhood	Positions/Specializations PS = Public School PvtS = Private School PCS = Public Charter School AP = Advanced Placement PD = Professional Development	Degree(s)/ Certifications	Teaching Experiences as of Fall 2017 Formal (F) & Other (O)	Years Living in Hawai'i
Lynne (see note) New Jersey	PS: 7th grade life science PvtS K-12: Five levels of science PCS: High school general science, life science, 12th grade biology *Current*: Dean of curriculum and instruction (VP) at charter school	B.S. Plant Science with education minor M.A. Biology Curriculum & Instruction	8 years (F) 3 years (O)	10 years
Karen (see note) Pāhoa, O'ahu	PS: High school biology, marine science, physics *Current*: Teaching online physics (AP) in E-School	B.Ed. with Physical Science specialty AP Physics certification	12 years (F)	36 years
Malia Hālawa, O'ahu; and Hilo, Hawai'i	PS: High school 9th grade physical science, 11th/12th grades chemistry/AP chemistry, engineering technology I	B.A. Chemistry MEdT Secondary Science Teaching	16 years (F)	36 years
Ed Pu'ukoli'i Plantation Village, and Lāhainā, Maui	PS: High school chemistry, AP chemistry, physics, mathematics, physical science *Current*: Ocean/Science Bowl coach & AP chemistry coach	B.A. Chemistry with Physics & Math minors M.Ed. Science	31 years (F) Retired in 2000	65+ years
Eddie Kenya and East Africa	PvtS: 7th/8th grade AP biology; high school (**majority**) chemistry, biology, marine biology PD: Science teachers and students grades 6-12 (science teaching in South Africa & Kenya)	B.A. Secondary Science Teaching M.S. in Biology with Chemistry minor	36 years (F) 3 years (O) Retired in 2016	15 years
Chuck, "Doc," Burrows Nu'uanu, O'ahu	PS: 7th/8th grade sciences PvtS: Gr. 7, 8 sciences; high school (**majority**) biology, marine science, chemistry, physical science, environmental science *Current*: Environmental educator	B.A. Biology, Chemistry M.Ed. M.S. Biology, Earth Sciences Ed.D. Instructional Development & Research	40 years (F) 17 years (O) Retired 2000	70+ years

Note. (1) Pseudonym assigned as requested; (2) VP = Vice Principal; (3) MEdT = Master of Education in Teaching

Educator Descriptions

      Lynne. Lynne (pseudonym) is a Caucasian female who was born and raised in New Jersey. She attended a private Catholic school for Kindergarten through second grade and then transitioned to public schools for the remainder of her third through 12th grade years. After completing high school, Lynne obtained a science degree from Rutgers University and completed a B.S. program in plant science at Rutgers with certification in education. After finishing her teacher education program, she taught seventh grade science for a year and a half in New Jersey in the same classroom where she student taught. She then returned to New Zealand after a previous trip? and taught secondary science (five grade levels) at an all-girls Catholic school in Auckland for three years.

      Back in the U.S. Lynne obtained a Master's degree in biology curriculum and instruction and began teaching sixth through 12th grade sciences at a public charter school in Honolulu, Hawai'i. Over the four years of formal teaching she taught biology and then primarily the 12th grade biology course. She transitioned into her current role as Director of Curriculum and Instruction (Vice-Principal) and occasionally still teaches science, whether as a substitute teacher or helping to train and model for new teachers to the school.

      Karen. Karen (pseudonym) was born and raised in Hawai'i, on the island of O'ahu. She grew up in Pauoa Valley where she attended public schools. She is of Japanese, Chinese, Hawaiian, and German ancestries. Karen, like her parents and siblings, attended the University of Hawai'i. She obtained her secondary education degree with an emphasis in physical science.

      After obtaining her teaching license in secondary education, Karen continued to teach at the same high school where she student taught. She began teaching courses in the physical and marine sciences and later taught biology and marine science courses until 2014. During her nine years of teaching at the public high school, Karen also taught online physics to 10th through 12th graders through the E-school. Karen, with the agreement of her husband, took an extended leave of absence from classroom teaching to give birth to her third child and stay at home to raise her children until the youngest starts Kindergarten. But teaching did not stop since she continues to teach science courses (physics, and now an AP physics II course online to 12th graders) online for the Hawai'i Department of Education (DOE) supported E-School.

Malia. Malia is of Okinawan descent and was born and raised on Oʻahu, in Hālawa where she attended a public elementary school. She and her family moved to Hilo, Hawaiʻi when she was in the 5th grade and she continued with public schooling through high school. Malia attended the University of Washington in Seattle, Washington to receive her chemistry degree (B.A.) and minor in mathematics. Although there was not a formal Bachelor's program in education at the University of Washington, Malia did take a course in algebra for teachers.

In 2001, soon after the events of September 11th, Malia returned home to Hilo and was approached by several of her former high school teachers. She taught chemistry briefly at her former high school for three-fourths of the school year. She applied to the Masters of Education in Teaching (MEdT) program at UH Mānoa on Oʻahu and completed her student teaching experience and was hired to teach secondary science at a high school in Windward, Oʻahu. Malia quickly transitioned into her current position of teaching chemistry and also worked to bring back the AP (Advanced Placement) chemistry course at her school. Currently, Malia is in her 16th year of full time teaching at the same high school where she completed the MEdT program. In addition to teaching chemistry, Malia now teaches a course in engineering to 11th graders. Since the fall of 2016 I have had the privelege of working with Malia and her team of engineering pathway teachers and CTE (Careers in Technical Education) coordinator.

Ed. Ed was born and raised on the plantation camp in Puʻukoliʻi on Maui, where his mother was also raised. He comes from an Okinawan family of six children. He attended public schools in Lāhainā, Maui and left the Island in 1959 to attend college in Colorado, majoring in liberal arts with interests in engineering and chemistry and a minor in mathematics. Ed remained in Colorado for five years and then moved to California for two years. He returned to Hawaiʻi in 1966 and was drafted into the Army. It would be in the spring of 1971 when he eventually returned to Maui to teach science and mathematics. For over 30 years Ed taught high school chemistry, physical science, physics, and mathematics. In 1993 he began coaching high school students for the national Science and later Ocean Bowl competitions. His students from Maui took first place at the state level six times since 2003 for the Ocean Bowl competitions. In addition to full time teaching Ed spent 15 to 16 years heading the school's science club and hiking club and also taught several courses at the college level at Maui Community College, and practice courses for the teacher PRAXIS tests for the state DOE.

Since retiring from full time teaching in 2000, Ed continues to coach students for the Science and Ocean Bowl competitions. He also continues to volunteer tutor students at the high school in preparation for the AP chemistry exams. He supports and recommends students for university entry, especially at the Massachusetts Institute of Technology (M.I.T.) where he has formed a long-lasting relationship over the past 20 years.

Eddie. Eddie is of Indian, Asian descent and was born in Uganda, in central Africa. Eddie grew up and attended elementary through high schools in Kenya where his family of four siblings and parents moved to. Eddie grew up surrounded by music, which he is still involved with today living in Hawaiʻi. His teaching experiences began after finishing high school, which led to his attending a teaching college in Nairobi where he completed his practicals at three different schools, and then briefly teach high school science.

Eddie moved to Ohio to continue his schooling to obtain advanced degrees in the sciences and continued to teach in both private and public school settings in Ohio and in Florida for a few years, in the subjects of biology and chemistry. Next, he relocated to Vancouver, Canada where he taught at another private Caholic school for several years. Drawn to warmer climates and coastal towns, Eddie moved to Hawaiʻi and resumed teaching in the private Catholic school system. He taught seventh- and eighth-grade AP biology for three years at an all-boys, private Catholic school and then at another private, Catholic-based high school where he taught chemistry, biology and then marine science until retirement in the spring of 2017. During summers, he taught science teachers and students as part of a Catholic Marianist parthernship with schools in Hawaiʻi and those in the following locations: South Africa, Kenya, and the Chuuk Islands in the Federated States of Micronesia. In total, Eddie has formally taught science for 36 years.

Chuck "Doc" Burrows. Doc Burrows, as he is commonly known, has been teaching science and affording secondary students and adults environmental science field-based experiences for 43 years, in both formal and informal settings. He was born in Kailua and raised by his Hawaiian grandparents in Nuʻuanu on Oʻahu Island. He is of Hawaiian, Chinese, and German ancestries. After high school he entered the U.S. Coast Guard and maintained an interest in the sciences. Doc Burrows attended colleges in Washington and Oregon to complete bachelor's and master's degrees in the areas of biology, environmental science, geology, and education.

He continued to fuel his passion for the natural sciences and education by completing two masters degrees through summer courses in Oregon, while he and his wife continued to teach in Hawaiʻi during the regular school year. In 1969 he attended Indiana University to focus on the biological sciences and educational technology. His doctorate research in education focused on utilizing technology to instill mediated learning practices supporting student achievement through the *mastery learning* of skills and content. Mastery learning as an apprenticeship model of students gaining knowledge and skills through observation and experience, became the basis for his approach to teaching in science throughout his professional career.

Back in Hawaiʻi Doc Burrows resumed teaching at the same private school in Honolulu serving Hawaiian students. As a teacher he provided relevant and rigorous field studies for his high school students in biology and environmenal science classes. He always followed Hawaiian protocol with his students, to keep cultural values and practices in mind. Throughout his 37 years of teaching Doc Burrows has built lasting relationships with scientists, tribal heads, and navigators such as Nainoa Thompson (master navigator of the Hōkūleʻa) and the late Lacy Veach (astronaut). While he retired in 2000 from formal science teaching, he continues to teach gardening and sustainability classes for a "green congregation" at a non-denominational church. Doc Burrows is currently involved with the Kawainui-Hāmākua Marsh initiative to restore and protect native cultural and natural heritages of the wetlands in Kailua. He is part of the community effort proposing a master plan to develop a State wildlife sanctuary with Hawaiian cultural and science education enhancements.

Data Collection

In conducting this qualitative case study research, I carefully considered the research and methodologies of Indigenous and/or ethnographic scholars such as Glen Aikenhead, Oscar Kawagley, Kepā Maly, Manulani Aluli Meyer, and Linda Tuhiwai Smith. This was a means to honor the voices of the teachers whom I worked with from 2012 through 2017. We co-constructed knowledge to better understand the meaning making taking place with eco-identity development and shaping. This was not a purely objective process since the re-storying process was based on memories of these lived experiences for each teacher. The personal realities involved re-interpretation of situations and events.

Moreover, Kelchtermans (1993) emphasized how narrative research techniques can influence how teachers use specific ways of talking in an interview or questionnaire and may implicitly or explicitly acknowledge the researcher in the process. I therefore needed to consider the multiple perspectives and epistemologies of these teachers and impacts of narrative inquiry when interpreting their responses.

Chinn (2002) conducted a narrative exploration of Asian and Pacific Islander women scientists and engineers with respect to racial and gender stereotyping, effectively utilizing rich, personal narratives to co-construct knowledge, and to share voices of those often marginalized and stereotyped in today's Caucasian and Asian male-dominated post-secondary institutions. Thus, in addition to the sociocultural contexts that need to be taken into consideration when conducting interviews, I needed to be mindful of teacher gender and ethnicity with respect science attitudes and science epistemologies arising from multiple, varied perspectives (Bang & Medin, 2010).

Narrative Inquiry as Naturalistic Process

Narrative inquiry was the primary method for studying the selected science teachers in this qualitative case study, bringing to light in a naturalistic way the stories of intentions, hopes, competing personal and professional values as science educators, and transformations over time through lived experiences and reflections. In my study on science teacher eco-identity, I was able to effectively capture these stories in the form of *identity narratives*. In the study of teacher stories, narrative research as advanced by Clandinin and Connelly (1992, 1995), moves through multiple analytic lenses. The identity narratives became the focal point of studying how the science teachers navigated the teaching landscape and how they made sense of events and situations to eventually develop their personal and professional realities of self. Eco-identity work (meaning making process) through narrative inquiry involves abductive reasoning and symbolic interactionism when capturing these stories told and retold. It is thus a complex process whereby I had to consider my role as a researcher.

Role of the Researcher in Narrative Inquiry

Positivistic Ideologies of Western Research. Guba and Lincoln (2005) note that in qualitative research there are overlaps in assumptions; more importantly there are contradictions, controversies, and confluences among genres of behavioral research today.

In Western forms of social science research, the ideas, beliefs, and theories about the social world and the development of the human "self" are assumed to be based upon social relationships and cultural groups which individuals belong to, suggesting that the development, learning, and shaping of identities are causal and can be predicted (Smith, 1999). Concerns about this positivist approach to viewing teacher identities as predictable and therefore evaluating teacher effectiveness based upon student test scores, predetermined pedagogies, and curricula are documented in the research literature (e.g. Cochran-Smith & Lytle; Darling-Hammond, Day, Delpit, Noddings). Furthermore, positivistic ideology of identity development for teachers supporting a predictable and uniform process of identity development has been argued against.

With identity development for new teachers, which can also apply to veteran teachers, factors of self-doubt and uncertainty are crucial components to the meaning making processes of unique and dynamic identities (Settlage, Southerland, Smith, & Ceglie, 2009). This is especially important to consider when teachers are working with multicultural populations of students who bring multiple epistemologies to the classroom such as in Hawai'i. Thus, teachers practicing in diverse settings will likely experience periods of self-doubt and uncertainty that can impact identity development in unique ways. Hence, I considered methodologies utilized by Indigenous researchers in order to include the multiple perspectives of teachers who work with multicultural populations.

Indigenous Methodologies Informing Narrative Inquiry. When Linda Tuhiwai Smith (1999) writes about recovering the stories of the past for Indigenous peoples, she notes how this process is inextricably bound to a recovery of language and epistemological foundations. Language, forms of communication, and how one makes sense of the world are therefore dialogic processes tied to the storytelling process. As I encouraged individuals to recall and retell their experiences, values, and beliefs associated with the development of their identities as science teachers, I took on a dialogic approach with the co-construction of knowledge. As with Indigenous approaches to recovering stories of the past, I adopted a stance that was not merely focused on science teachers' acquisition of competencies, beliefs, and knowledge based upon professional development. Instead I utilized a dialogical approach assuming non-linear dimensions of multiplicity-unity, discontinuity-continuity, and social-individual (Akkerman & Meijer, 2011).

As a former secondary science teacher, I was engaged with the co-construction of knowledge during the narrative inquiry process, but I also adopted a role as an "outsider" looking into the lives of these individuals. I acknowledged the existence of multiple epistemologies and unique experiences of each teacher. Thus, I approached the interviews with an understanding that *storying* can be a *reiterative narrative* process. Storying became the process of telling and re-telling stories as teachers recalled experiences and situations of the past and present, to eventually construct the identity narratives and eco-identity maps. The reiterative narrative process assumes that storytelling is not always linear and chronological and that it can become "repetition combined with elaboration" (Ewing, 2016, p. 376). Considering the current sociocultural contexts of Hawai'i, I was mindful of this kind of reiterative narrative process of storytelling with my participants. An informal, dialogic approach to the interviews ensued and the result of storying and re-storying became cyclical and discontinuous at times. Meyer (2004) utilized a talk story format to inform her understanding of Hawaiian epistemology with the very understanding that as a cultural group Hawaiians are deeply connected to nature, whereby human behavior is also externally influenced by spiritual, higher beings and sacred objects. I wanted to understand how external influences could be tied to eco-identity development and shaping for these teachers, regardless of their ethnic backgrounds.

Reflexivity in Narrative Inquiry. In examining my stance as a researcher, I also positioned myself from the perspective of constructivist grounded theorist, as I became a part of the meaning making processes of constructing narrative realities with each teacher (Gubrium & Holstein, 2009). With narrative inquiry I utilized interactionist and reflexive approaches (Charmaz, 2006) not only with my participants during the interviews and with member checking, but also when discussing my approaches and analyses with colleagues during my writing group sessions. These writing group sessions took place at least two times a week for four to six hours each time, across ten months (fall of 2016 through spring of 2017) and in the fall of 2017 for another five months.

Reflexivity in research is the process of self-awareness and when regular efforts take place to consider one's own thoughts and actions in light of varied and multiple contexts (Mills, Durepos, & Wiebe, 2010). I thus conducted ongoing critique and critical reflection of my own biases and subjectivity as part of the constructivist grounded theory process.

In addition, I utilized reflexivity throughout my research to consider my own positionality as an Asian American science educator and the positionalities of my interviewees (Parsons, 2008), knowing that there would be subjectivity and bias in the process of conducting research using this narrative inquiry approach.

Methods of Narrative Inquiry

Triangulation can be defined as a process of corroborating evidence from different and multiple sources: individuals, types of data, or methods of data collection (Creswell, 2008). Upon reviewing case study research on teacher epistemologies and teacher identity development I found commonly utilized methods of data collection which includes interviewing, observations, focus group discussions, surveys, artifact collection and examination, and audio recording. While many scholars argue that having multiple sources of data is the one intrinsic characteristic of qualitative research, Seidman (2013) notes the contrary:

> The use of the in-depth interview alone, when done with skills and ethical mindsets, can avoid the tensions and misrepresentations that can occur when a researcher uses multiple methods. (p. 5)

Triangulation served to enhance the accuracy and further validate the results and analyses of science teacher identity narratives from the interviews. Below are descriptions of the narrative inquiry methods I utilized for my study followed by a summary of the data collection process and timeline in Table 3.3.

Interviews. The primary instrument for data collection was in the form of audio recorded interviews and notes in the form of *memo writing*. Saldaña (2013) compares analytic memo writing in grounded theory methodology to researcher journal entries as a "place to 'dump your brain' about the participants, phenomenon, or process under investigation by thinking and thus writing and thus thinking even more about them" (p. 41). The memo writing during and after the interviews became the place for me to reflect further upon processes, events, situations, and emotions of individuals' storied lives. The interview process in case study research is an effective means to gathering life stories of teachers and used primarily in qualitative inquiry and the narrative process (Alsup, 2006; Chase, 2005; Clandinin & Connelly, 1995, 2000; Hatch & Wisniewski, 1995; Lincoln & Guba, 1985, 2005). Interviewing using the constructivist grounded theory model, like the classic, is open-ended, emergent, and paced, yet unrestricted.

Charmaz (2006) states:

> Our attempts to learn help us to correct tendencies to follow preconceived notions about what is happening in the field. In addition to picking up and pursuing themes in interviews, we look for ideas through studying our data and then return to the field to gather focused data to answer analytic questions and to fill conceptual gaps. (p. 29)

Conducting interviews in this constructivist manner allows for *symbolic interactionism* when learning about the participant's viewpoints, lived experiences, and actions. Symbolic interactionism is a perspective, which assumes that people construct selves, society, and reality through interaction and that there are dynamic relationships between meaning making and actions (Charmaz, 2006). As a researcher one must take guard not to force interview data into preconceived categories, noted Glaser (1978), and this holds true for the constructivist utilizing grounded theory. I maintained constant reflexivity with questioning during the interviews, in order to maintain the constructivist grounded theory framework with the understanding of subjectivity and bias involved with the co-construction of knowledge.

I set up places of teacher choice and conducted the open-ended interviews in two main sessions for each. All interviews were open-ended and conversational, and followed a protocol that was sensitive to the teacher being interviewed in terms of sociocultural, historical, political, economic, and environmental contexts. I upheld confidentiality with data collection and utilized proper ethical practices as a naturalistic researcher, addressing biases and assumptions that may have unintentionally interacted with those being interviewed (Lincoln & Guba, 1985). During each interview I took field notes with attention to setting, scene, and place, which I incorporated into the coding process as well, to take into account how this data interacts with the interviewee (Kusow, 2003).

Guiding questions. I utilized guiding questions to reflect the symbolic interactionist focus of constructivist grounded theory to learn about the participants' views, lived experiences, and actions (Charmaz, 2006). I asked specific questions to gather background information which included: years of teaching science, subjects taught, places/districts/states working as a science teacher, current places of teaching science, and number of years at the current school/district. The interview guide utilized for all interviews is located in Appendix E. In keeping with an informal, talk story format for the interviews and in order to build continued trust by teachers, I used this guide as a means to assist with the focus of my research.

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With the understanding that the storying process can be reiterative, the interview guide ensured that the interview was focused yet conversational. This put all teachers at ease during the interviews. During the interviews I also asked each person open-ended questions related to sociocultural and pedagogical factors of *place-based education* and *culturally relevant* and *culturally sustaining teaching* models in Hawaiʻi. Teaching practices along with lived experiences were discussed during the interviews as they related to science teacher practices in Hawaiʻi and how they could have influenced eco-identity shaping. The open-ended questions (Appendix E) that I referred to during the interviews were:

- In what ways do you use resources and teaching strategies to promote culturally relevant and sustaining learning experiences for your students?

- What are some key concepts and skills in science that you feel your students should develop that will help promote sustainability in Hawaiʻi today?

- How important is it to you as a science teacher to address not only environmental/ecological issues in the classroom, but also historical and current sociocultural and political issues, both local and global?

Follow-up interviews and member checking. Final follow-up interviews were done in fall 2017 to complete the *member checking* process, whereby I discussed my preliminary findings with each teacher on what their identity narratives were revealing about eco-identity development and shaping. This co-construction of findings about science teacher eco-identity with member checking became a way to ensure that teacher voice was being authentically and ethically represented (Charmaz, 2006; Macedo, 2000). In the summer and fall months of 2017, I conducted these follow-up interviews with each teacher, which lasted 40 to 60 minutes. The follow-up interviews captured new events and/or situations relating to their practices as science teachers and how they continued to view themselves as situated in this community of practice. The last set of main interviews took place in 2014 and 2015 and it was therefore necessary to now conduct these follow-up interviews in order to gather current experiences that may have influenced construction and reconstruction of eco-identities. The multiplicity, discontinuity, and social nature of identity (Beauchamp & Thomas, 2009), follows dynamic, narrative processes (Alsup, 2006; Meijer, Korthhagen, & Vasalos, 2009) and therefore required such follow-ups.

Revised NEP Scale Questionnaire. After the first interviews with each teacher, I asked each to complete a 15-statement Likert scale questionnaire: the revised *New Ecological Paradigm (NEP) Scale* (see Appendix F). The *New Environmental (NEP) Scale* was initially published in 1978 by Dunlap and Van Liere and then revised in 2000 (Dunlap, Van Liere, Mertig, & Jones) to address a wider range of perspectives, including an ecological worldview. The revised version offered a balanced set of pro-NEP and anti-NEP (Dominant Social Paradigm, or DSP) items in a Likert-based format of 15 statements. The Dominant Social Paradigm (DSP) posits endless progress, growth, and abundance from a human standpoint, which contributes to environmental degradation and exceeding capacity with respect to environmental limits. The pro-NEP ideology on the other hand, highlights these disruptions and environmental degradations to give an alternative worldview (alternative to the DSP) which is an ecological or *eco-centric worldview*. This NEP Scale was therefore created and revised by Dunlap et al. (2000) to offer a means to account for the wider view of relationships between modern societies and the environment and proposed shifts in people's worldviews, from a dominant anthropocentric, human-centered one to an eco-centric one with humans seen as part of nature rather than being above it.

At the start of the second interviews I reviewed the questionnaire responses with each teacher as a means to help each participant to think more deeply about what her/his values and beliefs about the environment were at the present time and how this may have changed over the years and potentially influenced by external factors and lived experiences. In addition, to encourage discussions on environmental values and beliefs and teacher connections to places, I added an open-ended question at the end of the questionnaire:

> Where do you feel most connected? This place could be specific (your house, a particular park or beach, your school, etc.) or a broader type of place like beaches, forests, parks, cities, or towns. Explain briefly as to why you feel connected to this place. (see Appendix F)

Informing the qualitative case study. Through member checking during the interviews I was also able to discern teacher perceptions on their epistemologies with respect to learning science and teaching science in multicultural settings.

I reviewed a multitude of instruments used in quantitative studies in experimental psychology along with guidelines and rubrics developed from studies of critical pedagogy of place (Gruenewald, 2003a, 2008) and culturally responsive teaching (Ladson-Billings, 1995), to then select this revised NEP Scale questionnaire (Dunlap, et al., 2000) commonly used in environmental psychology. While surveys measuring aspects of sense of place and pro-environmental behaviors in individuals and communities are typically used in large scale, mixed methods research (Dunlap & Van Liere, 1978; Dunlap et al., 2000; Kellert, 1996; Thompson & Barton, 1994; Weigel & Weigel, 1978), I utilized this questionnaire to inform my qualitative case study.

Recent original research by Yang, Lam, and Wong (2010) validated an instrument for identifying secondary teachers' beliefs about education for sustainable development on a large scale that would support future quantitative research as a means for "tapping teachers' beliefs" (p. 195). To reiterate, my study utilized the revised NEP Scale questionnaire (Dunlap et al., 2000) solely as a purpose for guiding the discussions on science teacher environmental beliefs and values, and sense of place. Unlike the larger, mixed methods forms of research, the NEP Scale questionnaire in my study was used only to encourage discussions and make potential connections of eco-identity with pro-environmental behaviors of the science teachers.

Teacher Artifacts: Extant Texts. A final source of data as part of the narrative inquiry process included collecting teacher *artifacts* in the form of written reflections, e-mails, phone conversations, commercial video recordings of interviews (outside of the DOE setting and done by other parties), and contributions to published documents in the field of science education. During the interview process, several teachers willingly shared artifacts attesting to their teaching of place-based science in a Hawaiian cultural context. Since I was unable to participate and support teachers in the classroom for my study, this kind of sharing of artifacts became essential for building rapport and increasing levels of comfort with each participant. In the field of community psychology Kelly (1986) defines an ecological perspective in research that "involves a commitment to a relationship where there is self-consciousness and care about the reciprocal exchange of resources that have complimentary benefits" (p. 581).

Qualitative researchers utilize, in addition to interviews, supplementary sources of data that can come in the form of text and video/photographic images. They may be used as "objects for analytic scrutiny themselves rather than for corroborating evidence" (Charmaz, 2006, p. 35).

Extant texts are forms of data that are appropriate for constructivist grounded theory research. As a researcher I had no influence on the shaping of documents that were voluntarily shared with me during and after the second and final interviews. These artifacts were used in addition to the interviews as part of the textual analysis process. They provided raw narrative sources for thinking and re-storying to better understand the identity process (Liu & Xu, 2011) and more specifically eco-identity development and shaping.

Data Collection Timeline

Methods of narrative inquiry for data collection were described in the previous section. The data collection with respect to the interviewing (main interviews) and secondary literature review occurred between years two (2013) through four (2015). The extended period of interviewing was interrupted at times throughout the entire six-year period of my dissertation research due to personal health issues. While the multiple case studies design of my research extended for several years studying, it was not a longitudinal study but rather it involved interaction with a small sample of individuals in a dialogic process of storying. A subjective and interactionist approach to data collection (Charmaz, 2006) therefore excluded my study from being considered a longitudinal study. I audio recorded the 70 to 100-minute interviews and transcribed them verbatim, with memo writing and preliminary findings (initial codes) added to these transcriptions.

I began the process of transcribing each interview (first and second interviews) in the spring of 2015 but was met with health issues in the fall of 2014 and also took a medical leave of absence in 2015. Moreover, I had experienced data loss in 2015 with a hard drive crash in my computer and was not able to recover any of the transcriptions. While not able to obtain a transcription service and with the advent of having to redo and continue these transcriptions myself, I found this process critical to my understanding of teachers' meaning making processes with identity work.

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Seidman (2006) attests to the essentiality of full transcriptions of interview recordings in narrative inquiry:

> The participants' thoughts become embodied in their words. To substitute the researchers' paraphrasing or summaries of what the participants say for their actual words is to substitute the researcher's consciousness for that of the participant. Although inevitably the researcher's consciousness will play a major role in the interpretation of interview data, that consciousness must interact with the words of the participant recorded as fully and as accurately as possible. (p. 114)

In 2016 and up through the final interviews with each teacher in 2017, I member-checked transcriptions, notes, and emergent codes and categories with each teacher as well as continuing to conduct the memo writing. I revisited the data, revisited my research questions and revised them to address emergent issues and dilemmas, and continued to make comparisons among incidents and emergent patterns within each case study (single teacher) and across all six teachers' lived experiences as retold during our interviews. I utilized the constant comparative method to conduct such analyses on events and situations and emerging categories while also maintaining an interpretive form of inferencing that focused on abduction, rather than strictly adhering to the process of induction (Strauss & Corbin, 1998). I continued to do the memo writing with conceptualizations of teachers' identity narratives in the form of identity mapping.

As a "no preconceptions" methodology (Glaser, 2016) with grounded theory research, I further reviewed literature common to the emergent theoretical codes arising from my data. Glaser (2001) recommends delaying the literature review in order to prevent the researcher from utilizing any pre-established concepts and focusing on predetermined problems during analysis. Thus, the majority of the literature review took place after the data were collected and analyzed, up through second cycle coding.

Over the months of July through September of 2017 I revisited the data and met with each teacher one final time for shorter follow-up interviews. This answered questions I had regarding the data and allowed me to reach a saturation point with the information gathered. Table 3.3 on the following page summarizes the data collection timeline.

Table 3.3
Data Collection, Initial GT Analysis, and Literature Review Timeline

Year One (2012)	Year Two (2013)	Years Three (2014) and Four (2015)	Years Five (2016) and Six (2017)
• Reviewed relevant research on topics of science teacher identity, professional development, environmental psychology, and environmental science education curricula. • Received exemption status approval for study from UHM Human Studies Program in September 2012. • Contacted and asked eight science teachers in the state of Hawaiʻi about participating in my research. • From preliminary conversations with eight science teachers, received commitment from six science teachers who agreed to participate. • Conducted short pre-interviews to obtain background information of each prior to the main interviews.	• E-mailed research narrative and guiding questions to each teacher prior to first interviews. • Did not receive HI DOE approval for in-school research in spring 2013 and proceeded with revised study. • Obtained formal consent to participate after with signed adult consent forms. • Met with three of six teachers for first of two main interviews. • Audio recorded each interview (lasting 70 to 90 minutes each) along with writing notes and memo writing. • Continued research on topics of measuring environmental beliefs and values and grounded theory methodology. • Selected questionnaire for teachers: revised New Ecological Paradigm (NEP) Scale and constructed open-ended question to add to questionnaire.	• Conducted two, first-time, and five, second-time interviews with teachers; took notes and proceeded with memo writing. • Audio recorded interviews (70 to 100 minutes each). • Began interview transcription (spring 2015) and was interrupted to due to personal health issues (medical leave of absence) and loss of data (hard drive crash). • Prior to the final, main interviews with all six science teachers, E-mailed revised NEP Scale questionnaire with one open-ended question. Asked them to complete this prior to the interview. • During the second interview reviewed responses and engaged in discussion regarding environmental values and beliefs and sense of place.	• *Restarted* data transcription, conducted two cycles of coding, and continued member checking with each teacher. • From the emergent patterns, codes, and categories, was prompted to revisit existing literature on science teacher identity development and negotiation of multiple identities across time and space. • In the summer through fall 2017, met with each teacher one final time and conducted follow-up interviews (40 to 60 minutes each). • Discussed recent life events and situations influencing further changes on science teacher identities, to reaching saturation point with my data collection. • Further memo writing was done to analyze the data and conceptualize categories and theoretical codes.

Note. (a) UHM = University of Hawaiʻi at Mānoa; (b) For one teacher (Lynne) I interviewed her once for an extended period of 100 minutes; (c) I kept all of this information in a secure location over the six-year period of this study.

Data Analysis

Constructivist Grounded Theory as an Analytical Process

As I have noted in the rationale and theoretical framework for the use of constructivist grounded theory, the processes for analyzing the teacher narratives, the revised NEP questionnaire, and extant data served to situate their accounts within sociocultural and physical contexts. In addition, the extant texts from the teacher artifacts revealed beliefs, values, and intentions, and sometimes unintended responses to the audiences those texts were directed at (Charmaz, 2006).

Analyzing the Narrative Pieces. The narrative inquiry process for data collection produced narrative pieces from the interviews (primary source of data), revised NEP Scale questionnaire, and teacher artifacts. The analysis and compilation of results of these teacher narratives followed grounded theory logics (Glaser & Strauss, 1967; Strauss & Corbin, 1998) of theoretical sensitivity, coding, constant comparative analysis, and memo writing. A flexible but systematic, constructivist approach was taken for the data collection and analysis, whereby with each teacher we co-constructed meanings of what it meant to have an eco-identity, with the understandings of contextualization relative to time, place, culture, etc. (Creswell, 2008; Guba & Lincoln, 2005). I used the constant comparative method throughout the analytical process while also maintaining reflexivity (Charmaz, 2006), to acknowledge biases and researcher perspectives I imparted during the cycles of coding in constructivist grounded theory:

- continuous analysis/re-analysis with the first through second/third interviews with each teacher;
- memo writing in a journal book to elaborate on categories and (re)define relationships;
- identifying gaps in the stories and seeking clarification and confirmation with codes, categories, and themes/concepts emerging from the data through member checking and the constant comparative method;
- conducting further literature review after developing an independent analysis of these teacher narratives; and
- potential theory development (first with theoretical codes) throughout the data collection and analysis process. (Charmaz, 2006; Glaser & Strauss, 1967; Strauss & Corbin, 1998)

Coding in Constructivist Grounded Theory Practice

     Saldaña (2013) notes that coding is "only the initial step toward an even more rigorous and evocative analysis and interpretation," and "not just labelling" (p. 8). Throughout the interviewing, literature reviewing, and memo writing processes and with four major rounds of coding, I recoded, further managed, and highlighted emergent findings to capture salient points in the teachers' stories and artifacts gathered. I did not perceive the coding as reductionist because I was able to corroborate with each teacher to uncover and support the meaning making processes of multifaceted identities in a symbolic interactionist manner (Charmaz, 2006; Saldaña, 2013). Qualitative codes, advocates Saldaña (2013), "are essence-capturing and essential elements of the research story that, when clustered together, according to similarity and regularity (pattern), they actively facilitate the development of categories and thus analysis of their connections" (p. 8). By capturing and linking the data, coding involves the categorization of segments of data and giving a short name to the data that summarize and account for each piece of data, while also requiring the researcher to constantly ask analytic questions of the data collected (Charmaz, 2006).

     First cycle coding. Saldaña (2013) characterizes the coding process as cyclic due to the nonlinear and iterative nature of analyzing the data. Thus, I refer to the initial coding process as *first cycle coding.* In this first cycle of coding I utilized the *in vivo* and *open coding* methods for this initial process of understanding the raw data in the form of transcribed interviews and extant texts (teacher artifacts that included e-mails, contributions to published work, and video interviews). The initial phase of first cycle coding involves the naming of each word, line, or segment of data, and should stick closely to the data itself, without applying pre-existing categories, curbing the tendency to conceptualize and/or make theoretical assumptions (Charmaz, 2006).

     In vivo and open coding. In first cycle coding I considered actions and using short codes, going line-by-line and sticking close to the data itself, first utilizing the in vivo process (Glaser, 1978; Glaser and Strauss, 1967; Strauss & Corbin, 1998) which is often referred to as "literal coding" and "indigenous coding," due to using the actual language used by the participant themselves (Saldaña, 2013). It was the first step as a grounded theory researcher that prioritized and honored the participants' voices.

Next, taking the interview data I initially generated as many codes using the following logic:

(1) subjects of focus in the data,

(2) perspectives from which the person being interviewed is speaking from,

(3) specific processes taking place as the person tells the story, and

(4) how this person acts and thinks while involved in specific processes. (Charmaz, 2006).

The data within each category were explored further to gain richer and deeper ("thick") understandings of what these emergent concepts meant in the specific case of each teacher. My goal of initial coding was "to remain open to all possible theoretical directions indicated by readings of the data" (Charmaz, 2006, p. 46).

For the entire coding process of this study, I did this manually rather than focusing on any of the sometimes, complex instructions and multiple functions of qualitative data analysis programs. For open coding I printed out the transcripts for each interview and highlighted key phrases and words (in vivo coding) that focused on specific events and situations and how the person felt, and the behaviors and any changes in attitudes and beliefs arising from these actions. Saldaña (2013) offers this advice for first-time or small-scale studies:

Code on hard-copy printouts first, not via a computer monitor. There is something about manipulating qualitative data on paper and writing codes in pencil that give you more control over and ownership of the work. (p. 26)

I conducted in vivo and open coding with Word documents, highlighting important ideas with colored pens. I transferred all information to Excel spreadsheets and used highlights, colored fonts, and shaded sections to emphasize emergent codes and categories, alongside the interview notes. I continued memo writing in a journal. I combined both in vivo codes (actual teacher words/phrases) with open coding for the first cycle using Excel spreadsheets. Table 3.4 (p. 96) lists 30 of the 79 initial codes I arrived at after first cycle coding. These open codes were phrases focused on the literal, in vivo codes to conceptualize how teachers were feeling about events and situations and the kinds of actions and processes taking place in their stories.

Table 3.4

First Cycle Coding: Science Teacher Open Coding Samples (After In Vivo Coding)

Data Sources	Open Coding	
• Interview Transcripts and Interview Notes • Revised NEP Scale Questionnaire with Open-Ended Question • Extant Texts • E-mail correspondence • Memo Journal	Understanding one's role as a science teacher **Negotiating multiple identities** Understanding Western science as a process for learning and studying **Being concerned with global environmental changes** Changing behaviors comes from within Becoming ecologically literate through educational experiences Finding meaning with natural places Being "turned on" by the environment Wanting all students in Hawai'i to be exposed to outdoors and Hawaiian culture Finding importance with field studies **Connecting science with Hawaiian culture and technology** Talking about issues in the environment Caring about the environment Feeling proud of students' accomplishments Supporting future generations in Science	Contemplating changing careers Feeling underpaid as a teacher Feeling unappreciated as a new/novice teacher **Finding one's calling** as a high school science teacher over time Finding meaning working with students from varied backgrounds **Merging personal and professional lives** Perceiving oneself as learner and teacher Being culturally responsive as a science teacher Adapting science teaching to places and cultures Culturally sustaining pedagogy **Developing sense of place in Hawai'i** **Becoming a reflective practitioner** Teaching as a humbling experience Teaching as a lifelong profession Feeling accomplished as a science Teacher

Note. Bolded statements were refined and focused on for second cycle coding.

Second cycle coding. After successive coding the number of codes became smaller and more focused to eventually develop a more select list of broader categories, concepts, themes and/or assertions (Saldaña, 2013, p. 207). In Table 3.4 above, I also used boldface fonts to highlight the common categories arising from first cycle coding. With second cycle coding, the methods became advanced ways of reorganizing and reanalyzing the data, and in grounded theory analysis I utilized *focused coding* and *theoretical coding* to eventually arrive at a conceptual form of organization to create the science teacher eco-identity maps and make generalizations specific to the multiple case studies of these six science teachers. In qualitative data analysis and in grounded theory analysis in particular, methods of second cycle coding are neither prescriptive nor inflexible (Charmaz, 2006; Glaser & Strauss, 1967; Saldaña, 2013).

Focused coding. As part of second cycle coding process and following the in vivo and open coding methods I followed this streamlined adaptation of *axial coding* in classic grounded theory: focused coding.

Subsequent publications by Strauss and Corbin (1990, 1998) suggested a type of coding called axial coding, relating to categories and subcategories, the sorting, organizing, and synthesizing of large amounts of data, and reassembling them in new ways. Charmaz (2006) contends that while axial coding may help researchers explore their data it encourages them to apply an explicit analytic frame to the data, which may be limiting how and what learn about their studied worlds, thus restricting the codes they construct. Charmaz offers caution here and therefore in the constructivist grounded theory approach for coding, axial codes and its streamlined version of focused coding are used to help clarify and sharpen the analysis, but not impose a forced framework upon the analysis (2006, p. 62).

Focused coding in grounded theory analysis is more directed and selective, and conceptual in nature, while still remaining focused on the data itself. During focused coding, notes Charmaz (2006),

> A key process and mindset to avoid is to impart one's own perspectives and prior
> experiences as 'truth,' when coding the data. Seeing the world through their eyes and
> understanding the logic of their experience brings you fresh insights. (p. 54)

The goal of focused coding is to develop categories and sub-categories relating codes while in the process of "comparing newly constructed codes across other participants' data to assess comparability and transferability" (Saldaña, 2013, p. 217). This called for the identification of commonalities and differences in each category of the cultural, historical, and behavioral, action-oriented frameworks (Strauss & Corbin, 1998) of each teacher, as s/he traversed the landscapes of science teaching in Hawai'i. I attempted to discern the dynamics amongst multiple contexts particular to each teacher: a multifaceted eco-identity, shifting perspectives due to situations and events, and the existence of conflicting identities which interacted in a dialogic process of meaning making (Akkerman & Meijer, 2011).

From the first cycle coding (see Table 3.4 on page 96 for sample open codes) and second cycle focused coding I reviewed the emergent conceptual codes, noting the dominant ones common to all that characterized and initially defined emergent eco-identities for each teacher. I reorganized the data to develop categories and sub-categories and also found differences with ranges and levels of these conceptual codes. I utilized the second interview narratives to further refine and shape these focused codes to ensure that they were grounded in the data.

The constant comparative method (Glaser, 1998; Strauss & Corbin, 1990) was employed to check for similarities and differences amongst the teacher narratives with respect to eco-identity development and negotiation. At this point in the grounded theory analysis I looked for *transferability* to see if these sharpened conceptual codes characterized an eco-identity with respect to these six science teachers.

From this focused coding I arrived at four main categories organizing the conceptual codes that explained the common situations and processes influencing science teacher eco-identity development. Displayed in Table 3.5 below, are the four categories arising from focused coding: (a) thinking like an island (b) negotiating roles as a science teacher and teacher of science, (c) becoming a reflective environmentalist, and (d) bridging knowledge systems. Sub-categories and conceptual codes further refined the characteristics of an eco-identity that I was witnessing as commonly existing in these science teachers.

Table 3.5

Focused Coding with Emergent Categories and Conceptual Codes

Main Categories:	Thinking Like an Island	Negotiating Roles as a Science Teacher and Teacher of Science	Becoming a Reflective Environmentalist	Bridging Knowledge Systems
Sub-Categories:	• Sustaining natural resources • Understanding an island ecosystem • Merging Hawaiian cultural and modern practices for *living like an island* • Sustaining Hawaiian culture	• Structure and adaptive structure • Expectations in teacher education programs • Fitting in the science teacher COP in Hawai'i • Adapting to environmental changes • Finding a sense of agency • Merging personal and professional lives	• Valuing the environment • Connecting spiritually, culturally, and religiously to places • Thinking critically about human impact on Earth • Developing agency	• Promoting 21st century skills (Western science) • Sustaining Hawaiian culture and Hawaiian knowledge system ('Ike Hawai'i) • Acknowledging multiple epistemologies
Conceptual Codes:	Island Biogeography Sustainability Ecosystem	"Authentic carer" Mastery learning Situated/experiential learning	Biophilia Eco-centrism Anthropocentrism Sense of place	Critical pedagogies of place Land education

Note. (a) Island biogeography theory (MacArthur & Wilson, 1967); (b) "Thinking like an island" concept (Chirico & Farley, 2015); (c) structure and adaptive structure in COP as defined by Sewell (1992); (d) "authentic carer" (Savage et al., 2011); (e) situated/experiential learning in historical and current sociocultural contexts of Hawai'i.

Theoretical coding. For the final, second cycle process of the grounded theory methodology I looked to the teacher artifacts shared with me during and after interviews: teacher contributions of writings to books, e-mail correspondence, and video interviews. In this second cycle process of *theoretical coding*, I refined and reorganized the conceptual codes attributed to the characteristics of science teacher eco-identities and the processes with which this kind of eco-identity negotiation occurs. Further within and cross-case (amongst the teacher participants) analyses took place along with member checking. Additionally, I reviewed literature relevant to the emergent patterns and relationships coming from the categories and conceptual codes of first and second cycle coding. In line with grounded theory methodology and the "no preconceptions" mindset (Glaser, 2016), I then began a more extensive review of the literature to gain insights on science teacher identity development and its impact on practices and continued work in the field. The follow-up interviews in 2017 supported this co-construction process allowing me to further conceptualize what it means to have an eco-identity as a science teacher, how this develops and is negotiated over time and space, and what external situations and/or events continue to influence these teachers' eco-identities.

While not the grounded theory itself, these theoretical codes became the umbrella linking all categories and subcategories from the focused coding (Table 3.5, p. 98) to a *central/core category* (Saldaña, 2013). In order to take the codes and categories to a higher level, I sought to describe the processes of unique science teacher eco-identity development in Hawaiʻi for these individuals, which could be described under a common theme. This core category became that theme—the common thread leading up to the grounded theory. Charmaz (2006) notes that "a theoretical code specifies the possible relationships between categories and moves the analytic story in a theoretical direction" (p. 63). With *theoretical sampling* I revisited my codes and categories and more importantly went back to sources of my data in the narratives, the extant texts, and the related literature. With such sampling I was to ensure a saturation point, with the understanding that the level of generativity could transcend the particulars of these case studies. This enabled transferability to comparable contexts of: (a) island biogeography, (b) veteran (beyond five years of teaching) secondary science teachers, (c) those who have adapted their practices to be culturally responsive and sustaining, and (d) bridging multiple knowledge systems in science education.

I moved beyond the codes and categories of sampling to define the boundaries of what was emerging from these case studies, without transcending too high, to not lose sight of "more insightful origins" (Saldaña, 2013, p. 249).

In theoretical coding I linked the categories and sub-categories from focused coding (Table 3.5, p. 98) to make the connections to the processes of identity making. I continued to ask myself the questions of "how" and "why" this process of eco-identity development occurred and why this was significant. In theoretical coding, the four categories and sub-categories identified after focused coding became systematically linked with the central/core category. This core category explained a unique science teacher eco-identity development and why this was important: *Eco-Identity as a meaning making process supporting one's calling as a science teacher*. What emerged was a taxonomical system of the four generated categories from focused coding, with each category having equal weight when characterizing science teacher eco-identity development and negotiation as situated in Hawai'i. An overarching theme (core category) emerged as a means for explaining what keeps these science teachers going.

As a researcher I was reminded of the integrated nature of the theory-building process and that I "do not categorize and then connect" and instead "connect by categorizing" (Dey, 2007, in Saldaña, 2013, p. 216), which is what I have organized in Table 3.6 (p. 101). I selected narrative pieces to support each of the four categories and wrote an interpretive summary of how each relates to the overarching theme (core category) of finding one's calling as a science teacher. Glaser (2001) notes that while not the theory itself, the theoretical code is an abstraction that models the integration (p. 17). I was also able to connect the main categories from focused coding to explain how having such an eco-identity may have impacted their practices as science teachers, and how they are unique but also similar in the sociocultural context of Hawai'i.

Table 3.6

Core Category Supported by Theoretical Coding

Core Category: Eco-Identity as a Meaning Process Supporting One's Calling as a Science Teacher		
Theoretical Code	Datum Supporting Theoretical Codes	Interpretive Summary Linked to the Core Category
• Thinking Like an Island Promoting Living Like an Island	Ed: We do have a lot of renewables…if I were to run Maui Electric I would place big solar fields right outside of Kīhei…every day that I drive through there it's sunny. If you use the wind and the Sun, you could take care and not have to use the oil.	*Island biogeography* promotes *thinking like an island* which in turn facilitates *living like an island* with the understanding of *traditional ecological knowledge* and Western scientific principles to support sustainability.
• Eco-Identity as a Meaning Making Process • Balancing Agency and Structure in a Community of Practice	Malia: I think that's been a struggle throughout my career. It's like, what am I teaching? I know that there's standards. I understand that and now the question becomes: what is relevant to their lives and/or how do I prepare them for college? Those are two different things: what is relevant to their lives and how I prepare them for college.	*Eco-Identity* is a *meaning making process* for science teachers based upon the lived experiences and sociocultural contexts. *Eco-identity* is *multifaceted*, *dynamic*, and *complex*, and is negotiated as situated in a science teacher *community of practice*.
• Developing Agency Through Biophilia and Sense of Place • Becoming a Reflective Environmentalist	Lynne: I've been vegan for 14 years and one of the reasons I decided to do that was I really became more aware of where my food came from and what went into making food. I became very aware of the impact on animals and also the environment and decided that it was too much to ask…especially since we have the knowledge and the ability to choose and then have less impact on the Earth.	*Agency* is developed through valuing the natural environment and seeing oneself as part of nature through *biophilia*. Having a *sense of place* is finding meaning and attachment to places that warrant *pro-environmental behaviors*. Science teachers who think deeply about their roles in education and society as a whole are *reflective environmentalists.*
• Multiple Epistemologies Equals Multiple Pedagogies	Doc Burrows: So, my teaching of science was not only in the classroom. Whatever we do, we always involve Hawaiian cultural studies as well, like the Hawaiian archaeology, cultural hikes, doing coastal plant transects along the way, getting into the water and doing marine transects, looking at the *limu* and so forth."	Understanding that everyone can bring different ways of knowing to the classroom with *multiple epistemologies*, teachers utilize *multiple, culturally sustaining pedagogies*. This includes outdoor learning, cultural studies, experiential learning, and *bridging knowledge systems*.

Analytic Memo Writing

Charmaz (2006) notes that as part of the grounded theory process, memo writing is the "pivotal intermediate step between data collection and writing drafts of papers…Memo writing constitutes a crucial method in grounded theory because it prompts you to analyze your data and codes early in the research process" (p. 72). Early memos entail recording what is seen happening to the data in the field setting and within interview accounts, what people are doing and saying, and what the contexts which these statements and actions emerge. Advanced memos will then lead to tracing and categorizing the data, describing how the category emerges and changes, identifies any beliefs/assumptions, includes varying perspectives, and makes comparisons. The "conceptual element in a theory" (Glaser & Strauss, 1967) is the conceptual category which emerges from memo writing and further focused codes.

In addition to systematic analysis for arriving at conceptual codes, memo writing can also help the researcher to "uncover information through informed hunches, intuition, and serendipitous occurrences that, in turn, will lead to a richer and more powerful explanation of the setting, context, and participants in any given study" (Janesick in Saldaña, 2013, p. 41). Memo writing can therefore support both theoretical interpretations and going back to the empirical evidence and help the researcher to manage any tensions between inductive and abductive reasoning (Charmaz, 2006). Abductive inferencing also takes place with the examination of all data, entertaining all possible explanations for the observed data, and coming to plausible interpretations by the end (Strauss & Corbin, 1998).

The memo writing took place throughout the study and served to help me as a researcher to document and reflect upon emergent patterns, categories and sub-categories, themes, and concepts in the data. I maintained this ritual of memo writing in a journal to help me sort out the codes, observe and further analyze what was going on with each teacher as s/he negotiated identities over time and space. I also diagrammed patterns and connections for each teacher as a case study, to end up with six, unique eco-identity maps described in Chapter 5. In Figure 3.1 (p. 103) I extracted a sample memo writing piece from my journal. This is with respect to an advanced memo comparing individual cases of the three retired science teachers and what keeps them going in the profession and beyond (post-retirement work in the same field).

Figure 3

Sample Memo Writing Extracted from Journal Book

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9/10/17

Memo: What keeps these science teachers going?

Doc Burrows had been teaching both formally and informally for 40 years and Eddie and Ed have also been teaching for over 20 years each. I wonder what keeps them going. Why do they continue to do what they do, even after retirement?

For Doc Burrows, his passion and commitment to restoring environments and continuing to educate others (including visitors to the State) is still very strong. He has also had great impact on his students, like the one apprentice navigator on the Hōkūleʻa. Transformative learning and mastery learning were a part of the practices that Doc Burrows followed as a high school teacher. His students learned by doing and also by having experts model for them and teach them the proper skills to work on conservation projects. Doc Burrows sees himself as a science teacher who brings in community experts and Hawaiian culture to the learning. He is humble with what he professes to know and practices a community-focused and culture-based education to this day. Is this due to a developed eco-identity?

For Eddie, he is not originally from Hawaiʻi but is deeply connected to the ocean and marine environments of our Islands and continues to be fascinated with studying it and wanting to protect all aspects of these environments. Eddie lives his everyday life like a scientist and will continue to be this way even as a retired science teacher. I can see how his ways of thinking and doing as a scientist, science teacher, and lover of all living things have even impacted his wife, a colleague whom I've worked with in education. Can this be because of a strong eco-identity as well? While these eco-identities are unique to each teacher can identity-making also have similar characteristics?

Ed is passionate about seeing his students succeed with the Ocean Bowl and Science Bowl competitions and continues to coach students and volunteer with teaching an AP chemistry at the high school where he retired from teaching. What I've come to know about Ed is that his experiences as a K-12 student from the plantation on Maui have greatly influenced who he is today and why he continues to do what he does. At first, I wasn't hearing how he cared not only for his students but also for the environment. I see it now. Watching the video interview he did for a Maui television program and our second meeting helped me to see a different side of him. I now saw him as an "authentic carer," because he went above and beyond to help his students not only succeed with the bowl competitions but also with becoming self-confident and empowered to make a difference in the world.

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Limitations of the Study

Time Restraints with Respect to a Case Study Approach

Time was an obvious limitation to my study, as the grounded theory process and the qualitative nature of my study required an inordinate amount of time to collect data, transcribe information, conduct member checking and constant comparative analyses, and co-construct knowledge with the subjects (science teachers).

In years two (2013) through four (2015) of my research (see timeline in Table 3.3, p. 91) I proceeded with the main interviews (two per person), which included extensive literature review of related emergent theoretical codes. In fall 2017 I conducted the final follow-up interviews with each science teacher, ensuring a saturation point for theoretical sampling. I anticipated, with a small scale, a multiyear study of six secondary science teachers that would produce rich and descriptive accounts of these teachers' storied lives in the form of eco-identity narratives. I have attempted to showcase these voices as valid and authentic in terms of individual eco-identities.

Generalizability of Case Studies in Grounded Theory

Glaser and Strauss (1967) noted that there are challenges to the credibility, plausibility, and trustworthiness in sociological research. Thus, the grounded theory framework guiding this study also limited my research in that it was at times flexible with respect to methods and techniques, going against the canons of rigorous quantitative verification on such issues of sampling, coding, reliability, validity, conceptual formation, hypothesis construction, and presentation of information (Glaser & Strauss, 1967). A report on the generalizability of using case studies for grounded theory research in science education (Taber, 2000), however, contends that there are testable outcomes with respect to using grounded theory approach to look into the learning of science, and consider the generalizability of these results based upon testable predictions developed through methods associated with grounded theory.

The process of transitioning from theoretical codes and concepts to a grounded theory is not a given, and Saldaña (2013) contends that "many theories are provisional; thus, language should be included that supports the tentative nature of our proposals (e.g. 'may occur,' 'tend to')" (p. 250). Entering the analytical arena associated with grounded theory was not a guarantee that I would develop such a theory and I had to constantly remind myself that the rigors of grounded theory methodology would ensue, no matter what the outcome. Even in constructivist grounded theory and utilizing a dialogic approach under the sociocultural theory framework, I was cautious with characterizing teachers and making comparisons with respect to their attitudes, beliefs, epistemologies, and lived experiences.

The empirical works of Alsup (2006), Beauchamp and Thomas (2009) and Akkerman and Meijer (2011) stress the multiplicity with teacher identities that can be disruptive and conflicting and how this is dependent upon the situation and what is encountered in practice. A cautiousness with characterizing teachers and making generalizations was heeded and is explained by Akkerman and Meijer (2011):

> Categorizations of teachers are often treated as attributing a set of characteristics to the teacher as an individual, neglecting how these are informed and developed by the social environment and perhaps maintained by cultural conditions. Acknowledging the multiple, situated and social nature of identity calls for care with using static and individualistic categorizations. Alternatively, it would be of interest to study the dynamics of a teachers' identity, describing in more detail the self-dialogue that is pursued by a teacher in striving to maintain a coherent and consistent sense of self. (p. 316)

With grounded theory as a methodology for my study I worked to be mindful of my own biases and my own assumptions, values, beliefs, and feelings.   As a former secondary science teacher with a background in Western, positivist perspectives with respect to learning science, I also added subjectivity to my study. As an aspiring educational researcher in the interpretivist school of thought, I referred to the following characteristics of a grounded theorist to frame my study:

- an ability to step back and analyze situations critically,
- an ability to recognize the tendency towards bias,
- to be able to think abstractly,
- an ability to be flexible and open to criticism,
- having sensitivity to words and actions of respondents, and
- upholding a commitment and sense of agency with respect to this research process (Strauss & Corbin, 1998).

Epistemological Discomforts

My choice of constructivist grounded theory as a methodology required me to become aware of what appears to be systematic and scientific in terms of procedure, as actually flexible and continuously evolving. As I collected the data, conducted analysis, and revisited the data, literature, and participants to gain more information, I was then able to construct meanings in the form of concepts and eventual theories (Charmaz, 2006; Piantanida et al., 2004).

An *epistemological discomfort* (Piantanida et al., 2004) challenged me to reconsider and reshape my assumptions as an educational researcher and science teacher. With the participants of my study we reconstructed lived experiences in collaboration and attempted to co-construct meaning from these stories. Thus, a potential limitation to my study was the nature of my own identity and the sociocultural underpinnings that I brought to the study as a locally born and raised, non-Hawaiian, science educator. I was schooled in a Western framework with a personal epistemology rooted in the biological and environmental sciences.

In addition to being a participant and observer in my study, I also considered myself as an "outsider" with respect to my research context embodying Hawaiian ways of knowing in a place-based science education program, still rooted in Western values and ideologies. Along with questions of my own eco-identity and its development over time as a science teacher, I also questioned my positionality as an Asian American woman attempting to study how Hawaiian ways of knowing and traditional ecological knowledge (TEK) could be considered valid and effective in Western-based educational systems today. Who am I to suggest this? As a science educator living and practicing in Hawaiʻi, I do perceive myself as having a strong sense of place in the Islands and with the natural environment in particular. I became very aware of the nature of my study. My own biases stemming from a Western science education and being Asian American could impact my perceptions of a Hawaiian knowledge system co-existing with Western science in our schools today.

CHAPTER 4: RESULTS

ʻŌlelo Noʻeau: He pūkoʻa kani ʻāina.
A coral reef that grows into an island. (Pukui, 1983)

Research Focus and Understandings of Eco-Identity

This Hawaiian proverb handed down through oral tradition and gathered by Mary Kawena Pukui in the ʻŌlelo Noʻeau (1983) reminds us that a person's identity, beginning in a small way, gains steadily like the young coral until becoming firmly established as an island. Science teacher eco-identity is unique to each person and grows and develops steadily over time and space. This chapter presents the meaning making stories of eco-identity as told and re-told, constructed, deconstructed, and reconstructed by six science teachers.

The restorying process reflects a reinstatement of why these science teachers continue to practice both formally and informally in Hawaiʻi and continue to identify as "science teachers" and "teachers of science."

Recapitulating the Research Questions

The focusing research question and sub-question that guided these eco-identity narratives were:

- Focusing Research Question

As a secondary science teacher in Hawaiʻi what does it mean to have an eco-identity and why might this be important?

- Related Sub-Question

How do secondary science teachers negotiate their eco-identities over time and space and how does this impact their practices as situated in the sociocultural contexts of Hawaiʻi?

What Characterizes an Eco-Identity and Why is This Important?

While in the beginning, the interviews were more formal as I described my research objectives, defined eco-identity (Thomashow, 1995), and provided guiding questions, they became more conversational with each meeting. Because this research used a co-constructive process, interview time did not dwell on defining the term eco-identity, but rather allowed teachers to tell and re-tell their stories about becoming, and sustaining themselves as a science teacher in Hawaiʻi. Since teachers shared their experiences in a reiterative narrative process (Ewing, 2016) the stories often overlapped and were not in chronological order. Events and dilemmas, choices made, and the consequences of these actions taken were discussed as related to eco-centric and anthropocentric values and beliefs.

Science Teacher Meaning Making Process of Eco-Identity

As a result of theoretical coding, memo writing, and member checking discussed in Chapter 3, I linked categories and sub-categories from focused coding to the emergent theoretical codes to make sense of eco-identity development and shaping. What emerged from the data analysis were four categories that characterize an eco-identity as a meaning making process: (a) becoming a reflective environmentalist, (b) negotiating roles as a science teacher and teacher of science, (c) bridging knowledge systems, and (d) island biogeography. Through further analysis and review of the interview transcripts and previous codes I ensured a saturation point with respect to the data collected (i.e. follow-up interviews, extant texts, literature review). I arrived at the core category/theme of: *Eco-identity as a meaning making process supporting one's calling as a science teacher*. This theme was the common thread that ran throughout the stories of each teacher. In Table 4 below I've summarized my findings of the science teacher meaning making process of developing and sustaining an eco-identity and how this supports one's calling as a science teacher in Hawai'i.

Table 4

Eco-Identity as a Meaning Making Process Supporting One's Calling as a Science Teacher

Category	Theoretical Code
Reflective Environmentalism	● Developing agency through biophilia and sense of place ● Becoming an authentic carer
Evolving Science Teacher Community of Practice	● Negotiating roles as a science teacher and teacher of science ● Balancing agency and structure in a community of practice
Bridging Knowledge Systems	● Linking culture based education (CBE) with land education for bridging 'ike Hawai'i with Western science ● Multiple epistemologies equals multiple pedagogies
Island Biogeography	● Thinking like an island promoting living like an island

Note. This is a further refinement of focused coding (Table 3.5) and theoretical coding (Table 3.6) in Chapter 3.

Visualizing the meaning making process of eco-identity development and sustainment can be supported by a graphic organization of categories and theoretical codes under the main theme of how eco-identity supports one's calling as a science teacher. Figure 4 below is a process-oriented representation of the information in Table 4 (p. 108), and both will frame the following science teacher eco-identity narratives.

Figure 4: *Eco-Identity as a Meaning Making Process*
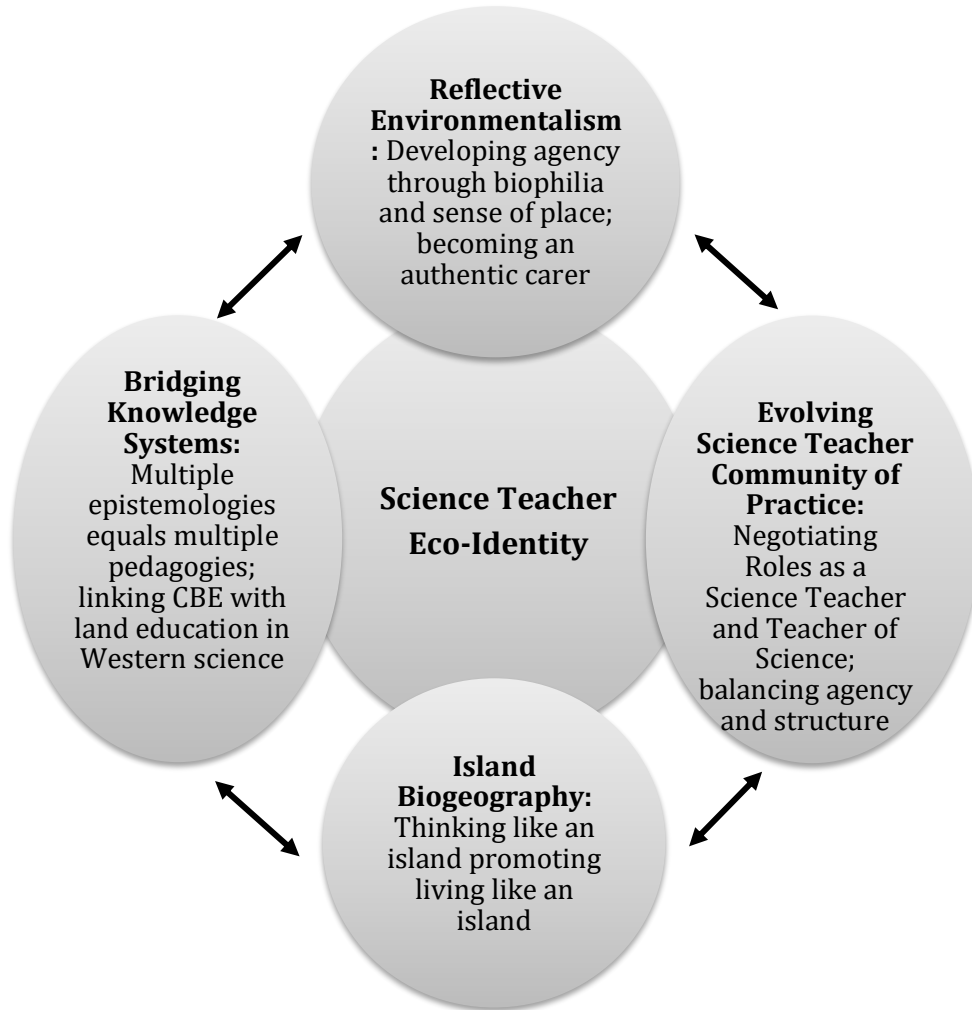
Science Teacher Eco-Identity Narratives

As identified in Table 4 (p. 108) and depicted in Figure 4 on the previous page, these categories guide the eco-identity narratives for each science teacher. Wherever possible I use the voices of these teachers, rather than summarizing and conceptualizing their values and beliefs, communities of practice, and knowledge systems. Moreover, while capturing voices as stories were told and re-told, the interactionist nature of dialoguing took place and therefore the meaning making process and an eco-identity was co-constructed.

These eco-identity narratives are case studies of each teacher's storied life over time and multiple spaces. From focused and theoretical coding in Chapter 3, the emergence of four common threads in the identity narratives came about naturalistically. This meaning making process showcases unique eco-identity development and shaping that are filled with rich stories and reflections. Here, I have highlighted the key events and situations most relevant to each person's eco-identity narrative within each category. A detailed personal timeline of events with demographics for each teacher is organized in Appendices G-L.

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Case Study #1: Chuck, "Doc," Burrows' Eco-Identity

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Reflective Environmentalism

As a child, Doc Burrows was raised by his Hawaiian grandparents living in Nuʻuanu. During his elementary and intermediate school years Doc Burrows lived with his Hawaiian grandparents and attended English Standard school and was not able to learn the Hawaiian language at the time. He eventually returned to Kailua to live with his family and attend Kamehameha School for high school, on the Kapālama campus on Oʻahu. Soon enough, his ethnic identity as a Hawaiian strengthened with his entry to into Kamehameha School where he studied Hawaiian language.

After completing high school at Kamehameha School on Oʻahu he continued to develop his studies in biology and the natural environment. Doc Burrows then committed to joining the U.S. Coast Guard where his connection to Hawaiʻi was never forgotten, but instead grew stronger with the time away from the Islands. In the Coast Guard his interests in the sciences continued and he knew that he'd be returning to Hawaiʻi eventually. His sense of place has been grounded since childhood and his appreciation for the flora and fauna in their natural habitats, once present in the islands, has continued to drive his actions as a science educator and eco-justice advocate.

Doc Burrows never felt judged or treated unfairly during his time in the U.S. Coast Guard as he traveled to ports in Washington, Alaska, and along the East Coast. He recalls that, "in the Coast Guard is where my interest in the sciences continued. I was interested in becoming a hospital corpsman or medic. That's how it got started." After his time in the Coast Guard Doc Burrows resumed his education in Oregon and his interests in the sciences and in ecology in particular were pursued. Doc Burrows shared with me his eco-centric views on conservation for the sake of preserving and protecting natural spaces:

> The courses that I took there were actually ecology courses and back then, even in the 1950s, you know, the word "ecology" was not known and understood. But there in Oregon, [they were] very conservation-minded about the protection and enhancement of the ecosystem, from the coasts, the oceans, up to mountain regions…protecting the wildlife. And that's how I became interested. (Interview, 11/12/14)

In our discussion on environmental topics of what he sees happening today with our natural resources revealed his concerns not only for the social injustices happening with Indigenous and marginalized community members, but what also emerged was a deep caring for the environment itself. He shared his concerns:

> What is happening throughout history and even now is the exploitation of natural resources for immediate, monetary gains. That's why today there's a wide division between the rich and the poor. The rich are 100,000 times richer than they've ever been, and the poor are getting less and less. And if this division continues, then there will be greater social [stressed] inequality. And this is the social aspect where we talk about justice, social justice issues…the eco-justice part…part of the eco-identity, part of an eco-minded concept and so forth. (Interview, 11/12/14)

When asked to share a specific place or a particular kind of place he felt most connected to at this time, Doc Burrows shared that his place connection was to the ahupua'a of Kailua on O'ahu. This was based upon his childhood experiences and current ones focused on caring for wetland ecosystem where he has lived and worked for most of his life.

He explained his place connection and why this place has meaning for him:

> I feel most connected to the wilderness or natural resources places. Closest to my
> home where I was raised, taught and engaged with community groups to protect,
> conserve and restore its natural and cultural resources, is Kawainui Marsh in the
> ahupuaʻa of Kailua. (Interview, 10/1/17)

In terms of religion Doc Burrows had always been involved with the Christian faith and he
has been involved with various religious groups to address issues of climate change,
deforestation, loss of natural habitats, etc. through spirituality and faith. This notion of a
deep ecology that transcends into an eco-centric view of the world. Doc Burrows ascribes
intrinsic values to non-human species and environments with a form of *biophilia*. He also
uses the collective power of multiple faiths to take action in Hawaiʻi and elsewhere in the
world. Having reverence for all living things and natural places and respect for multiple
faiths, he stressed the importance of the human-nature connection:

> I have also been involved with spiritual aspects, working with faith groups. That's
> the reason why I also have been paired up with a group called "Hawaiʻi Inter-Faith
> Power and Light." "Inter-faith" meaning not only Christians, but other faith groups
> who could be Buddhist, Jewish, etc. working on the issue of climate change, energy,
> etc. We've been doing it these past three or four years at the Crossroads, where we
> talk about responsibility of the religious groups to become the stewards of the
> creation and then be responsible for climate change and adapting to climate change.
> (Interview, 2/21/13)

Evolving Science Teacher Community of Practice

Doc Burrows was always interested in the sciences, and particularly environmental
science. After ending his career in the Coast Guard he attended college and earned various
degrees in the sciences and started to build his relationships with scientists. As a graduate
student in the sciences and then in education for his doctorate, Doc Burrows was interested
in *mediated instruction* whereby the learning was focused on mastering both content and
skills in science over time under the guided instruction of the teacher. Doc Burrows
emphasized the combining of experiential learning in the field with the provision of a
variety of resources and tools such as computers.

Doc Burrows defined the concept of mastery learning:

> The concept of mastery learning was that any child, given the time, could master the objective, regardless of ability. The only factor is that a child without high IQ: this individual, through his/her own processing ability, could pass the objectives—an individual who had a slower processing ability, given time and the appropriate mediated instruction, with the goals and objectives and feedback, with respect to testing/evaluation. [The] thing about it was that the grade is not dependent upon the successful passing of a test. (Interview, 2/21/13)

After receiving his doctorate Doc Burrows was not interested in teaching at the college level; instead he continued to teach science in the high school setting. His identity as a secondary science teacher became firmly grounded:

> When I came back to KS [Kamehameha School] I didn't care to teach at the university level. I just wanted to do what I was doing at KS [Kamehameha School]. In my vocation as a science educator, I enjoyed whatever I was doing. Teaching. It wasn't a job, you know. It was, in a religious sense, a calling. Yeah, it was [that] all the time. (Interview, 2/21/13)

As a high school science teacher, he headed the hiking and environmental science club *Hui Lama*, and the field component was always part of the experience for his students, be it during the school day or after school and on weekends. Doc Burrows has been a part of the scientific community for his entire teaching career, working with various professionals in the field—in addition to being a science teacher he is also a scientist. Stressing the importance of experiential learning and mastery learning, he afforded his students an education that involved scientists, educators, and local experts (i.e. Hawaiian cultural practitioners, *kūpuna* (elders)):

> Before going on field studies they would research subjects that they were studying, whether it was in botany, whether it was in wildlife or geology or ecology. So my goal was to involve the scientists to work with the students. The real-life scientists working with students directly. Students gained their knowledge not only from the text and research, but actually on these field studies…where students would go out and take water quality samples…set up transects to see what kinds of animal populations existed and studied archaeology to get the Hawaiian cultural sites studies. (Interview, 2/21/13)

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Doc Burrows saw his role in the secondary school system in Hawaiʻi focused on two key areas: (a) how students best learn through an apprenticeship model process of mediated instruction with mastery learning and (b) understanding the importance of experiential learning and working with scientists and other experts in the community. He noted challenges with scheduling field trips and pulling out his students during the school day; they sometimes traveled around the island and to neighboring islands. In terms of expenses and paying for transportation it wasn't always easy to coordinate and justify, even being at a private school. Doc Burrows contends that the public educational system needs to change and allow for more time to schedule in such experiences and how public charter schools are shifting in this direction:

> The times are important in order to do the things you need to do. That's an overall problem and that is where the charter schools come in. How things have changed and this is why charter schools are successful. With blocks of time to do different things, no matter if it is a Hawaiian charter school or any other charter school, as opposed to regular school...which has to change, you know? (Interview, 2/21/13)

Doc Burrows said that "there is no reason why others cannot do this, including the public-school teachers," with proper support from civic clubs and other organizations, including Kamehameha Schools. He sought out scientists and other community experts to work directly with his students and afforded them experiences as far away as New Zealand, Rapa Nui, Alaska, and the Smithsonian Institute in Washington D.C. Doc Burrows shared how this practice has been a lifelong passion and commitment and how a teacher needs to be that model as an agent of change for his/her students in an evolving community of practice:

> This is something we've been trying over the years, to have other school teachers involved, especially in science education. It takes the teacher to organize, set it up, and to continue it, and to work with the kids. (Interview, 2/21/13)

What has kept him going as a science teacher even after retirement and what has led to his sense of purpose as an educator and environmentalist?

> We feel it's very important to have our youth, to have our people, scientifically educated from science educators, understanding what science is about. Science is not only about the facts and knowledge about the wildlife, plants or animals, about the environment, about the planet Earth. What science is about is a method of learning and studying. (Interview, 11/12/14)

Bridging Knowledge Systems

Doc Burrows not only finds it critical for his students to conduct the research and field studies to gain the scientific content knowledge from a Western framework, but he also integrates Hawaiian cultural understandings and practices constituting 'ike Hawai'i. This continues to be the case after his retirement in 2000. He's taught and modeled the traditional practices and protocols of Native Hawaiians and community members (i.e. chanting before entering a forest and when leaving, offering gifts to hosts), in addition to practices of Western field scientists. Doc Burrows described a typical project revealing deep connections to the ahupua'a of Kailua with the bridging of 'ike Hawai'i with Western science:

> When I was teaching at Kawainui Marsh I used to take students every year as part of the high school biology program. It was in Kahana Valley where we would set up at a higher elevation than Kawainui and invite scientists to work with them [to] study the biology of the area…We also built up skills using technical equipment. Of course, we always set up to do Hawaiian protocol [prior] to conducting our studies. (Interview, 11/12/14)

Doc Burrows' concerns for the changes globally and how native peoples worldwide have had their traditional practices encroached upon, in addition to natural ecosystems being exploited, continues to be his mission as an educator and eco-justice citizen.

He stressed the need to have traditional knowledge systems work together with Western science to combat these issues at governmental, political levels:

> We would go to places that very few people would go to. We also would bring scientists with us so that the kids would be learning from the scientists. Wherever we go we always try to meet with the village peoples of those sites. Whether Alaskan Natives, in the Southwest with the Navajo and with others there, studying their cultural sites and what they were doing. (Interview, 2/21/13)

His multiple roles as an environmentalist, an educator, and as an eco-justice citizen make up this eco-identity that has flourished for over 40 years. Doc Burrows explained the importance of bridging 'ike Hawai'i with Western science within an eco-justice framework:

> Eco-justice is not only being concerned and aware of humans, especially the marginalized people throughout the world…also to be concerned about the plants and animals. Caring for the creation as ecologists. You talk about the web of life, you know? You talk about…and that includes humans as well, as well as the animals and so forth. That's the same thing as from that spiritual perspective, yeah? (Interview, 11/12/14)

The bridging of both worlds is exemplified by his bringing together of two very prominent navigators in Hawai'i: ocean *wayfinder*, Nainoa Thompson, and the space explorer Lacy Veach. It is the evening in 1994 where two navigators (one an ocean navigator and the other a space navigator) came together and sat atop a prominent point in the middle of Kaho'olawe Island. These two individuals shared perspectives on oceanic and celestial navigation as he and his students sat gathered a central point on Kaho'olawe island:

> This is the first time that it has ever occurred…On that trip we also invited Nainoa Thompson on the Hōkūle'a to come to the island. It [voyaging canoe Hōkūle'a] had not been to Kaho'olawe at that time. So…ending with the crew of Hōkūle'a, and the master navigator Nainoa Thompson. For the evening session by lantern light, we had a Polynesian navigator talking to the students, and astronaut Lacy Veach, who was a classmate of Nainoa Thompson, in the middle of Kaho'olawe Island, talking about navigation. (Interview, 11/12/14)

Since retiring, Doc Burrows has continued to support an environmental education that has bridged Western science with the Hawaiian knowledge system of ʻike Hawaiʻi. What keeps him going? He shared:

> What has kept me going is the pursuit of knowledge of Hawaiian culture and science. I'm now also working with Standing Rock Sioux tribes with protecting their sacred sites and water resources to prevent development of the Dakota access pipeline, and other areas like the Keystone Pipeline. It's about working with other Indigenous peoples and also my work with the Kawainui master plans. (Follow-up Interview, 9/5/17)

Doc Burrows never assumed to be all-knowing and understood his role as a teacher of science who also includes community partners and experts. He is part of an evolving science teacher community of practice embodying the thinking like an island mindset with how he views a science education program in Hawaiʻi encapsulating island biogeography principles:

> It all goes toward addressing the environmental concerns. That's the bottom line. It's one thing to become knowledgeable and be informed and aware, but the bottom line is what are you doing? In whatever way we can support the "doing part" is important. The government can't always be doing. The community needs to be involved and doing. The government has limitations on what it can do. Limitations in money, personnel…or, they may not have the interest or the *aloha* in doing. (Follow-up interview, 9/5/17)

Island Biogeography

As an educator at Kamehameha School at the Kapālama campus on Oʻahu for nearly 40 years, Doc Burrows continues to focus on environmental education projects that reveal his commitment to restorative justice not only with places in the main Hawaiian islands, such as on Kahoʻolawe and currently in the ahupuaʻa of Kailua. He has and continues to support projects worldwide (e.g. on Rapa Nui, in New Zealand, in Alaska, and in the Southwestern United States). He is currently involved with the Kawainui-Hāmākua Master Plan Project to develop and restore the natural wetland areas in this ahupuaʻa where he was raised.

When asked about opposition to this Master Plan Project in Kailua, Doc Burrows shares his understandings from a Western scientific viewpoint with the underlying notions of sustainability and conservation from an island ecosystem perspective:

> Right now, there's more pollution going in to the marsh, from storm drains, from roadways, from civilian communities. What we will be doing is that...other places could utilize these technologies and techniques taking this pollution, the runoff, into the marsh. We are just as much concerned with the marsh ecosystem…and this is where we can work together. We need a place, or places, educationally, culturally, where students and people could come to. (Interview, 11/12/14)

In the ahupua'a of Kailua Doc Burrows continues to coordinate other restoration projects with youth groups and faith-based groups from as far away as Japan to participate at Kawainui Marsh, Ulupō heiau, and Na Pōhaku O Huawahine on O'ahu. The work at these special places always includes a learning component of the Hawaiian culture and Hawaiian spirituality. Doc Burrows shared what he's observed over the years and what motivates people and drives them to react to and act upon issues that challenge what they value. He exemplifies how thinking like an island can promote living like an island:

> Climate change, global warming is not only an environmental issue, not only is it an environmental and political issue, but it is a moral issue. We have to change one's [*sic*] behavior. It has to come from that spiritual perspective of changing within first. The person changes in [his/her] behavior and this is where education comes in. Whether it's part of the culture that inform, the religious part comes in there too, you know? All essential. And that's what motivates people, drives people to do what they are doing, either for the good or the bad. (Interview, 11/12/14)

Doc Burrows continues to do what he does because he embodies a thinking like an island mindset. He understands the concepts of island biogeography and by being reflective environmentalist he not only thinks like an island but also acts upon this mindset because of he has made sense of his lived experiences to develop and sustain a strong eco-identity.

Case Study #2: Eddie's Eco-Identity

Reflective Environmentalism

Eddie is of Indian descent but was born in Uganda, Africa where he and his four siblings were raised initially in a wealthy neighborhood in the city of Kampala. At a young age his connections to places and his natural world were already being grounded in Africa. By age 12 he and his family moved to the neighboring country of Kenya, to the coastal town of Mombasa. His experiences in the private Catholic school system as a high school student were reflected upon:

> So my high school was right in a very beautiful part of Kenya, right on the beach. A lot like Hawai'i and it was essentially where I grew up. And so I had very good science teachers…and this is back many, many, many years ago. But very good teachers [who] exposed us to a lot of things. And science was one of the interesting subjects for me. (Interview, 6/28/13)

Eddie's interest in science and his sense of place were developing through his connections to coastal regions of Africa. Being schooled in a European-based framework and taking rigorous exams from Cambridge, England, he learned quickly (back then in the 1960s) that: "we had to know our stuff if we wanted to go ahead with our lives."

Growing up in turbulent times when British colonies in Africa were striving for independence, Eddie incorporated an independent and resilient nature into his core identity which influenced his beliefs and values as an adolescent. In addition, he was inspired by his natural surroundings during high school, which strengthened his naturalist identity and sense of place in Kenya. High school was "where it all started, basically," for Eddie:

> I had a very interesting biology teacher who was a naturalist and he just loved showing people the world…to the eyes of nature, you know? He took us to the beach for walks, he took us to his house. He had a big place where he had his own native plants and those days nobody knew what natives were. These are the indigenous plants from here [Kenya] and that's what I'm into. (Interview, 6/28/13)

Eddie experienced a British colonizer's educational system growing up and it was accepted at the time; but he also saw the importance of studying and doing the kind of science that mattered to preserving natural environments and to the locals in Africa.

Wherever Eddie has lived and worked as a science teacher he makes it a goal to better understand the environment, the people living in the community, their cultures, and the history of these places. Sense of place and having this connection to particular places in nature and finding meaning with these natural areas is something that Eddie has clearly identified with over his 36 years as a classroom teacher. As a reflective environmentalist today, Eddie shared what he thought about having a sense of place as a teacher:

> As far as teaching goes, a sense of place is absolutely important. For me, anyway. Because, it's what I am turned on to in the environment itself, and it's what I want to turn other people on to, so…for example, right here in Waikīkī [where he currently lives]. So, we [he and his wife] are constantly on the beach looking for…looking for any specimens that I can pick up to take to the classroom. For example, taking in jellyfish…some who have never seen the box jellyfish that come in every month. (Interview 6/28/13)

In terms of place connection, Eddie wrote a response in the NEP Scale questionnaire: "In tropical settings, preferably with an ocean setting. I also feel connected to high school through college teaching institutions." Be it in Africa, Ohio, or in Hawai'i his connection to natural spaces has been established over time. Eddie epitomizes what E.O. Wilson describes as biophilia: having the urge to affiliate with other forms of life and having an environmental altruism.

Evolving Science Teacher Community of Practice

During his high school years Eddie played piano in this band and playing for fun was his thing to do to at the time, but at a certain point he was met with a dilemma. As a high school student he was inspired by a young science teacher who was passionate about nature. Still unsure of the path he was to take, Eddie shared: "But you know, teaching was not at all in my plans. I wanted to be a musician, I think, like my dad." He described his carefree high school years and how he and his high school bandmates were:

> Little brown boys doing music on the beach. And we used to play in the tourist hotels, so we had to be good, you know? Yeah, we *kinda*…it wasn't for a living…it was just having fun and this was like a high school job, so to speak. But it was the time to move on and we did the Cambridge exams and we did okay. Good enough to move us on to the next step. Then, I said, "What am I going to do with my life?" I had no aspirations to go to any colleges. (Interview, 6/28/13)

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Up to this point Eddie had not considered a teaching profession and the thought of teaching didn't cross his mind; but there was a sudden shift in thinking when it came time to decide what to do after high school. Eddie credited his neighbor with encouraging him on this path to becoming part of a teaching community:

> So one of my neighbors said, why don't you go into teaching? She was a teacher and today she is a principal somewhere in Canada. Anyway, so I said, "nah" and "I'm a stutterer and I can't do any of this stuff." She said just give it a shot. So my first teaching experience was teaching poetry in a little African school right on the coast, called Shimalateva…and I was teaching poetry to 9th graders…which is kind of unique in itself because I know nothing about poetry. That is my stepping stone into the world of teaching. So, hey, for once in my life, I said, "I could talk in front of a group," which in high school I couldn't do. (Interview, 6/28/13)

Being exposed to good science teachers in high school, like the young man from his parents' birthplace in Goa, India, who Eddie said was "passing on the torch to his students," Eddie considers himself to be doing the same with his students. Eddie was finding his place as a practicing teacher and this initial experience of teaching poetry was his introduction to the teaching community of practice:

> Right after high school. I must've been like 18 years old. I was even 17, probably, and instead of sitting on the couch playing the piano, I was actually doing something. And not for the money, but just for the challenge of…just getting in front of a group and making my presence. One thing led to the next and I ended up at the teacher training college in Nairobi. (Interview, 6/28/13)

During the 1970s there was a high need for teachers, noted Eddie, due to the population boom in Kenya. He felt privileged to be part of a government program to train teachers where it was an "all-paid chance to become a teacher."

He recalls a British biology teacher who inspired him with field-based experiences and a passion for what he was doing:

> He actually bought his Land Rover from England and he took us to the game reserve where he was doing research on the cheetah. Sometimes you got stuck because there was a "black cotton" soil in these parts and although we had a four-wheel drive, there were problems when spinning these wheels. That soil…it's like quicksand, so to speak, and once you get stuck in it, it's hard to come out. So when the Land Rover was stuck and spinning its wheels and getting deeper and deeper into the "black cotton," we had to literally jack the car up and put stuff under the wheels and gradually move. This happened more than once, but that is a good experience. (Interview, 6/28/13)

As a practicing teacher Eddie noted the rigor and challenges for the next three years while in the program. His place connections and naturalistic identity were building along with his self-confidence while placed at various schools in Kenya for his practicums. For his student teaching placements Eddie would bring his toolkit of resources:

> Using a lot of African connections like the stuff I grew up [with] right on the coast. I used to have a box of shells that I carried around. I knew the plants by now at this stage so we were encouraged to use a lot of the surrounding flora and fauna as far as we could and exposed the students to all this, their surroundings. (Interview, 6/28/13)

Like his K-12 schooling, his learning in college was based in the private, Catholic, European-influenced system. At his first teaching job Eddie was inspired by the Marianist brothers he worked alongside with at a Catholic national Kenyan high school, Mang'u High School. As a new teacher he found the motivation of the 600 male-only students was to pass the exams to then get into the university. Eddie described his work alongside his colleagues who were Catholic, Marianist brothers:

> The Marianist brothers did a fantastic job. They went out of their way…all the way from sports to social stuff, teaching them how to live, and even how to use a…how to use a toilet facility, because a lot of these kids…they came from the bush. They didn't know about toilets and things. (Interview, 6/28/13)

Eddie's admiration for the selflessness of the Marianist brothers at this high school influenced his beliefs and values with the acceptance of all peoples from various socioeconomic, cultural, and religious backgrounds. For Eddie, education was a privilege.

He shared how the Mang'u High School was set up to follow a strict observance of the Catholic religion, with a mission to provide pertinent education to produce "solid Catholic men of good character." At this point, when deciding what he was going to do next he asked himself, "Should I do music…or should I stay with the teaching stuff?" While music was still a passion, he confirmed his emergent role as a teacher by stating, "I'll just teach science." Eddie's association with the Catholic religion had continued on when he was accepted on a scholarship into the University of Dayton in Ohio, founded by the Society of Mary (Marianists) and associated with Mang'u High School. Eddie completed his schooling there and furthered his science content knowledge, majoring and receiving another degree in biology, with a minor in chemistry. After finishing his master's degree program and teaching briefly at an elementary school there, the harsh winters in Ohio made it difficult for him to stay. Ohio was a place far removed from what he grew up with in Kenya and Eddie shared his reasoning for the move:

> But the problem with Ohio is it has winters and so [I] moved to Florida because Florida has no winters and it was the closest thing to Mombasa. Mombasa is where I grew up. It is just absolutely beautiful. So I got to teach in a big Catholic school there [Florida], called St. Thomas Aquinas School. (Interview, 6/28/13)

Eddie's affinity for the private, Catholic school setting for teaching, while he did teach in the public school system while in Florida, was explained:

> I did public schools in Florida but I just kind of disliked it because the structure was totally different from private schools. I guess I'm more into the discipline part of it and I'm not a good disciplinarian. I'm more into the teaching end of it rather than the discipline. (Interview, 6/28/13)

After marriage and starting a family Eddie moved on to another Catholic school, now in British Columbia, Canada. Eddie commented on being in Canada and that while Vancouver has its beaches and that it was "beautiful country" with "beautiful people," it was not the kind of tropical, temperate place that he was used to. The eventual move to Hawai'i to continue to teach science became a sensible choice whereby Eddie taught at two different Catholic schools for the remainder of his teaching career.

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In Hawai'i Eddie completed his final 13 years of teaching science in Catholic school settings where he taught biology, chemistry, and marine biology. Prior to teaching at the Marianist high school where he finished his teaching career, Eddie taught at an all-boys school in Honolulu at the middle school level. Teaching at the middle school level (general science) was not to his liking. Eddie "wasn't teaching science to keep the students entertained." Eddie explained his science teaching experiences at the middle school and why he needed to move up to high school:

> Three years. Ah, it was okay, but at the same time it was the disciplinarian issue… constantly….and it's all about standing in line and not touching the wall and uh, that's not my thing. I'm more into doing the actual teaching parts. So, I enjoy [high school] because I have the freedom to do what I want to do. (Interview, 6/28/17)

According to Eddie, the classroom management issues tended to occur more often at the middle school level and also more often in the public schools. Teaching science at a higher level of rigor was something that he felt that he couldn't accomplish with the middle schoolers:

> I wanted to go back to high school. That's why I went there. I was tired of…No, I felt trapped. I felt I had too much information than these kids. I don't know if you can put it in those terms but all the stuff you learn in university…You need to pass it on…I feel this is what we are put on this Earth for: to pass on our little bit of scientific knowledge. And I couldn't do that in middle school. You know, it only gets you so far. Don't you feel that sometimes? (Interview, 11/16/14)

Eddie also revealed his understood role as a science teacher with respect to how students needed to learn and be able to use scientific terminology when discussing and writing about phenomena in the natural world, and when addressing real-world issues today. His pedagogical content knowledge focused on teaching for key concepts and skills and where scientific literacy were stressed:

> Teaching science for key concepts and skills. For science, vocabulary is very important because we assume students know these words…because they need to find out the meanings of these words. They're quite difficult for those hearing them for the first time. I guess I'm guilty of that, as I assume they know what the words mean; but a whole lesson in itself is getting them used to the science vocabulary. (Interview, 6/28/13)

Eddie went on stressing the process component in science and being able to communicate findings to address real problems in the world today. "It doesn't matter if the experiments work or didn't work," he noted. Three years into teaching science at the Marianist high school, he was given the opportunity to teach the marine biology class. Eddie rewrote the curriculum and selected a textbook for the course. Obstacles were met with finding an appropriate book that was up to date and relevant to living in Hawai'i. As a science teacher he needed to help students find meaning with what they were learning, stating to his administration, "Let's revise the whole subject because we are surrounded by ocean, yeah?"

During the last seven years of teaching marine science Eddie brought in live specimens to the classroom, such as the jellyfish he'd scoop up into plastic containers with his homemade coconut ladles at Waikīkī Beach in the morning along his way to school. As a science teacher his awareness of places and strategies as a science teacher living in and teaching in Hawai'i included hands-on experiences so students could "touch, see, smell, and observe, and think." Eddie stressed: "For science that's absolutely important."

Within the science teacher community of practice in Hawai'i, Eddie utilized resources gathered when attending the local chapter (HaSTA) of the National Science Teachers Association (NSTA). His use of curricula and experts in the field helped to promote authentic and rigorous learning for his students. Eddie described his common practices and expectations for the marine biology class, revealing an integrated approach: "Every day is a different day. I try to do labs…for marine, it's always hands-on. It's looking at plants, sand, etcetera every day." He stressed the importance of having this sense of place and helping his students to feel these connections as well, despite the challenges that can come with time constraints and financial resources within any type of educational institution:

> That's the sense of place…taking them out to explore their neighborhood. Last year we did do a different field trip. We did the aquarium several times, we went to Coconut Island…and so I take them where we can take them. But the problem is economics. You take them out of class, and it's almost $200. (Interview, 6/28/13)

Science teaching for Eddie has been a lifelong profession that continues to this day, even since retiring in June 2017.

I asked him about why he continues to do what he does as a science teacher and what he'd likely be doing when he retires from formal teaching (this was in 2014, during our second interview conversation), he replied,

> I still love it, though. It's amazing. You ask me, are you ready to retire, but what am I going to do, sitting at home? I say, no. Ah…let me go discover some new hermit crabs, walk on the beach and look for something else. (Interview, 11/16/14)

Bridging Knowledge Systems

Eddie's upbringing in a British-influenced system of education, up until and including his teacher training, took place in Kenya, Africa. During his three years of teaching science at Mang'u High School in Africa, Eddie feels content that he has passed on the knowledge to his students, to help them become successful and contributing citizens in their own country. He pointed out how teaching science at this high school in Kenya was a means to support the sustainability of culture and living productively in Africa through the education of the younger generation:

> There's this thing in Africa, believe it or not…when I was teaching these kids…these kids, guess what, they went to medical school, they went into dental school, and Kenya was just turning these people out. Because they needed their own...you know…in their own tribes. (Interview, 11/16/14)

As a means to promote a bridging of Western science with Indigenous ways of knowing, Eddie and his wife (a retired education professor at a private university in Honolulu) collaborated with Marianist schools in Africa over the years while teaching at their respective schools, to address the needs of teachers and students in less fortunate situations. In June 2011 Eddie traveled to South Africa to work with teachers in a program to provide science teacher training. There he worked in the summer months to support science teachers with connecting the learning to their environments and their culture.

Eddie shared how these countries in Africa are former ex-colonies, with Kenya being an ex-British colony, and how the educational systems differ in each country and how the social injustices are being addressed today.

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Eddie's work with teachers in a formerly Dutch-colonized system of South Africa exemplifies a passion for helping others in need and for empowering people with the knowledge and practices of science:

> Teaching teachers science, chemistry, and math. Oh, they just were so happy to have us! And they just loved it. This was during their [summer] break. They don't get much of a break. Yeah, about 300 or so. So many of them. And all we did was give them a workshop for six weeks. And again I used whatever I could find around. I went around looking for flowers and looking for stuff … place-based. Whatever you could find around…because the schools, again the schools, they are packed. One school had literally 80 students, "Eight-zero," in one classroom. (Interview, 6/28/13)

He reiterated what the educational system in South Africa looks like today and how he feels fortunate to have the support of his current administration and general public as a science teacher in the U.S.:

> Eight-zero. And we actually went to see it and how it operates. And they all sit like sardines in rows like this [Eddie demonstrates this to me]. The teacher stands right in the middle of the classroom. Not in the front, but in the center. That's where the teacher teaches, and there's a little board on the side. And…that's how they teach! (Interview, 6/28/13)

In addition to the rigors of Western science, Eddie helps his students connect with the Hawaiian culture and how 'ike Hawai'i is a valid knowledge system to study, value, and preserve the native flora and fauna of the Islands. He emphasized: "Students need to know about their own culture," and that it's important for them to "keep their own timeline, their own pedigrees, all the way from their own families, to their roots." Eddie has worked over the years with other scientists and colleagues at his school to provide for integrated experiences at places like the He'eia Fishpond, the *lo'i kalo* (taro patch) system at the University of Hawai'i Hawaiian School of Knowledge in Mānoa, and the Paikō Lagoon Wildlife Sanctuary in East Honolulu. Eddie shared his rationale for taking his students into the field and for having them experience Hawaiian cultural practices (like ancient aquaculture methods) to better understand the marine biology concepts and to emphasize sustainable practices living on an island.

Eddie's reflections and follow-ups after the field trips like the one to Heʻeia *loko iʻa* (fishpond) revealed the importance of a Hawaiian culture-based education for all students:

> The follow up was that they really appreciate when you take them away from school, obviously. But, they learned a lot. A lot of these kids have never been on a field trip of that nature. I mean, they're growing up...I think every kid growing up in Hawaiʻi should be exposed to fishponds and Hawaiian ways and culture. Every student, regardless of where they come from, whether they're from here or overseas. *'Cause* Hawaiʻi's got...it's so rich. You know, the culture is amazing. (Interview, 11/16/14)

Island Biogeography

Eddie has a sense of place here in Hawaiʻi and his teaching practices included hands-on and field experiences that were also connected to the situations of living on an island. Eddie explained how the knowledge of the past in Hawaiʻi can inform us of what is going on today, to make better decisions, and how "science has got a lot of historical stuff." He shared how valuable a place like the Bishop Museum contains so many shells and other artifacts, and how "schools should pay more attention to this."

He shared his fascination not only with the flora and fauna of the Hawaiian Islands and how he's "been discovering new things every day," but also the Hawaiian language and music. He understands the importance of bridging ʻike Hawaiʻi and Hawaiian cultural practices with Western-based teachings in the secondary science classroom. He shared: "I think we live in such a unique place in the world, that we should take full advantage, you know? And I don't think our school is doing enough."

Eddie wishes that he could speak the language but finds that his time planning for and teaching science takes up most of his time. Hawaiʻi is a special place and he wishes that he could do more in the cultural respect and with respect to ʻike Hawaiʻi and cultural practices with respect to the environment. Eddie's sense of place is firmly rooted in Hawaiʻi, as he continues to learn more about the Hawaiian culture and knowledge system of ʻike Hawaiʻi and how this connects to Western practices of sustainability and island biogeography.

Case Study #3: Karen's Eco-Identity

Reflective Environmentalism

Karen (a pseudonym) was born on Oʻahu, and she and her four sisters lived in Pauoa Valley all their young adult lives there with their parents. Karen, like her sisters, completed their K-12 schooling in the Honolulu ahupuaʻa where Pauoa Valley is situated. Her parents, like herself and siblings, all attended the same high school in Honolulu and also obtained post-high school degrees from the University of Hawaiʻi at Mānoa. Karen felt most comfortable and grounded by being near family for most of her young adult life. She described this place connection to Pauoa Valley:

> I lived in Waipiʻo, but that was before I went to school so I don't remember too much. I remember the parks and walking around. That was until I was four years old. We moved when my sister started kindergarten. So then we lived in Pauoa Valley. It was like a seven-minute walk to school, but my mom would drop us off at school. I lived there in Pauoa Valley until I got married. It was a long time. I was 26 years old! I lived at home until I got married. (Interview, 9/4/13)

Growing up and attending elementary school Karen was inquisitive and interested in the sciences and mathematical challenges, stating, "I would read science magazines on my own from cover to cover. I'd be very interested in books and I had my own little chemistry set and played with the chemicals at home." While Karen didn't have too many memorable events that may have influenced her attitudes toward science and toward the environment during her K-12 years, she did find ways to challenge herself and satisfy her curiosity at home. Having a solid public-school education right here in Hawaiʻi was important to her parents when it came to their five daughters, noted Karen.

In terms of science teachers who inspired her, Karen couldn't remember specific teachers. She did, however, bring up one experience in middle school that was traumatic for her and also challenged her Christian belief system:

> As for my science teachers, not any of them stuck out. I would actually read a lot of creation and evolution books that my dad would provide for me, so that I could look at both sides. I had a teacher in middle school who sort of humiliated me in class after I wrote a paper defending Creationism. He kept me after school to talk to me, since he disagreed with my thoughts. I had to hold back my tears when he did that. (Interview, 9/4/13)

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Karen's educational experiences in high school were similar; nothing really stood out except for the laboratory, hands-on experiences in biology class, along with writing up the reports in the end. Her experiences with high school were "okay," she noted, and she expressed: "I remember the activities but I'm actually not sure if I learned the concepts that well; although I knew how to do the lab reports and stuff." There wasn't a lot of confidence with respect to completing science courses of AP (Advanced Placement) chemistry and honors physics in high school but Karen pursued these subject areas and completed high school with the intent to go to college.

In school she worked hard to learn what was expected of her, determined and intrinsically motivated to get good grades. Her persistence and resiliency throughout her K-12 schooling helped to build the strength and focus that was to be needed when she became a teacher:

> I found that I was really interested in science, but previous to that my teachers actually hadn't taught much science or done many science labs. I didn't have much actual experience with science and I'd only had [gained] information on my own. Science, I wouldn't say, was my strongest subject. For science I'd sometimes get Bs, you know? I would just try my best. (Interview, 9/4/13)

With respect to place connection and keeping her familial ties strong Karen continued to situate herself in Honolulu and she shared how growing up in Pauoa Valley and being encouraged by her parents to stay in Hawai'i has kept her connected to family and familiar places. Karen's reasons for staying in Hawai'i and attending the University of Hawai'i in Mānoa were expressed:

> We all went to UH as well. My parents paid for our education. Even if my sisters had full scholarships to go to other schools my parents just wanted us to go to UH so we did. I know they wanted to keep us in Hawai'i though. They were both born and raised here and they both went to UH. (Interview, 9/4/13)

After high school Karen attended the University of Hawai'i at Mānoa to take education courses. Initially unsure of her path in education and on the path to becoming an elementary educator with a special education license (dual licensure track), she eventually decided upon secondary science education.

It was during her second year in the education program at UH and upon the advice of adult role models like her father and *his* former teacher, that Karen switched her focus in education:

> I think I was actually in an elementary education program, in the bachelor of education program. I then saw that I could get dual certification with SPED [special education] as well and thought about this at the time. But my father's teacher heard that I was going to go into that and she had a long conversation on the phone with me. She told me not to go into it [the dual licensure program with SPED] so that's when I thought about science. (Interview, 9/4/13)

Family, for Karen, is at the center of her core values and she remains connected geographically by having her parents, in-laws, and aunts and uncles nearby, supporting her today with raising her children. Her parents still live in Pauoa Valley and they still are involved in her life. Notable in her NEP Scale questionnaire response was how she wrote about her home as the place she felt most connected, "because that is where I love to be and am comfortable there." Karen's sense of place is situated in her home in Mānoa and with her family and also where her parents still reside in Pauoa.

During our discussions on environmental values and beliefs her values as a Christian and what she believed about how we should care for the environment were connected. Some of her responses paralleled what Dunlap et al. (2000) define as an individual having a predominately Dominant Social Paradigm (DSP). When asked if she felt that her religious background had influenced these beliefs about these statements on the questionnaire she replied, "Obviously, I grew up with my religion and I originally thought that. I grew up with it. When I was really young…most of my years it was the Assembly of God and after that it was Four Square."

At times Karen "disagreed" or "strongly disagreed" with statements such as: "We are getting too close to having too many people on Earth," "Plants and animals have as much right as humans to live," and "The Earth is like a spaceship with very limited room and resources." She also "agreed" or "strongly agreed" with statements such as: "Humans have the right to change the natural environment to fit their needs," "Humans were meant to rule over the rest of nature," and "The Earth has plenty of natural resources if we just learn how to use them."

When asked to write about where she feels most connected to, and why, she noted, in addition to feeling most connected to her physical home and family: "I also feel even more connected to God during prayer when I know He is leading and I am praying according to his heart."

Thus, for Karen, being a reflective environmentalist is part of her eco-identity that is strongly influenced by her Christian background and strong family connections. She is concerned about her surroundings and what is happening in our world today in terms of global environmental changes and social and ecological injustices. As a Christian she is reflective and respectful of her surroundings, and exudes care and compassion mediated by the teachings of God.

Evolving Science Teacher Community of Practice

As noted previously, Karen initially intended to enter the elementary education field with an additional certification in special education for K-12. By her second year in the university teacher education program, however, she was discouraged from this and decided upon a focus of secondary science teaching in the physical sciences. Her parents didn't point her in any specific direction with career choice and no one in her immediate family was a teacher. She felt secure with her decision to switch focus, recalling that "they totally supported me with schoolwork though." The main thing, Karen shared, was that all of them (all five sisters) attend the University of Hawaiʻi in Mānoa to get a college degree.

For her student teaching experience, Karen described it as being "okay," and that she "had a good mentor teacher" who was the science department head at the time. She was becoming indoctrinated into the field of teaching and developing her teacher identity. While an eco-identity had not been developed at this time the practice of teaching and mastering this role in the community was being shaped and influenced by her mentor. Karen shared how her mentor had a lot of experience in the field exploring many marine environments and how she was dynamic with her teaching, especially since she lived on a boat with her husband and children at the time.

Karen expressed awe and wonder and appreciation for her mentor with the opportunity to continue in her mentor teacher's line once leaving the school to do other worldly pursuits:

> She was a great mentor and teacher and had so much experience, being a horse rider and scuba diver. So, a lot of the resources that I got for marine science was from her. She had photographs, she had lots of corals, she had shells, from all over the world. But that's when I was downstairs in her classroom. Then I moved upstairs and didn't teach marine science for a while so I had kept the resources in that old room. (Interview, 9/4/13)

Karen described her student teaching experience with me as a process that she accepted as part of entering the field of teaching. Her practicum took place at the very same high school where she had continued to teach at for all nine years of her career up to the present. Upon completing the program in secondary education and passing the required Praxis exams for the content of physical science, she landed a full-time position teaching physical science and also the marine science class. As a developing science teacher she gained the confidence as she experienced teaching the ninth-grade physical science class for six years and then moving up to teaching the upper grades for the biology and marine science classes. The willingness to teach different subject areas and adapt to what the administration was asking of her was evident:

> I actually like biology. I am learning a lot. Physical science was okay, but I was ready to move on to a new subject after having taught it for so long. I wanted to…like…well, when you teach you kind of learn a lot of new stuff too. So, I wanted to do something different. (Interview, 9/4/13)

Karen exhibited a firm but fair demeanor when interacting with her students when it came to teaching classes of 10th through 12th graders at this public high situated in the urban core of Honolulu. In spring 2013 Karen mentored a student for her student teaching practicum and I was the university supervisor conducting the observations. I was able to indirectly observe Karen's interactions with this student teacher and with her students in the high school science classroom. Karen's interactions revealed a confident and caring teacher of science who understood her role of providing for a rigorous and relevant science education for her students.

As a science teacher Karen had grown to be very confident and competent.

Her quiet disposition was not to be taken for passiveness or any inability to manage her students. She had developed her science teacher identity and was also very comfortable working with a multicultural population of students at her school, many of whom were from a range of socioeconomic backgrounds. A large number of students were children of immigrants from the Philippines and some students lived in the low-income housing project nearby. Karen disclosed how the first year was a "little challenging as a new teacher." She explained how she adapted to teaching the various grade levels and how she tried to make science learning relevant:

> As long as I had the time to prepare, I could make the lessons connect. My first year of teaching was harder to do this, but after that I was okay…I think I liked the upper grades more. I had at-risk students as well in ninth grade. (Interview, 9/4/13)

The ninth-grade physical science classes that she taught in her beginning years contained a number of at-risk and special needs students whereby she'd have a co-teacher (in special education) to support her during those periods. As a new teacher Karen felt supported in the school system. She overcame the challenges with accommodating those at-risk students, while also being able to engage the higher-level students included in these "inclusion" classes at this high school. She never wavered and didn't ever consider leaving the profession of teaching, even when provided with the option to accept a job at the post office where her parents worked.

It was not until November of 2014 (over a year after our first session) that I was able to reconnect with Karen for our second interview. Karen was now a stay at home mom with a newborn baby girl. Karen mentioned teaching science for the Hawai'i State Department of Education's (DOE) supplemental *E-School* program while she was teaching at the high school. With her husband's support and encouragement, she decided to leave the formal classroom teaching for a few years, until her daughter started kindergarten. Karen was now focused on being a mother while continuing to teach physics classes online for the *E-School* program.

In terms of teaching and taking a leave of absence from the high school she rationalized:

> So, I decided to take a leave for a year. My husband thought it was best if I stay home. He knew that I'd be out for five years, after our daughter starts kindergarten. I think because I knew it was coming [the leave of absence] that I was fine with it, but previous to that I was going to teach for 35 years, until I retired…until my husband suggested I stay home. But, once I stopped…I guess…I have three kids to watch…then it's easy to not think about it, you know? (Interview, 11/13/14)

Karen's role as a classroom teacher has paused but she continues to teach physics online through the *E-School* program which has a set curriculum with assessments and evaluation which she is very comfortable with. Her daily routine is to check in with students online, conduct live instruction, answer students' questions online, and administer oral exams. While Karen enjoys the online teaching at home so she can care for her newborn, there is now a new dilemma:

> I think at the beginning it was hard to separate myself from school because I was into school so much. And like, when I would teach, I like would put myself out there, and think about it at home. I was always doing things for school. I never thought that when I was teaching that I would be going out of the profession, actually. Right now, I see myself as a…I stay at home with my kids…and I do my part time teaching. (Interview, 11/13/14)

When asked if she missed teaching at the high school, she shared that she is now happy to have this time to raise her daughter at home. She noted how, "whenever I saw my colleagues, they all said, "Wow, you're so lucky to be at home." While she has empathy for her colleagues and their current challenges in the public school system, with new program mandates changing administration, she feels fortunate that she is able to stay at home at this time. This realization of her current status as a stay-at-home mom led her to reflect upon the importance she previously placed on her role as a science teacher by stating, "I never thought that when I was teaching that I would be going out of the profession, actually. It's more something of a reality after I stayed home for a year."

Her central role as a mother is still evident, but she is also anxious to get back into the regular classroom. In 2017 Karen shared that she is now teaching AP Physics II online through *E-School* and is enjoying the challenge, feeling confident with teaching this advanced science course to motivated students.

She plans on continuing teaching online even when she returns to the classroom. Karen is currently applying for high school science positions in the Honolulu district area only. Since not finding a job in the district at the start of the fall 2017 school year, she will "try again, and stay home another semester, if needed," until she finds that job in the district where she considers her place of work to be as a science teacher.

Bridging Knowledge Systems

With respect to the fields of science and her schooling experiences in the Western educational system in Hawai'i, Karen successfully completed her high school program, which included classes in biology, AP chemistry, and honors physics. While at times feeling less confident in the subject areas of the sciences, she took on the challenges and further grounded her science identity at the college level. While not necessarily inspired by any specific teacher in high school, Karen did have one professor at the university whom she took several classes from, which included physical science and physics. She continued to further her knowledge in the physical sciences, physics, biology and marine science, as she taught these subjects (both in the classroom and also online through *E-School*) for the span of eight years, prior to becoming a stay at home mom. Now teaching the AP physics II course online through the *E-School* program, she is engaged with this subject matter and ensuring that students understand the key concepts of physics and applied physics with real-world applications. Karen is confident with teaching these physics courses online and her science identity from this Western framework of education has been strengthened since leaving the formal classroom.

A strong connection to 'ike Hawai'i and the Hawaiian cultural practices and knowledge system surrounding connections to the environment was not evident in Karen's schema and how she currently operates today. In her early years of teaching there were a few experiences she afforded her students outdoors and with Hawaiian cultural practices in mind, such as going to a *lo'i kalo* (taro patch), doing stream clean-ups in the area, stenciling storm drains, etc. Karen didn't describe it as an imperative for her to incorporate Hawaiian cultural values and practices relating to the environment into her daily classroom lessons. While she does identify herself as being Japanese, Chinese, Hawaiian, and German, she treats the subjects in science that she teaches as facts, concepts, mindsets, and skills to be experienced in a hands-on way, and learned from a Western framework.

Island Biogeography

        With respect to addressing principles of island biogeography with her science teaching, both in the classroom and online, Karen does conduct herself in ways that reveals thinking like an island and living like an island. In both her personal and professional lives she strives to model Christian values of care and respect and also understandings of the importance of stewardship, in order to live sustainably in Hawai'i. Her responses to the NEP Scale questionnaire statements revealed a Christian perspective but also included the reasoning of a scientist, with the natural laws of nature in mind and understandings of island biogeography:

> I think they [humans] can use resources and that might change the environment, but at the same time they have to deal with the fact they are changing the environment. Like how much they're doing. It's a natural law, like in the ocean: you can only get the ones that are so big, '*cause* you have to. (Interview, 11/13/14)

Karen's focus on the subjects of physical science and physics over the years has led her to focus more on the skills and concepts that prepare our youth for thinking critically and solving problems in a Western-focused framework of science. She does, however exhibit mindsets of thinking and living like an island through her teachings of science. Karen is content and feels fulfilled with her life and practice as a science teacher in Honolulu.

<div align="center">Case Study #4: Ed's Eco-Identity</div>

Reflective Environmentalism

        Ed was born on the plantation camp outside of Lāhainā, called Puʻukoliʻi, in Western Maui. He came from a large family of six children, born from parents of Okinawan descent. He is connected to his roots and when asked if he was a full "Uchinanchu" (common term used to describe Okinawans), he proudly exclaimed, "100-percent!" Ed grew up on the plantation with his five siblings and was public-schooled all the way through high school, which at that time was not considered a "given."

Expectations were low for Ed to succeed in high school, coming from a small plantation school:

> Well, what you have to remember is that the first-generation and second-generation people *might* have gone to high school. Teachers only needed a normal school education and Puʻukoliʻi was a small school. The larger towns like Lāhainā would have a larger school [and] would have more qualified teachers. It was pleasant but there was no challenge or stimulation, especially when we went to high school. We weren't expected to excel. (Interview, 11/9/13)

Ed's hard-working parents were role models who instilled not only a strong work ethic, but also the value of community and caring for others and sharing resources. Ed's father was from Okinawa and came to Hawaiʻi to work the sugar plantation and his mother worked hard to raise the family. They lived in a modest plantation home with no running hot water and no personal bathroom. His father started a family garden with vegetables for the family to harvest and raised chickens for meat and eggs. Even the chicken manure was used as fertilizer to promote a sustainable lifestyle on the plantation, noted Ed.

At that time everyone needed to be resourceful and harvests were shared with others. Ed is appreciative of all that his parents and members in the community have done for him while he was growing up. During a local broadcast of "Preserving our Recollections" on Maui television he recalled life on the plantation and how this impacted his worldview:

> We were poor, we had no telephone, no running hot water, no bathrooms in the house. It was a special time because we were all in the same boat. Everybody had to work hard. You know the old saying that "It takes a village to raise a child." For all of us that grew up there it was a village with all of us. (Maui Community College, 2010)

Ed shared that there was a lack of emphasis on education for first- and second-generation peoples living on the plantations during those times, since many of the parents of these children were immigrants to Hawaiʻi hired to work the land and support the sugar and pineapple industries. Feeling isolated on the plantation where schooling was considered secondary to making a living, he felt that "the worst part about growing up at the time was the education."

What Ed learned during his high school years was to be strong and resilient and focus on doing well in mathematics (Algebra, especially) which he found most interesting. This is exemplified by how in high school he was initially kicked out of the Algebra class because it was too full. Ed felt a sense of discrimination coming from the plantation village in Puʻukoliʻi. He stood up for what he felt was his educational right and got himself back into the Algebra class. Reflecting upon some of the unpleasant times attending public school he countered: "I guess the good part about it is, I learned how to stand up for myself; I didn't ask my parents for help." At a young age Ed found it important to study and get as good an education as possible no matter what the circumstances were, including being part of the system at the time that he referred to as a "plantation-controlled education." He was self-taught as an adolescent, and motivated to further his education and leave the Islands after high school.

Despite the initial challenges in high school, Ed persevered and excelled in mathematics. His interests in math and particular areas of science were expressed: "I liked science but not as much as math. I liked physics and chemistry, but not biology." In terms of environmental values and beliefs, Ed's responses to the NEP Scale questionnaire and his perspectives on the environment in Hawaiʻi and elsewhere in the world reflect his experiences growing up on the plantation and working on Maui as a science teacher for 30-plus years. His values and beliefs about his environment on Maui are strongly connected to his Western science education, and when asked "Where do you feel most connected?" he wrote:

> Although I live on an island, I am connected to this Earth. What we do as individuals may seem minor, but when we consider sum of our individual actions, the impact is great. For example, global warming is the effect of the sum of our actions. (NEP Questionnaire, 10/5/17)

Ed knows his places on Maui well and cares deeply about the natural beauty of this island, and while he has lived in Kīhei for nearly 50 years now, he shares that, "I really don't have a connection to Kīhei." After his time in the military and traveling the world and attending colleges out of state, he returned to Kahului, Maui and has noticed the changes over time.

He reflected upon on living in Kīhei today:

> It's a different world than what it used to be. Now, it's like suburbia and being with a lot of transient people…it's just a little bit different. You talk about place...it's not like the old community. I really don't have a specific place. I've also lived in Wailuku and then I actually was on the mainland. Although I do feel a sense of place it's just a place [on Maui], but I still, you know…the island in general. The buildings I grew up with, they're no longer in existence. (Interview, 12/5/14)

In terms of religion and spirituality influencing his environmental values and beliefs, Ed didn't express much in terms of religion. Our conversations, including when discussing his responses to the NEP Scale questionnaire for the first time, didn't include any talk about religion as reasons for his values and beliefs about the environment. He doesn't consider himself religious but did grow up in a family with strong religious practices and values. Ed contends that he is "more spiritual than anything," and never attended church back then and not even now. Upon describing his household and any religious aspects growing up in Puʻukoliʻi on the plantation, Ed shared his views on religion:

> My brother is a minister but…and my mother was very religious, but I'm not. Actually, that was the interesting part, because my parents were originally Buddhist, but we grew up in the Methodist church. Not for religious reasons, but as much as for social reasons. '*Cause* we're a small community and most of us, you know, used to belong to what they called the Methodist Youth Fellowship. So it was really a social group more than it was religious. (Interview, 12/5/14)

Ed is highly reflective with respect to his personal life and his genuine care for the environment and greater good of society transcends into his teaching practice. Becoming a reflective environmentalist was something nurtured over time for him as he grew up modestly in the plantation village where his parents were hard working and mindful of other cultures and the environment.

Evolving Science Teacher Community of Practice

After high school Ed left Maui to attend college in Colorado where he spent five years as a liberal arts major. Soon after college he returned home to Maui in 1966, unsure about the field he would go into and then drafted by the military in the following six months.

Ed realized his experience of being drafted as important with shaping who he is today: being more understanding of others' perspectives. While he initially felt "cheated" with being drafted into the military he shared how these four years were life-changing:

> The military was a great experience. Although I hated the fact that I got drafted, it actually helped me. The experiences that I had were invaluable. Being a teacher is much more than going to college and receiving training. As a teacher, what helps is your life experiences. The military gave me some of those experiences. It also gave me confidence that I could do whatever I wanted to do. I went to language school and studied Russian but in the field in Germany I was assigned to another job that I knew nothing about. The success that I achieved there gave me the confidence to do whatever I wanted to do. (Interview, 11/9/13)

After the military Ed returned to Maui in 1971 to help his mother after his father's passing. He was not yet sure about teaching as a profession and was confronted with the limited job situation on Maui at the time. Ed initially considered careers in business and accounting but the decision to become a teacher was largely due to an inspirational math teacher in high school:

> She was probably one of the reasons why I decided to go into teaching. Actually, I was the first one to go into teaching and no one else tried it. My younger brother tried teaching and didn't like it. I liked science but not as much as math. I liked physics and chemistry, but not biology…more so after I started teaching. (Interview, 11/9/13)

After teaching one year of high school science in Wailuku, Maui as a probationary teacher, Ed secured a permanent position as a science teacher and coach/mentor at the high school in Kahului in 1972. At this high school he taught full time for over 31 years and then part time for the next three years. Recalling his early teaching experiences, Ed shared that it was "rough at first, with its ups and downs," but he persevered and eventually developed his teaching identity and more specifically a science teacher identity. The strength, perseverance, and resilience over the years as a high school science teacher is something that Ed credits his plantation upbringing and also military experiences with.

Moreover, his philosophy for teaching chemistry and mathematics and preparing students for science competitions is one based upon relationship building at an adult-to-adult level when working with teens.

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He shared how taking a counseling course and learning about the book *I'm OK—You're OK* by Thomas Harris had influenced his teaching style as a new teacher. It was this emphasis on building personal relationships with his students over time and creating a supportive atmosphere for them to develop long lasting bonds on an adult level that helped Ed with developing his style of teaching and classroom management.

This relationship building was evident in Ed's care and concern for students experiencing personal, emotional problems in their home lives as well. Inspired by the *I'm OK—You're OK* philosophy, and working with students on a level that was equitable and respectful, he saw his role as a teacher evolving:

> Teaching, you know, has its good moments, and at first you reflect upon the mistakes you make and then you learn after a while that there's certain understandings and practices that will really help you. Then you start finding out why the students didn't get to a certain level and the result you want to get at is "I'm okay, you're okay" or the adult-to-adult level. It's the philosophy that I found really, really works with people and what you do with kids. At the same time you have to maintain the position of teacher and student. It's a real fine line, you know? (Interview, 11/9/13)

Ed helped a number of his high school students overcome personal tragedies and/or mental health challenges. His work with students, school counselors, and parents to address the personal social and emotional issues at the time was something that he felt obligated to do as a teacher. At times he realized that he wasn't equipped to handle the more severe cases and made these referrals to specialists but was always there for students and their families. As a science teacher he realized the challenges faced and came to terms with his own abilities as a teacher:

> Those experiences with those students that did have mental health issues…at least I understood that this was more than I could handle and I had to make referrals to parents to send their kids to a psychiatrist. And I had to make a couple of those calls. (Interview, 11/9/13)

Ed elaborated on his understandings of his role as a teacher in this community of practitioners on Maui and while challenging at times, he felt that he was able to positively support students not only with science learning but also those with mental health issues:

> And I think that's why teaching was great, you know? You do teach, but you have to understand, too, that teaching…as a human being, you have limitations even after your training. With students, you can't play God. There were times you'd have to know what you can and cannot do on the mental health side. And it's…as much as you would like to help, sometimes it's better to leave it to the professionals. It's probably one of the more valuable lessons I've learned. (Interview, 12/5/14)

> While officially retired from teaching in the public school system in 2005, Ed continues to dedicate his weekdays to help students prepare for upcoming Science and Ocean Bowl competitions, and coach students to take the Advanced Placement (AP) chemistry exams. High school science education, for Ed, was about understanding the major concepts in chemistry, oceanography, geology, etc., how they connected to the real-world, and how passing these high-stakes exams will help one to get into a good university after high school. Topics of carbon emissions, climate change, the ozone layer, fracking, and energy issues were discussed during study sessions in preparation for bowl events and in his regular chemistry classes.

> In oceanography we talk about all these issues…these are all part of the conversations. One of the big issues is about energy because those are the topics I talk about that never is covered in school in the regular classes. Most of the chemistry that is taught in the classroom is usually almost the textbook type. It goes back to relevance and it should be relevant to students. It's all built on foundation and everything falls into place. Seeing patterns and not just memorizing. (Interview, 12/5/14)

He continued to share this transformation as a science teacher practicing in an evolving community of practice in Hawai'i. What he's learned about himself and in his students over the years is that science teaching "doesn't happen in a vacuum."

Ed reflected upon this process of change for himself as a teacher of science:

> For those students who have gone to the science bowl and won, there was an interesting phenomenon that occurred. It's to the point where I don't have to ask them to meet, study, and practice, as they have formed not only a science bowl team, but a social group. They enjoy each other's company and enjoy competition. They have learned to love learning for learning's sake. (E-mail correspondence, 1/26/14)

In addition to teaching and volunteering at the high school to coach students in chemistry and other science topics for the Ocean and Science Bowl competitions, Ed also taught science and elementary math methods courses at Maui Community College to pre-service teachers. His commitment to the education profession and supporting pre-service and in-service teachers has brought on frustrations at times and he expressed that the public schools "haven't stepped up enough" to the challenges of preparing students to enter college and STEM careers. In terms of teachers' rights and being raised on the plantation where unions were historically very strong, Ed has gotten involved politically with helping to make changes in local government. Like his sister he has been involved with the Hawai'i State Teachers' Association (HSTA) to address teachers' rights.

Ed's years of teaching and continued volunteer work at the high school continues to involve challenges to how he feels science teachers get trained to become a part of this community of practice and how students should experience high school science in Hawai'i. Building relationships, applying science concepts to real-world problems, and nurturing a competitive atmosphere that prompts hard work and teamwork are a part of Ed's evolving eco-identity and how he continues to traverse the professional landscape of teaching in Hawai'i.

Bridging Knowledge Systems

Ed speaks from a Western scientific ideology when discussing the impacts of golf courses on Maui and the erosion of beaches and the results of climate change based upon research and data as evidence of the "truth." What about cultural and Native ways of knowing as they connect to Western science?

As a college student Ed enjoyed meeting people from different backgrounds and cultures and from all places in the continental U.S., which strengthened his ability to consider different learning styles and ways of knowing when teaching science:

> I think that's what really opened my eyes to what the rest of the world was like. You got to see people from different areas. So, you have a different perspective on the world when you come back. (Interview, 11/9/13)

In terms of connecting the Hawaiian culture and ʻike Hawaiʻi to support his teachings at the high school level, Ed has focused on these aspects through cultural relevance in Western science. He was involved for many years with the school's hiking and science clubs, traveling to Haleakala Crater and to Hana, on Maui, for outdoor experiences. He also encouraged students to get involved with astronomy and astrophysics through the programs at the University of Hawaiʻi at Mānoa (UHM).

It was through the projects at the Institute for Astronomy at UHM where we had initially met. Ed shared how with the astronomy programs, "we made the connections" and how "it gives you more real-world applications with math and physics." While Ed does not overtly address the Hawaiian culture in his science lessons, he embodies a sense of respect for all cultures, including the local culture, when addressing issues in our society today. A bridging of Western science with local cultures and practices based upon an amalgamation of ethnic groups coming to Hawaiʻi during the plantation era are evident in Ed's continued practices as a science teacher.

Island Biogeography

Discussions on environmental values and beliefs took place, based upon the NEP Scale questionnaire Likert-based statements such as Item 6: "The Earth has plenty of resources if we just learn how to use them." Ed responded with "agree," and because this item was not contextualized to the Hawaiian host culture and places with biogeographical contexts attributed to non-Western societies, this confused him. Ed's conceptualization of this statement revealed the kind of thinking associated with living on an island ecosystem:

> It depends on…you talk about natural resources like it would usually mean the Sun (thermal). You understand what I'm saying? Yeah. The wind, you know? Renewables …because we do have a lot of renewables but look at Maui; and if I were to run Maui Electric I would place the big solar fields right outside of Kīhei. Because every day that I drive through there it's sunny. (Interview, 12/5/14)

Ed cares not only the environment and place where he lives, but everywhere else on Earth. He is concerned about how humans are negatively impacting the environment and further elaborated on his sense of place on Earth and what an eco-identity means to him. His concerns reflect how thinking like an island can promote living like an island, when understanding island biogeography:

> You know I've seen changes that are really bad for the environment. Like, for example, I've seen it at the beaches in Kīhei where people try to steal land, but knowing that, to further their beachfront property…and the things people put out. Things like that. What they don't realize is that there's impact on beaches somewhere else. You know what's happened at the golf course here? The harbor has had a lot of damaging effects on the land. The golf course area, the Waiheʻe area…where the beaches have eroded as a result of the harbor being built and sanded. (Interview, 12/5/14)

Like the other teachers in this study, the specific mentioning of "island biogeography" did not occur, but the underlying principles of island biogeography and the thinking and living like an island mindsets were expressed.

Case Study #5: Malia's Eco-Identity

Reflective Environmentalism

Malia was born on Oʻahu and grew up in the ahupuaʻa of Hālawa where she resided with her family until moving to Hilo, Hawaiʻi while in upper elementary school. The place she connects to and where she considers herself from is explained when she shared: "We then moved to Hilo side when I was in fifth grade. And then I…so I consider myself from Hilo because it's where I went to middle and high school." While she currently lives in Hālawa and teaches at a public high school in the Windward district on Oʻahu, her connection to Hawaiʻi Island remains strong.

After completing the fourth grade, Malia and the rest of her family relocated to the Hilo area on Hawaiʻi island, where her father worked as civil engineer for the Board of Water Supply. Her mother was an educator and principal and Malia noted the educational influence by stating, "Yes, it runs in the family!"

As a child she was always curious about the outdoors and became more aware of her surroundings with the move to Hilo:

> [I] was in the yard a lot. Looked for bugs. I guess the most significant would be moving to the Big Island. We lived in a three-bedroom rental, and then my parents bought a five-bedroom place in Hilo. It was less expensive than Honolulu…with more land. (Interview, 10/31/13)

Her sense of belonging and continued connection to her family and the small town on Hawaiʻi island were becoming a part of her environmental identity and sense of place. Malia remembers an incident in her seventh-grade science class and being called in to the office with her mother and the science teacher. This experience with a misunderstanding about what the teacher saw her being a "seventh-grade brat," was really her insistence that "when I raised my hand…she would take a long time to call on me…and when she called on me that I would forget my question." She shared how this incident has influenced her teaching to this day in the ways that she responds to students' questions in her chemistry class and being more mindful of multiple perspectives and cultures of her students.

Malia continued to be tracked in GT program in middle and high school and recalls taking biology and chemistry classes (advanced versions) with the same group of students. Her experiences in middle and high school science classes were not quite engaging up until her Advanced Placement (AP) chemistry class in the tenth grade. Prior to AP chemistry, Malia noted how, "I don't remember anything from biology. I don't know why. I remember the egg shell dissolving in vinegar…for the cells." The lack of engagement for her was due to what she calls "traditional teaching" and "doing a lot of lab reports, using the Bunsen burner…lot of lecture." Up to this point, she wasn't doing well on the tests in the chemistry class, and it was not until the AP chemistry class in tenth grade where something happened for Malia. She remembers watching the movie called *Medicine Man*, about a scientist trying to find a cure for cancer. This experience in 10th grade impacted her with how she found meaning with science:

> Sean Connery [actor] was a scientist trying to find a cure…and it was a challenge with the development in the Amazon…and at the last minute they figured it out. So, from that movie I had aspirations of wanting to find a cure for cancer. I was doing research on it. (Interview, 10/31/13)

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In discussing the Likert-based responses on the NEP Scale questionnaire, Malia began to disclose the influences religion has had on her scientific thinking, sharing, "I might contradict with some of these." With statement six on the questionnaire, "The Earth has plenty of natural resources if we just learn how to use them," Malia's response fell into the "Pro-DSP" (Pro-Dominant Social Paradigm) rating, according to this Western-based scale (Dunlap et al., 2000). Her response was "agree," and she responded how some of these answers "stem from my religion, like how God has created Earth for us humans, and He's given us what we needed." Malia is a practicing Christian and grew up going to church as a child and she continues to attend church in Hālawa where she now resides with her own family. Malia understands and believes that humans are stewards on this Earth and that while she feels that some people are irresponsible with our natural resources, she does feel that humans were "given this Earth by God to use as needed, to survive." She explained further:

> I feel that God has put humans in charge of what dwells on this Earth but I don't think that means we should be irresponsible. God still tells us to be good stewards of the land. So I think that the Earth has enough resources but I don't think we know what they are and I think we exploit too many of the things we think are good, you know, like fossil fuels and stuff. It's interesting…I don't think we are good at that and so…but I think that the Earth...it's just that the Earth was surviving without us. (Interview, 3/1/15)

Malia went on to share that, "it's rare to find a person who believes in God and evolution. But I do." Her upbringing as a Christian and her continued practice as one has influenced her practices as a chemistry teacher, which she says has been uncomfortable at times. This teaching dilemma and conflict with her science teacher identity and Christian identity, as both a believer of God and as a teacher of science was a meaning making process:

> I am a Christian. We are Christian. So we go to a Southern Baptist church but that's what I grew up with, so my father-in-law is a former pastor and yes, we go to church and we believe in God. I believe in creation but I also believe in evolution. I believe that God created the Heavens and the Earth and I believe that God created all the animals but we can't deny the fact that there's evidence of evolution. I just don't know how that's possible. So…yes, I believe in both. (Interview, 3/1/15)

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Malia explained further about her agreement with respect statement number 12, which states, "Humans were meant to rule over the rest of nature." Again, while this response may appear to warrant a "Pro-DSP" rating in the Western framework of this Scale, Malia explained: "I think this comes from religion. We're the ones with the brains… supposedly…right? I mean, supposedly." Malia shares her concerns about the negative impacts humans can have on this Earth just to satisfy their own wants and needs, including making individual financial gains in Western society at the cost of the environment. She is concerned about the capitalistic thinking emerging in the Western world today and her pro-environmental perspective emerged:

> I think the desires of human nature will always surpass what's best for the Earth. So the greediness of companies, you know…that human nature aspect of it…that we have a right to do things…and we want more money. I think that will always take precedence over what is for the greater good. It's kind of depressing. (Interview, 3/1/15)

In addition to the concerns with global climate change and how she views human nature, Malia shared her thoughts on having a sense of place. In written response and also in conversation she shared that this place was Hilo on Hawai'i Island where she had lived for ten years as a young girl up until finishing high school: "if you were to ask me where I grew up, I think Hilo would still be a little bit more impactful, I guess, in my life." This sense of place in Hilo is similar to the connection to the area in Windward O'ahu where she currently teaches.

Evolving Science Teacher Community of Practice

Malia's indoctrination into the teaching field of secondary science was not what she had expected to go through. Her positive experiences in high school, with her AP courses in chemistry and physics, led to the building up of confidence with studying these subject areas. Malia's continued interest in the sciences were fueled when she decided to go to university. While she enjoyed her place connection to the small town feel of Hilo she realized that going away, out-of-state, for college was a good idea. "I enjoyed going away. The first year I didn't, but then after that it was good. It was a good thing," shared Malia. At the time of her graduation from the University of Washington in Seattle, as a chemistry major, it was right after September 11th (2001).

Malia was not sure what to do with her chemistry degree after returning home to Hilo after September 11th, questioning herself and lacking direction and assuming: "this was another one of my failures." During her time as a chemistry major, however, she experienced a pivotal moment that prompted her to decide upon teaching high school science. While Malia was not in an education program at the time, she had a positive impression of the profession:

> When I was in school [undergraduate chemistry program] though, I volunteered at a high school, tutoring in the classroom. And that's how I got that [experience] because I wasn't in an ed. program. I took, with my minor, "Algebra for Teachers." It was a good class and from there I connected with high school. I volunteered at a high school that was in the outskirts of a black community in the district. At this school they bussed kids in, as they did back in the day. It was mixed and there were all kinds of kids. I think from that, I kind of knew that I was going into education. I didn't have a plan after going to college. I didn't want to go into medicine. (Interview, 10/31/13)

Malia kept in contact with her former high school physics teacher and was able to take on a job as a long-term substitute back in Hilo, since this former teacher was now being called out to serve after the 9-11 incident in New York in 2001. The initial experience of being hired on short notice to teach for three quarters in the school year, for Malia, "was a huge learning experience." With her mother being an educator and principal she was encouraged to apply for the Masters of Education in Teaching (MEdT) program at the University of Hawai'i at Mānoa (UHM). After a year of emergency teaching on Hawai'i island she entered the MEdT program on O'ahu with the help of her mother.

Malia's experiences in this graduate program was an "interesting experience" for her, with a cohort of about 24 students, with half of them in the elementary focus and the other half in secondary teaching. As part of the MEdT protocol and the expectations from the Hawai'i State DOE, Malia continued on from her student teaching practicum in the third quarter to the emergency hire position at the same school, for the final quarter in the two-year program. She shared how, "We went for interviews and that it was a good idea to take the job you're offered," and how these expectations were something she felt the need to adhere to as a new teacher. "Not everyone did that, which didn't sit well with me and other people in the cohort," she stated.

As part of this teaching community of practice Malia understood that there were rules and guidelines and certain expectations for teacher behaviors, and especially as a new teacher. During her time in the MEdT program Malia recalls being "bothered" by not being able to pass the PRAXIS teaching exams for chemistry content and for the science pedagogy with desired scores. She was frustrated, admitting, "I remember I failed my pedagogy [exam] like three times. I didn't pass my pedagogy!" While not being able to work on becoming a tenured teacher right away Malia eventually mastered the pedagogy exam and has remained at this high school in the Windward district for 13 years (2017).

Malia's first three or four years as a science teacher were not always easy and she "wanted a different job." While things were not horrible in terms what she did for a living—she enjoyed and felt good about what she was doing in the classroom with her students—the realization of "the lack of pay for the amount of work we do" was evident to Malia. She shared how surviving in this profession while trying to make a living and start a family, and how she stuck it out, helped her to emerge stronger and wiser about the ways in which she teaches today. She expressed the challenges: changes with administration, the long hours put in to plan lessons and units, the time it takes to grade assignments and tests, and the constraints that come with teaching science in the public school system.

At times Malia didn't feel well-respected as a teacher and was frustrated with changes to the tenure system and not receiving bonuses with furthered education (Malia also completed a National Board Teacher Certification program):

> It wasn't the content [teaching]…it was all the other stuff, like grading the papers…and all the other stuff…and the lack of respect, too, from the public. They don't think that we do any work in the summer and that we just get time off. '*Cause* they don't know how tiring it is. Like people in the legislature…I think lawmakers should all teach in the public schools. Yes, yes…in my world! (Interview, 10/31/13)

As a teacher who has been indoctrinated into the world of public school teaching, Malia also finds not only meaning and a sense of purpose with teaching, but she also has compassion for her high school students. She has a passion for teaching science and especially the subject area of chemistry and the higher levels of AP chemistry which she now teaches.

Malia expressed how much she likes her job and teaching science and how she will fight for what she believes should be offered to the students at her school. She is an advocate for students learning the rigors of science in high school:

> I feel passionate about science. And so, whatever school…I think I've decided that whatever school I'm at I would look at the science program first. I feel proud in the sense that from when I first started until where I am now—although the State has helped us—there are now six sections of chemistry and one AP chemistry [section]. I started the program [AP chemistry] with 18 [students]. (Interview, 10/31/13)

In her practices as a public-school science teacher, Malia understands that she needs to teach chemistry from a Western science perspective and that religion is taught and discussed in the world history classroom. Malia describes her interactions with students while trying to get around the fact that she is a believer of God while also a science teacher who cannot refute that evolution is a process that exists:

> Okay, so this is where I get into trouble '*cause* some students will press me with "why, why, why?" you know, even in chemistry. And so we go as far as we can and then after a while I'm like, "I believe in God, '*cause* that's it." There's nothing else I can explain, you know? (Interview, 3/1/15).

Malia's new role as a mother has now taken precedence over doing any extracurricular activities on the school campus or taking on any committee roles at the school. Malia's time off for her pregnancy and birth of her son in 2012 has caused her to limit the amount of time she contributes to her profession. Her son was born with a medical condition requiring several surgeries over the years. Malia's teaching practices and overall mindset of the profession has changed since her priorities have changed:

> So, this year…last year and this year, with [her son], it's been a learning experience, learning not to bring a lot of work home, '*cause* I would tend to bring my work home. I didn't like doing work at school. I still bring it home [the work] but I try to do as much as I can at school so that my weekends are free. And the weekends that [husband] has guard duty I'm in charge of [her son] so I can't do work. Things don't get done, and then this year has been hard, trying to be a good mother…like balancing my career. (Interview, 10/31/13)

She explained this negotiation process with respect to her professional and personal lives:

>Because this year is hard. I have three preps: one is AP and the other is a new one. Yes, so this year has been hard but I already told [husband] that I need to devote some quality time to school, *'cause*, you know I took time off to have a family and then now I want to get back into my career. So when I say "I took time off," I used to advise classes, advise a club, and things like that…I did a lot of things. After advising I set up the STEM club at my school which I kind of let go of because I had [her son]. So it was hard when he was born. (Interview, 10/31/13)

As a chemistry teacher at the high school for almost two decades now, Malia feels good about what she does and has a great relationship with her science department colleagues. At times she still struggles with mandates such as the recently adopted NGSS put upon public school science teachers. Malia has managed to come to conclusions about her science teaching career, and self-doubt and self-efficacy as a science teacher are a part of Malia's meaning making process of being a science teacher:

>I think that's been a struggle throughout my career. It's like, what am I teaching? You know, I know that there's standards there…I understand that, and but now, the question becomes, what is relevant to their lives and/or how do I prepare them for college? *'Cause* I think those are two different things. What is relevant to their lives and how do I prepare them for college because I always thought of the nitty gritty chemistry things, like when you think of chemistry. Whereas, in real life, who cares? You know? Like stoichiometry, who cares about that? Really, right? If I have kids who aren't going to go into college chem., then why? I feel like, why do I need to? (Interview, 3/1/15)

Professionally, Malia has progressed tremendously over time, and her involvement with standing up for teachers' and students' rights has been longstanding. She is open to and adaptive to new things to incorporate into her teaching practices, including taking an Excel course. She shared: "Every now and then, I'll try something new, you know?" She always has "grand intentions" to make the learning more rigorous, relevant, and real-world for her students. What keeps her going, as she continues to practice at the same school for all of her teaching experiences thus far (13 years now)?

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Noting that "everybody has a bad day," that her new role as a mother had taken away time from doing extracurricular projects at school, what it comes down to is the fact that Malia feels like she belongs in this community of science teachers at this school, and that she feels connected to this place on the Windward side:

> I think it's my department, because my department is very caring and they're competent, you know? Good camaraderie. We work very well together…that's the main thing. Students are nice. They're pretty humble. You know what's best is, even the *kolohe* [mischievous] kids, they know what respect is. I don't know how to say this, but you know how there's some teachers that it's "My way or the high way?" It's not really my style. I would like them to listen to me but there's other things going on in their lives. I understand that. So, if we can just work together and make the year doable, then I'm fine with that. (Follow-up Interview, 10/23/17)

Bridging Knowledge Systems

Malia's practices and her professional development over time was challenged in 2012, during a time of great turmoil and resistance to change, with respect to the school's community-based redesign project. She applauded the redesign process and how the community was able to come in and support teachers with rethinking how students at this school (with a high Hawaiian student population and also an overall minority percentage of just under 90%) would learn best and succeed. Malia shared how the development of Small Learning Communities (SLCs) at this high school was envisioned in 2012 to provide for personalized learning environments with teachers integrating occupation and career-related goals into the classes, to enhance real-world relevance and maintain high academic standards.

As part of this change with programs with increased community involvement Malia saw the emergence of an integrated science course for the ninth-grade students, which she supported.

This integrated learning in high school, especially in the ninth-grade makes sense to her:

> It's because I think that's how human beings learn science, in a holistic approach. Yeah. So, my vision for ninth grade is Integrated Science. You talk about a topic and you bring in all of the sciences. For me, that's how people learn science and math. I don't think they should be teaching science and math as content areas. Of course, I'm probably the minority, because everyone who teaches science, majors in a specific science, right? But I don't think that's how people learn. (Interview, 3/1/15)

Malia openly shared her struggles with respect to what she feels would be most relevant and authentic in terms of learning science while also at the same time keeping the rigor of chemistry going her classes. On the topic of providing for integrated learning experiences, she understood the need for the SLCs on the campus at the time. She shares the frustrations of a teacher who has to adapt to the modifications and expectations with the changes in administration over the years. Malia admitted that she wasn't implementing any Project-Based Learning (PBL) into her curriculum at the time, but that her intentions were there:

> Yeah, but I think I just get distracted by what is the nitty gritty of the [chemistry] course. So I'm not good at the whole, project-based learning, you know? I have grand intentions. Like every time we get something told to us, I try to integrate it. (Interview, 3/1/15)

While it's been a struggle for her to implement a PBL program into her chemistry curriculum in the past, she believes how science in general, at the high school level, should integrate the Hawaiian cultural values and practices with the Hawaiian knowledge system of ʻike Hawaiʻi. Malia is also mindful of her students' religious backgrounds. While she makes it a point to keep the religion and any form of spirituality out of the chemistry courses she teachers she has struggled, however, with coming to realize the importance of including Hawaiian culture and its associated spirituality into her science curricula:

> For now, I just know what I need to focus on, making sure my students understand. You know, content and drawing more from real-world, real-life experiences. I'd like to work on that. Sometimes I feel like that's impossible, because there's three different classes I'm doing that for. (Interview, 10/31/13)

The integrated approach to having students experience science, where Western science is bridged with 'ike Hawai'i is something that Malia supports but feels that she needs more training with:

> At our school they take "Integrated Science." It's a school decision which I support. It's because I think that's how human beings learn science, in a holistic approach. Yeah, so, my vision for ninth-grade is "Integrated Science." You talk about a topic and you bring in all of the sciences. For me, that's how people learn science and math. (Interview, 3/1/15)

In her engineering technology course, Malia is bringing to light the engineering marvels of the Hawaiian people with their *loko i'a* (fishponds) and *lo'i kalo* (taro patches). As part of the land education process, she is now not only incorporating types of places like the fishponds and wetland areas of today, but also the critical, historical understandings, and the need to restore the Hawaiian culture and the places which they once practiced sustainability.

Island Biogeography

In addition to participating in professional development to better understand the engineering design process (EDP) and to design and implement units of study in their engineering courses, Malia is also part of the engineering pathway team today and is teaching the Engineering Technology I course. Field-based experiences and community partnerships have been provided for in these engineering courses, in addition to the EDP-focused units of study being implemented.

Malia shared her most recent ideas for integrating the engineering process not only into the engineering class, but also into her chemistry classes. She is content [chemistry] driven and does enjoy the change with the engineering course, as it has taken her outside of her comfort zone of science teaching and science content knowledge. Noting how she "always wants to improve," and that "stagnation is not good for teaching," Malia is enjoyed teaching this engineering course in the 2017-2018 school year. In this class, her students wrote letters to the governor on this topic of biofuel research in Hawai'i to meet the clean Hawai'i Clean Energy Initiative for the State, by 2045. The understanding of sustainability and thinking like an island are evident in Malia's work today.

Principles of island biogeography are understood and practiced in Malia's classroom today, although not explicitly stated.

Within the framework of thinking like an island is the understanding of the importance of Hawaiian ways of knowing and technologies of the past. With respect to ʻike Hawaiʻi and bridging this with her practices and science content from the Western perspective, Malia has become that voice and advocate for students' rights, and their needs as students living and being schooled in a Hawaiian cultural context. She acknowledges the high Native Hawaiian population of students at her school and works to integrate her lessons in chemistry and with the engineering course she is currently teaching.

Case Study #6: Lynne's Eco-Identity

Reflective Environmentalism

Lynne (a pseudonym) was born and raised in New Jersey and she and her older brother and parents all completed their K-12 education in the town where she grew up. Lynne recalled her natural love for the outdoors as a little girl and she was always outside, preferring to be outdoors rather than being inside. "What I remember about growing up was that I can very easily entertain myself. By myself, outside…for hours," she stated. Early connections to her places at home in New Jersey were important, informal learning experiences for her:

> I just remember that I would just inspect everything and I was really into finding bugs and looking at the different plants and collecting parts of plants and leaves…at a very young age. You know, I grew up in New Jersey and so the changes of season and being outside experiencing all that was really huge as a child. (Interview, 6/29/15)

Lynne continued to describe these experiences to reveal an early affinity for natural things and phenomena:

> I remember, especially in autumn, collecting all the different leaves and different colors…you know when you can see different animals at certain times of the year, and I was always very interested in that. We had rabbits in the backyard and we could see when they had their babies and they weren't around anymore when they were hibernating. So these are all the things I noticed. I was clearly more interested in being outside than playing with dolls and that kind of stuff. (Interview, 6/29/15)

Lynne's freedom to be outdoors as a child to explore her natural surroundings, were at times challenged when she entered grade school.

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Her first schooling experience in the kindergarten through second grade setting was "very limiting and sterile," according to Lynne, as she was placed at a Catholic school. This was where her father attended school and it was also because her parents didn't want to have Lynne wait an entire year due to the starting age requirement for kindergarten at the public school. Lynne recalled her negative experiences:

> Ugh…I hated it. Absolutely hated it. I think when I was younger a lot of my experiences as far as being outside in the environment were through family and through play, because in the kindergarten through second grades I went to a Catholic school and I hated school. The structure was very rigid and I hated wearing a uniform. I felt like the teachers were not nice. So, by second grade I wound up in the nurse's office all the time. (Interview, 6/29/15)

Her mother was concerned and after many trips to the health room and instances of staying home, so Lynne was finally able to attend public school in the third grade. From then on, noted Lynne, "as far as education, my feelings about school changed a lot," and that "it was a shock to the system with the freedom I had."

Lynne's K-12 experiences were positive and nurturing toward her outdoor interests. Lynne's interest for learning more about the world around her was instantly satisfied with her third-grade teacher at the new school. This teacher modeled qualities for her back then, which Lynne now realizes as a positive influence on her teaching of science. She recalls her third-grade teacher's calm and caring demeanor:

> I do remember that she was very interesting and she brought a lot of her experiences into the classroom, and I think that's what made her so interesting as well. I'm sure many people can't remember all their teachers but I distinctly remember that she traveled to Kenya, and she told us all about…and we actually studied it. I guess she went the summer before we had her as a teacher. She brought back all this stuff from Kenya and told us about the trip and the animals, and…I think sharing that with our class was huge, you know? (Interview, 6/29/15)

The continuation in the public-school system was filled with many positive experiences for Lynne. She remembers the sixth grade and how her teacher had them send tomato seeds to NASA, where they would be taken up into outer space in the space shuttle and then returned to be grown to see the effects of space on tomato plant growth. Lynne felt that this experience was "the most amazing thing ever!"

In ninth grade Lynne's self-confidence in science was compromised when she was placed in the remedial science class, which she shared was, "like physical science…just general science, and I was like, this is terrible." Lynne was surprised and disappointed, disclosing, "funny enough, they didn't think I was ready for freshman biology." She overcame this difficult year in high school and by sophomore year she was feeling more like herself again, describing her experiences and a strong, continued interest in the life sciences:

> I took biology my sophomore year and *loved* it. I had an amazing biology teacher who was just…I don't even know what it was about him, but he was just…it was general biology…I thought it was interesting and I really loved learning and understanding how everything works. So, he did something right. (Interview, 6/29/15).

Lynne realized her passion for studying in the area of the life sciences. Determined to be prepared for college and studying in the sciences, she learned from the school guidance counselor what needed to be done and in her junior year doubled up and took chemistry and physics at the same time, to then be able to take the biology II course in her final year.

In terms of role models in high school, the life science teachers for her sophomore biology and senior advanced biology courses were most inspiring. Lynne revealed characteristics of this advanced biology teacher in her senior year, which paralleled those of her third and sixth grade teachers for science. Like those science teachers during her elementary and middle school years, this teacher, she says, was "another amazing biology teacher":

> I think that he had the most influence on me, as…when I became a teacher, because I think his style of teaching I kind of naturally absorbed into my style of teaching. It was a lot of sharing of personal experiences and stories. So, you almost didn't realize you were learning the science because he would tell you these crazy, elaborate stories about something that happened in his real life and show you pictures from it. And then somehow, he inserted all the science in there and you're like "wow!" I realize, too, that I didn't take notes *'cause* I was listening to the story and…he just explained this whole scientific process within the story. (Interview, 6/29/15)

Lynne was engaged in this advanced biology class which also earned her college credit. She continued to be inspired by this teacher, noting how the science learning was the kind of learning that was "very real-life; everything happening in real life." There was a time during this course that Lynne was able to take home an animal (her teacher's focus was zoology, and he did animal shows on the side) and she chose a boa constrictor. Caring for such an animal at her home for over two weeks was an exciting learning experience:

> We were able to choose whatever kind of animal we wanted. I went for the boa constrictor. My mom was not happy. I came home with the boa constrictor in a cage and in the middle of the night she would come into my room and put bricks on top of the cage because she was afraid it would get out. It was funny! Actually, I would take it out in my room and I would hold it and feed it. It had to be fed baby mice. (Interview, 6/29/15)

Lynne's love for animals and also for plants in the living world were fueled further in her senior year, with another project, this time focused on plants. Lynne credits her teacher's style and vast knowledge of animals and plants, and how he exposed them to real-world experiences.

Lynne's responses to the NEP Scale questionnaire confirmed her strong, eco-centric values and belief toward the environment. When posed the question about where she felt most connected Lynne answered that the ocean was her place of connection and a way to appreciate not only life in the ocean but also on land, as she realizes the interconnectedness of all life. Her written response revealed a strong sense of place and belonging in communities near the ocean:

> In the ocean (any ocean, really; more so here and in NJ – my homes) actually being in the water in the ocean allows me to disconnect from daily stress/thoughts and be more mindful and focused on the present moment. It is also not your typical environment so floating and drifting feels a bit more magical to me than standing or sitting on the land. (NEP Scale Questionnaire, 10/1/17)

While not born and raised in Hawaiʻi, Lynne considers Hawaiʻi her home:

> I feel more at home here because of the culture. I really like to play outside which is from way back when so the opportunity to be outside all the time and play outside...I surf, I run, I bike, I swim, I hike. I thought it was really important that I understand Hawaiian culture here. I started dancing hula about a year after I got here and that was a huge way to better understand the Hawaiian culture and learn language and learn history and legends and the important places to the Hawaiian people. It was a huge, important thing to do for me to better understand my sense of place here in Hawaiʻi, and my role here as well. (Interview, 6/29/15)

Evolving Science Teacher Community of Practice

Lynne knew that she would be going to a college after high school and that it would be in the life sciences and most likely studying plants. In her search of college with a plant sciences program she chose to attend the University of New Hampshire. She visited the school and was immediately sold:

> When I went to visit there they told you [*sic*] about the greenhouse you'd [*sic*] be working in and the different farm areas…the land…the agricultural land that they had to do experimental research on. I thought, wow, this is great…it's beautiful out here and the campus is beautiful and I want to be out on the farm…testing, you know, doing research with plants. I was like, "this is it." (Interview, 6/29/15)

Lynne's dream to become a plant scientist were temporarily stalled, as she went to the University of New Hampshire for one semester and then had to get out of there. The school's distance from her home in New Jersey was not the issue. Lynne commented on how it was "a weird school" and how she felt out of place socially. There was reason why she felt that she didn't fit at this university and how this place posed a challenge for her and her pursuit of a science degree: the lack of diversity and what she described as "very 'New-England-y,' very white."

Lynne ended up at Rutgers University and went on to finish undergraduate school to obtain her degree in plant science with a certification in education. In her last year of school, after trying out classes in different areas of plant science and finding that "there was nothing that I was really connecting with," she tried a course in education. Not wanting to be stuck indoors for work, Lynne talked to others about her dilemma and what she wanted to do with her life, and how she really loved studying her natural world.

She also wanted to share this knowledge and passion with others. This led to the realization that she could teach science:

> After talking with a bunch of people, you know, about what I wanted to do with my life, I said that I really liked this sharing…you know, being outside…and my love of all of nature with people. And they were like, "maybe you should teach science." I thought, yeah, maybe I should! Yeah, so I did my all my course work in four years and then I had a semester of student teaching. And once I did that, I was sold…I loved it. I knew that was exactly what I wanted to do. (Interview, 6/29/15)

As a practicing teacher Lynne student taught in an urban area in New Jersey in a seventh-grade life science classroom. Her cooperating teacher was descried as "the best mentor teacher I've ever come across," because she was supportive and willing to give up the freedom of the classroom to let her try. Lynne realized that during this time of practice she would need to be a risk taker who would learn from her mistakes with a "failing forward" mindset:

> She [mentor teacher] also let me fail a couple of times, to see what that was like, which at the time, I felt bad about…but I realize why she let me do that, so that when it came to having my own class, I wouldn't make those mistakes. I wouldn't do the same things. So, I kind of adopted a lot of her styles of teaching, too, which was bringing themselves into the classroom and being dynamic: basically, a combination of putting on a show, slash, educating, you know? You were this entertainer as well. (Interview, 6/29/15)

After completing her student teaching practicum in the fall, Lynne took a semester off to become a snowboard instructor in Vermont for the winter. In between snowboard instructing in Vermont and taking a teaching job the following year, Lynne spent three months in New Zealand with her then boyfriend who was also an instructor at the Vermont school, and originally from New Zealand. She admitted to having "an exciting life," which mirrored her carefree and athletic, outdoorsy nature. Lynne was offered another science teaching position at the same school when the original teacher returned from maternity leave. While offered a full-time position at this point she declined, in favor of traveling back to New Zealand.

Once in New Zealand, Lynne began applied for teaching jobs and was in the meantime dating her boyfriend and fellow snowboard instructor.

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She was able to do more traveling and outdoor activities with him in the area and was able to stay with his family at the time. What she acknowledged about her boyfriend was that he had a strong connection to places and people in New Zealand, where he was born and raised. She realized the importance of knowing where you come from and where you live:

> He was the most amazing tour guide. I've never met someone so knowledgeable about their own country. So, I was really impressed…and so that is how he won me over. He knew a lot about the history of everything, all the different places, but also…if I pointed out plants or animals, then he knew what they were. He's a very smart guy. (Interview, 6/29/15)

Thus Lynne's heart was won over with the people (including her boyfriend) and places in New Zealand and she soon wound up teaching science at a Catholic, all-girls school. Over the next three years Lynne learned from the locals, including her students, which humbled her. She also realized the discrepancies with respect to her Western-based training as a teacher and a scientist and also the differences with native ecosystems in New Zealand. Lynne was challenged when working with her mostly Maori students for the first time. She was attentive to the culture, languages, Native ways of knowing, and the new environment she was now immersed in. Lynne reflected upon this experience and how it supported her growth as a science teacher:

> So, to be somewhere else with other languages being spoken and another completely different culture that I was very unfamiliar with, to be patient and learn about that. I realized that also, here I am, a science teacher smack dab in the middle of the environment that I was completely unfamiliar with. So how do I learn? I knew the style of how I taught was very much bringing personal experiences in, and so all of a sudden, my examples didn't make sense anymore. (Interview, 6/29/15)

Lynne realized that she "couldn't very well talk about squirrels and deciduous trees" based upon previous environments back home in New Jersey. Moreover, her teaching style needed to be re-thought and revised and the challenges she was confronted with forced her to be a "quick learner in a new environment," with "new plants and animals and examples of that. Not only that, using the local Maori names as well." This was a pivotal moment in her science teaching career because it helped her to confirm that what she was doing was the right thing to do as a science teacher: to provide for relevant, rigorous, and real-life learning experiences for her students.

Lynne adapted and made shifts in her ways of thinking about her science teaching and what was appropriate for these impressionable girls in New Zealand:

> I had my own style, you know. I made a lot of my own resources as well. Later on, after my first year, the guy who hired me who was the head of the science department said, "You know, we were a little nervous when we hired you, '*cause* you're young and you're from the states." He said, "Well, we thought you were going to be, you know, not the hardest worker. Americans have the tendency to have a…to be considered lazy as employees." And I said, "Oh really?" He then said, "We hired you," and "man, you're putting us to shame here. You're making us look lazy!" I guess because I just loved it so much and I wanted to learn so much. (Interview, 6/29/15)

Lynne continued practicing as a science teacher, moving to Oʻahu, Hawaiʻi and noting how her experience in New Zealand was "kind of a good transition, because it prepared me for Hawaiʻi." Prior to coming to Hawaiʻi to teach, however, Lynne returned to New Jersey and then on to Florida for graduate schooling to get her master's degree in biology curriculum and instruction. After two years Lynne got married to her boyfriend from New Zealand. As a middle ground, they decided to make the move to Hawaiʻi, where she would end up at a public charter school in Honolulu to teach high school biology.

With an attitude of "we'll take our chances and see how it goes," she and her husband came to Hawaiʻi, where he could continue his work online with a New Zealand company and she would continue with her career as a science teacher at a new school. Lynne enjoyed her four years of teaching science, ending up in her final years as the 12th grade biology teacher and also the science department head. She worked diligently up the ranks in the community of teachers whom she embraced and was accepted by at this public charter school.

Lessons were learned over these four years of teaching science and her self-confidence and identification as a science teacher were firmly grounded, as was her sense of place in a community surrounded by the ocean. As part of the teaching profession and this community in which she felt 100% acceptance, she gives credit to all of her science teachers and professors who have mentored and modeled for her over the years.

Lynne is grateful and humbled with these learning experiences over the years:

> I very much still feel like when I teach it was like putting on a show and entertaining, and to bring stories of my own personal experiences. Now with technology, you know, I did PowerPoints all the time and would have photos of things that I've done and places that I've been that shows what I'm talking about. The kids thought it was hysterical, because there would be me next to an alligator and…you know? As cheesy as it was, they would remember the story that I told them and that story was really the science. I think that's how I learned in biology. It was these stories that made sense when it's put into perspective of something that someone's experienced. (Interview, 6/29/15)

With her latest teaching experience in the 12th grade biology classroom at the charter school on Oʻahu Lynne was able to make lasting impacts on her students, inspiring her students to stand up for what they believed in, supporting this sense of agency with respect to addressing social and environmental issues in our communities today. Lynne was open and honest with her students. She allowed students into her personal life, which many teachers don't always allow to happen, fearing a breach of the teacher and student relationship. This included disclosing that she was a long-term vegan. She maintained connections to students beyond their high school years, after having taught the 12th grade biology course for the past four years. When asked her about student career interests in the sciences after high school, she said that there were a few, and how the administration was taking note of this informally:

> Having [taught] biology in senior year there tended to be science and engineering students, which is really nice. And a lot of kids actually came back and told me, "You know, I didn't realize that science could be so interesting," and "Your work was so hard but it was rewarding and I'm so prepared for college." It was really so nice to hear that all the hard work that I was doing, and the love that I was putting into what I was doing, was actually rubbing off on them. (Interview, 6/29/15)

After four years of teaching science at the high school level, Lynne moved on into an administrative role. In 2015 Lynne completed her first year in a new, administrative role at the same public charter school she started out at in 2008. As Vice-Principal and Dean of Curriculum and Instruction she noted that it was a very busy first year for her.

While she does miss the classroom teaching this change with learning and doing new things as an administrator was a needed change. Lynne's new role was something that she felt was coming, as she wanted new challenges in her career:

> I needed the [change]…if for whatever reason I got this feeling that when I wanted it to be something else, that I would take myself out of the classroom. I feel that's when you start to lose that…that spark, that thing that makes you a good teacher. You know that if you don't have that 100% drive, then that's time to do something different. I'm glad I ended the year I did. I started to get that little bit of a…like it needs to be something different, and it was a great class…they were very dynamic and engaging, so at least I had that going for me, for my last year. Yeah, so I think that was a nice way to end everything. (Interview, 6/29/15)

The past few years in this role as Dean of Curriculum and Instruction were filled with challenges of getting the school through the accreditation process. This included: working with faculty with a "deep dive into curricula," then experience the observations by evaluators and receive feedback for improvement, and finally, coming up with an action plan to have a systematic professional development timeline. Lynne has overcome challenges working with faculty from the perspective of an administrator and has developed the respect of her peers (former classroom teachers) to make that shift into this new position.

Bridging Knowledge Systems

From the very start of her teaching career, beginning with her student teaching practicum in that urban school in New Jersey, Lynne knew that the traditional classroom setting indoors and sitting still were not the best ways for her and her students to experience and learn science. Be it that she learned in a Western system of schooling throughout her K-12 years and then at the college level up through obtaining her master's degree, she was always drawn to teachers who modeled an experiential, student-centered approach. Her dislike for the rigid and impersonal style of the teachers of the Catholic school where she attended for three years was evident. Her naturalist identity and love for exploring her environment were fueled by supportive teachers in the third grade and up.

As a new teacher completing just under two years of science teaching in her home state of New Jersey, Lynn took upon the challenge and flew back to Auckland, New Zealand to eventually obtain a job teaching science there for three years.

In addition to having to win over the approval of the science department at this school, Lynne was also to do the same with her students, many of whom were "a little skeptical and standoffish in the beginning," but soon opened up once they saw how she wanted to get to know them and learn more about their culture, their language, and their natural environment. She developed an atmosphere of mutual respect as a teacher at this large Catholic school of all-girls, in Auckland, New Zealand. At this early point in her teaching career she was able to bridge two very different worlds in terms of what is taught in Western science and how it is taught in culturally relevant ways:

> It was in Auckland. It was a fairly big school. Very nice school…the kids are really nice there. I also taught a lower level science course and it had a lot of at-risk, what they considered at-risk youth, in that class…which was a lot of girls from different Pacific islands, like Cook Island and Samoa and Tonga, who also had, you know, socioeconomically struggled, in their families. I worked with them and they were the ones who *kinda* gave me the hardest time as far as whether or not they were trusting of me as the foreigner coming in…my teaching them. I think once they realized that I really did care and that I love what I did and I wanted them to love it, they were the ones who eventually became my teachers and taught me—like a ton about the Pacific Island cultures. (Interview, 6/29/15)

Lynne went on to describe how she overcame the challenges of being an outsider:

> They definitely at first were very closed off. I think it was, so what my intentions were and what I thought about them, is what they were waiting to see whether or not I had preconceived notions of them. I think when they realized that I just was here to do what I do and I'm honest, and I don't know anything about Pacific life, you know, that they were more open to sharing that with me. (Interview, 6/29/15)

Lynne wanted to understand the Maori culture and language and realized the importance of bringing in their Native knowledge system into the science curriculum:

> I just had to approach it by being honest and open with the students, and that I don't know about their culture, and giving them the opportunities. I told this to them too. You know, "give me the chance to learn about you, and be open to me, teaching you what I know" and "I want you to teach me what you know about yourselves and your culture." I didn't know anything. (Interview, 6/29/15)

After experiences in New Zealand and further schooling in biology curriculum and instruction, Lynne embarked on her new place of teaching sixth-grade science, and 12th grade biology at the public charter school in urban Honolulu. Like her initial challenges in New Zealand, she also had to win over the hearts and minds of her students here in Hawai'i:

> So, my experience teaching in New Zealand definitely helped me prepare for over here. Not that Hawaiian culture is the same…but similar. And so, I guess I was more prepared for it because the students here did the same thing. For the first quarter, at least, they definitely pushed [me] and tried to see, you know, who I am and again what my intentions were for being here. That class had also gone through apparently a number of teachers, and a lot happened with that class. For some reason, maybe, they were a little jaded to begin with, too, as far as a newcomer coming in and then leaving them. So, they were like, "Oh, you're just like the other one." (Interview, 6/29/15)

Lynne's understanding of Pacific Islander cultures (from being in New Zealand) helped her to better connect to her students in Hawai'i, in addition to understanding some of the Hawaiian and Samoan words, to the surprise of her students.

In terms of what she considers essential and rigorous science, Lynne believed in immersing herself in the place and culture of the people wherever she taught. Lynne has made positive impacts on her students with her unique style of culturally relevant teaching. Whether it be learning about the local flora and fauna in the New Jersey woods, along with their Latin names or identifying endemic species of plants by using the Maori language, she was able to bridge the gaps for her students. Her approaches may not have always been traditional like her Western form of training as a teacher, and she improvised and adapted to better connect with her students and show them that she cared about them emotionally and intellectually.

Island Biogeography

In the NEP Scale questionnaire, the statement that prompted an extended discussion was: "Nature is very delicate and easily harmed." Lynne's response was "Strongly Agree" and how she responded revealed a science teacher as a reflective environmentalist.

This reasoning emerged from both the scientific and eco-centric perspectives and with island biogeography principles in mind:

> I think the most significant...like how delicate it is and how easily harmed it is, that we are so unaware of or realize what we are losing. So many species out there that we've destroyed or are destroying that we don't even know about. And to me that's…and again, in this day and age, with all the knowledge and technology, that there's species out there that we haven't identified yet that are going extinct or are extinct or exist and we didn't even know it. And how easily it is for them to be lost, you know? Anything like that…it's all over…any habitat, any environment is experiencing that, unfortunately. (Interview, 6/29/15)

In terms of having a sense of place in Hawai'i, Lynne shared how her connection to the ocean waters surrounding our Islands have great meaning for her. As a surfer, she has a deep connection to these ocean spaces and reverence for all life, being a long-time vegan and naturalist and science teacher. Throughout her teaching practices while situated here in Hawai'i, she has always made the effort to learn about the Hawaiian language, culture, and traditional practices, to then integrate them into her science curriculum. Understanding that we live on an island, on an island ecosystem, she engages her students with mindful practices daily, by knowing where one's food comes from, recycling, and creating lighter footprints on this Earth.

Her concluding thoughts on this journey of negotiating her science teacher eco-identity in Hawai'i is exemplified by her current endeavors: "I took it upon myself, and I thought it was really important that I understand Hawaiian culture here." She felt that her practice of hula and surfing "was a huge way to better understand the Hawaiian culture and learn language and learn history and legends and the important places to the Hawaiian people." Her values and beliefs embody the thinking like an island mindset, and her actions as a teacher and administrator reflect living like an island.

Reframing Eco-Identity of Six Science Teachers in Hawai'i

How people perceive themselves in reference to nature, as living and breathing beings connected to the rhythms and cycles of the Earth, and to the expansive and complex diversity of ecosystems. An eco-identity emerges from an ecological worldview that may lead to new ways of understanding personal identity in a socially mediated framework of the human-nature relationship (Thomashow, 1995).

An eco-identity is having a sense of place, which incorporates place identity, place attachment, and place meaning, while also having a sense of *biophilia* that embodies an eco-centric worldview supporting a sense of personal agency at various societal and ecological system levels (Gedzune & Gedzune, 2011).

Through these teacher narratives, theoretical patterns have emerged to further elucidate this notion of an eco-identity and what this looks like for these secondary science teachers as they live and practice in Hawaiʻi. Through a Vygotskyian sociocultural lens I have been able to categorize these lived experiences of these purposefully selected science teachers, without losing the voices of each. The narratives extended beyond what was shared in this chapter and teachers' timelines are detailed in Appendices G-L to fully explain their lived experiences thus far. In Chapter 5 I will summarize the science teacher eco-identity characteristics that reveal a common thread running through each of these uniquely storied lives. I will also utilize these science teacher narratives to expand on theoretical concepts and processes that seek to explain how Hawaiʻi sociocultural and biogeographical factors can influence and shape unique eco-identities over time, and why this should matter.

CHAPTER 5: ANALYSIS AND DISCUSSION
Eco-Identity as a Meaning Making Process Situated in Hawai'i

In Chapter 4, I recounted teachers' voices and used rich descriptions to characterize unique and dynamic eco-identities. With the reiterative process of storytelling these narratives didn't always follow a chronological pattern. While unique, the eco-identity narratives of six secondary science teachers situated in Hawai'i were also connected by a common thread: *Eco-identity as a meaning making process supporting one's calling as a science teacher.* The narratives were naturalistically categorized through a sociocultural lens that allowed teachers' voices to come through in authentic ways. I approached the restorying process in a co-constructive manner with each teacher, paying attention to the multiple and situated nature of identity development and shaping. Table 4 in Chapter 4 (p. 108) organized the eco-identity narratives into four categories that became the common thread characterizing each teacher's meaning making process: (a) reflective environmentalism, (b) evolving science teacher community of practice, (c) bridging knowledge systems, and (d) island biogeography.

In this chapter I will address my focusing research question and sub-question to further describe the meaning making process of eco-identity for each teacher not as static events, situations, and characterizations, but as unique and dynamic. In addition to the sociocultural lens through which eco-identities have emerged, the situated nature of living on an island ecosystem—island biogeography—such as Hawai'i adds to the complexity of these identities. Adapting Jessop and Penny's (1999) use of cameo analysis in narrative research, I will then address the fluid and dynamic nature of meaning making with the use of eco-identity maps. In a profession commonly filled with dilemmas, self-doubt, and risk-taking, the negotiation of an eco-identity becomes an important process of addressing challenges as a science teacher.

What are the Characteristics of an Eco-Identity and What Might This Look Like in Secondary Science Teachers in Hawai'i?

I first address the focusing research question that guided the narrative inquiry process and constructivist grounded theory perspective for coming to know these six, secondary science teachers through their dynamic and unique eco-identities. The focusing research question driving my study was: As a secondary science teacher in Hawai'i what does it mean to have an eco-identity and why might this be important?

To stress the multiplicity and fluid nature of science teacher eco-identities I was cautious when characterizing teachers and making generalizations in a static manner. Upon reviewing Jessop and Penny's (1999) use of cameo analysis to add dimensionality to their teacher narratives, I created eco-identity maps to complement the storied lives to focus on the meaning making process as it took place and continues to take place.

Based upon the past decade of science teacher identity research (Enyedy, Goldberg, & Welsh, 2005; Meijers et al., 2016; Melville & Bartley, 2013; Wink, Ellefson, Nishimura, Perry, Wenzel, & Hwang Choe, 2008), what I can surmise in Figures 5.1 through 5.6 is that personal and professional identities and the lived experiences have influenced eco-identity development over time and space. Moreover, a comprehensive review of research on personal and social factors and how they may influence pro-environmental behaviors (Gifford & Nilsson, 2014) implicates sociocultural and biogeographical contexts associated with identity work and how these teachers have acted upon their perceived roles as science teachers.

Eco-Identity Map: Key Terms and Concepts

Prior to sharing the models in Figures 5.1 through 5.6 and discussing science teacher eco-identity for each individual, I will clarify the associated terms from the literature review and concepts identified in the science teacher eco-identity maps that emerged from the narratives and through focused and theoretical coding (see Table 4 in Chapter 4, p. 108). Table 5.1 on the following page contains terms and concepts that are used on the eco-identity maps to follow.

Table 5.1
Eco-Identity Map Terms and Concepts

• Science Teacher Community of Practice (COP)	Science teacher COP in Hawai'i is unique and evolving, whereby teachers seek membership and acceptance into the profession based upon shifting expectations of what it means to be a science teacher. Added factors of island biogeography and the sociocultural contexts of Hawai'i influence this science teacher COP. It is evolving due to reshaping of institutional expectations and roles addressing land education and inclusive epistemologies in science education.
• Structure in COP	From a Western perspective, structure is socially construed and agreed upon as a community of science teachers, whereby expected norms and behaviors supporting individualism, empiricism, and objectivity encompass the Western scientific mindset.
• Adaptive Structure (Agency) in COP	Acting on behalf of a group and for the greater good can come from associations with an EE perspective rooted in Western science. A sense of agency is an adaptive f structure supported by understandings of how one views her/his environment from eco-centric and Indigenous perspectives.
• 'Ike Hawai'i	A Native Hawaiian knowledge system based upon the interconnected system of values, beliefs, knowledge, and shared sustainable practices that connects humans to the natural environment intellectually, physically, and spiritually.
• Western Science	A knowledge system with Eurocentric traditions that is a way of knowing about the world and understanding everyday phenomena. Compared to Traditional Ecological Knowledge (TEK), Western science is mainly written, objective, reductionist, analytical, hierarchical, and based on laws and theories (Barnhardt & Kawagley, 2005).
• Environmental Education (EE)	From a Western science perspective, EE supports the "humans-as-part-of-nature" relationship which takes on an eco-centric worldview promoting environmental stewardship that is nearly void of cultural perspectives and multiple epistemologies. While EE is often touted as of science education that is place-based, it does not necessarily take into consideration the sociocultural and geographical histories of the original peoples.
• Education for Sustainable Development (ESD)	Western science education that focuses on scientific concepts and principles and skills of inquiry and evidence-based research to improve human technologies to survive and thrive in this world today. ESD supports an anthropocentric perspective where education is centered on human beings, creating a hierarchical dominance of humans over their natural environments.

Conceptualizing the Eco-Identity Map

Following the strategy used by Jessop and Penny (1999) to authentically portray and make sense of science teacher narratives, I use a multi-dimensional matrix system to characterize teachers' complex eco-identities over time and space. While eco-identity is present for all six secondary science teachers, it manifests differently for each teacher.

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These eco-identity maps represented in Figures 5.1 through 5.6 reveal the negotiation of multiple identities that are influenced by and continue to influence various aspects of a science teacher community of practice. This includes professional as well as personal identities.

Each eco-identity map is an emergent form of analysis of the teacher narratives and a way to re-tell and represent these storied lives in authentic voices. Using four-quadrant matrices as a template I was able to show relative emphases within each teacher's narrative for four categories characterizing science teacher eco-identity: (a) reflective environmentalism, (b) evolving science teacher community of practice, (c) bridging knowledge systems, and (d) island biogeography. Each portion (top, bottom, left, right) of the axes represents the tension between each quadrant, resulting in a continuum of characteristics based upon the four categories representing eco-identity. Rather than having a bi-polar representations, this model contains circles of three different sizes, with each quadrant containing a circle of a particular size. The bigger the circle, the greater the emphasis. When two circles of the same size are found next to each other on the same axis, this represents a state of ambivalence which signifies mixed feelings or contradictory ideas commonly brought up for some teachers with respect to environmental values and beliefs, personal and cultural beliefs, community of practice, and knowledge systems.

It was the work of Jessop and Penny (1999) that prompted me to utilize what they call cameo analysis for interpreting the eco-identity narratives. They contend that "instead of using matrices as instruments of comparative classification, they now become fairly subtle tools of description and analysis" (p. 228). In this case study utilizing these eco-identity maps in addition to the narratives, I was able to offer a more in-depth and three-dimensional representation of what such an identity looks like and how the sociocultural and biogeographical factors in Hawai'i were integral components of the meaning making process.

Explaining the Quadrants of the Eco-Identity Map

Before I share the eco-identity maps with characterizations and analyses of individual eco-identities, I will explain the four quadrants of the matrices first in Table 5.2 (p. 175). Again, this model reflects the individualistic, dynamic, and often contested natures of identities in general. Note how that with each teacher's eco-identity map, one or more areas are emphasized (play a more dominant role) by the larger circle diameters.

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Similar sized circles across axes reveal ambivalence and areas of negotiation with respect meaning making and transformative learning. The horizontal and vertical axes therefore become lines of tension.

Table 5.2

Four Common Areas of Negotiation With Eco-Identity

Quadrant	Lines of Tension	Common Characteristic of Eco-Identity
• Upper left quadrant: Anthropocentric Worldview	Vertical Axis: Reflective Environmentalism Horizontal Axis: Structure in Science Teacher COP	An anthropocentric worldview supports a type of education focused on education for sustainable development (ESD). Sustainable development is focused on competing in the global marketplace and views humans as apart from nature. ESD puts humans at the top of the hierarchy of needs.
• Upper right quadrant: Eco-centric Worldview	Vertical Axis: Reflective Environmentalism Horizontal Axis: Adaptive Structure (Agency) in Science Teacher COP	An eco-centric worldview focuses on environmental education (EE) with the notion of "humans as part of nature." With an eco-centric worldview there could also be feelings of biophilia and strongly identifying with everything in the environment.
• Bottom right quadrant: 'Ike Hawai'i	Vertical Axis: Bridging Knowledge Systems Horizontal Axis: Adaptive Structure (Agency) in Science Teacher COP	COP focused on teacher agency with content and pedagogy focused on 'ike Hawai'i. In a science teacher COP actions are agential in terms addressing real-world issues such as climate change and sustainability, while also sustaining traditional Hawaiian culture and practices. An apprenticeship model is adhered to in an adaptive structure of experts guiding novices through modeling and allowing for practice to master knowledge and skills.
• Bottom left quadrant: Western Science	Vertical Axis: Bridging Knowledge Systems Horizontal Axis: Structure in Science Teacher COP	Structured component in COP acknowledges apprenticeship model and mastery learning but focuses on learning concepts and skills as they relate to Western science. A structured science classroom typically includes: laboratory exercises, written research, building of skills and concepts through modeling and experiences, and testing. The overall objective is to prepare for college and careers in STEM.

Eco-Identity Maps Informing Dynamic and Complex Identities

Figures 5.1 through 5.6 represent the eco-identity maps that address the focusing research question: As a secondary science teacher in Hawai'i what does it mean to have an eco-identity and why might this be important? Along with each eco-identity map are characterizations specific to each teacher, revealing the uniqueness of eco-identities while also elucidating the common thread running throughout these narratives.

With each map, I will include the narrative piece of discussion and what Jessop and Penny (1999) refer to as cameo analysis. Science teacher eco-identity is a meaning making process and one that is negotiated as situated in the sociocultural and biogeographical contexts of Hawai'i. In addition to characterizing each teacher's eco-identity, I address the research sub-question: How do secondary science teachers negotiate their eco-identities over time and space and how does this impact their practices as situated in the sociocultural contexts of Hawai'i?

Case Study #1: Doc Burrows' Eco-Identity Negotiation

Figure 5.1: *Doc Burrows' Eco-Identity Map*
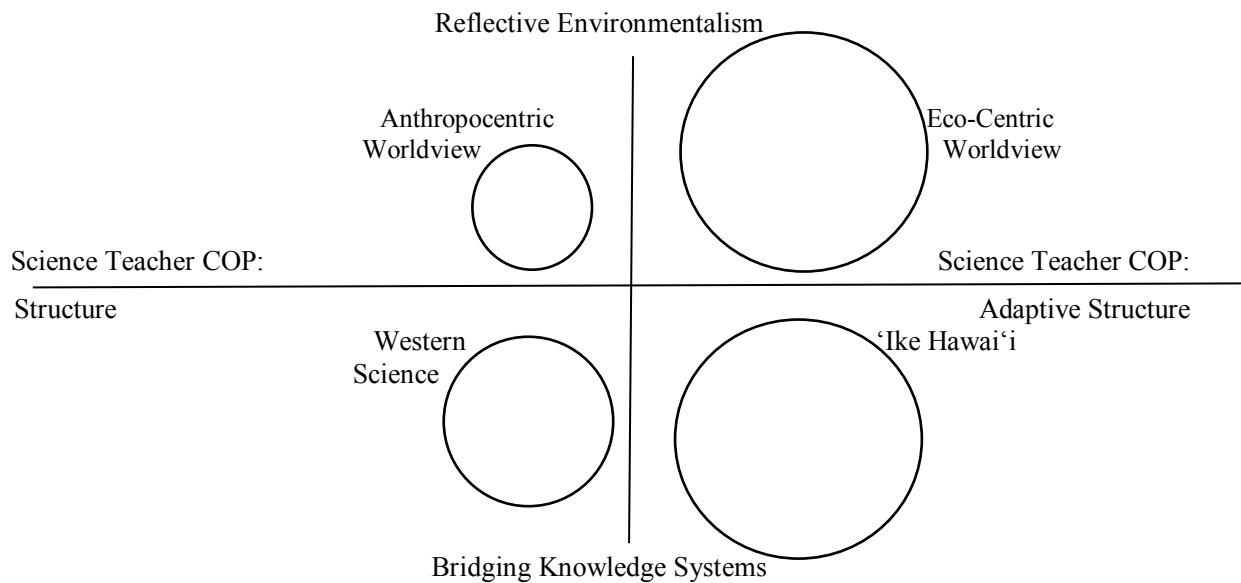
Reflective Environmentalism. In terms of Doc Burrows' environmental values and beliefs, his Hawai'i sense of place has developed into a strong eco-centric worldview. Essential to eco-centrism is also the care that he exudes for natural environments through field based experiences that support restoration and conservation.

This, in turn, has created his strong belief that as a science teacher his role is to inspire his students to study the natural environment and the issues that plague and threaten both our natural and human-made surroundings. Doc Burrows is able to negotiate his religious identity with that of being an environmentalist and one who exudes deep caring for his natural surroundings. On his eco-identity map his eco-centric worldview is more dominant than his anthropocentric one. Doc Burrows reiterated the importance of religion and involving multiple faith-based groups with his current projects today, revealing a reflective environmentalism that understands that human beings are an integral part of the natural environment:

> Why it is important to have religion in these projects? When working with the Sierra Club I saw a foundation with science and ecology, stemming from the 1960s. It came into being of environmental policies and destruction of these lands. Science ethics and values, but also with Hawaiian and other Indigenous peoples there are ethics and values. It's from kinship to the environment that humans are related to all things, animate and inanimate. (Follow-up interview, 9/5/17)

By having an integrated religious identity Doc Burrows does not face a dilemma that would disrupt his existing eco-identity. His confidence in his beliefs as a Christian and also as a scientist and teacher supports all that he does in environmental education and conservation/preservation of culturally and ecologically important places.

Evolving Science Teacher Community of Practice. Of equal importance in his eco-identity is the impact of environmental values and beliefs and eco-centrism on how Doc Burrows sees his role as a science teacher. It is to mentor his students and to help them to see the value in natural places through the restoration and conservation of native and endemic flora and fauna. Along the continuum of the science teacher community of practice, he negotiates the structure and formal Western science teaching style (left side of the vertical axis) with an adaptive structure that includes agency (right side of the vertical axis).

This negotiation over the 40 years of teaching has resulted in an emphasis of teaching from an eco-centric world view (upper right quadrant) with ʻike Hawaiʻi (bottom right quadrant). Doc Burrows shares, "There is no reason why other teachers can't do it—other classroom teachers."

Field-based experiences were essential to connect the classroom learning and make it real-world and "these are the kinds of experiences that my students were afforded as part of science education," he emphasized. In an evolving science teacher community of practice he did not see himself with all of the knowledge to bestow onto his students, but instead utilized a community based-education format wherever he and his students traveled. The diverse range of places visited comprised the Neighbor Islands including Kahoʻolawe, the Southwest or Alaska, and as far away as New Zealand and Rapa Nui. For Doc Burrows, he saw his role as both a teacher and scientist:

> Learning about current and relevant scientific issues and science content was about immersing the students in the field and having them work with scientists from all fields, including geology, archaeology, and biology. (Interview 2/21/13)

Bridging Knowledge Systems. Doc Burrows also places emphasis on the traditional ecological knowledge (TEK) of Hawaiʻi (ʻike Hawaiʻi) with his teaching. He integrates the process of mastery learning whereby students are experiencing authentic science from master teachers, cultural practitioners, and scientists in the field. Doc Burrows is at a point in his life and career whereby he embraces this holistic nature of a knowledge system where the lines are blurred between Western science and ʻike Hawaiʻi. His understandings of Hawaiian ways of knowing and traditional cultural practices is coupled with his self-identified role as a science teacher promoting eco-justice are evident in his practices. Today, after retirement, he continues to work towards the conservation of Kawainui-Hāmākua wetlands in Kailua for a master plan, explaining,

> We need to have more of that here in Hawaiʻi. That's very important, and that's important for the future of Hawaiʻi. In the future, have more scientific-rich programs that are associated with, and related to culture, wherever they may be. (Interview, 11/12/14)

Hence the areas on his eco-identity map on the right side of the vertical line are dominant (both upper right and lower right quadrants). Utilizing distinct modes of inquiry (historical and experimental) with close collaboration with field scientists and bridging knowledge systems of both Native Hawaiian and Western frameworks, Doc Burrows embodies a multifaceted and predominantly eco-centric and culturally responsive and sustaining focus in his eco-identity.

Island Biogeography. Doc Burrows understands principles of island biogeography and the impacts of global environmental change on local environments, and especially isolated ecosystems such as Hawai'i. Not only does he reveal himself to think like an island but also has experienced transformative learning events to impact the ways in which he practices living like an island in his personal and professional lives. This is evident in his eco-identity map, with dominant upper and lower right side quadrants. Since retirement, he continues to exhibit pro-environmental behaviors that reveal a reflective environmentalist:

> At the Church of the Crossroads we have what's called a "green congregation." Greening as ways to use less fossil fuels, use alternative fuels, and use alternative resources like solar power and use more energy efficient methods like certain electrical appliances. I work with Sunday school kids in the organic vegetable gardens...to work on composting with worms recycling. That's the other things that I still do. (Interview, 2/21/13)

Case Study #2: Eddie's Eco-Identity Negotiation

Figure 5.2: *Eddie's Eco-Identity Map*
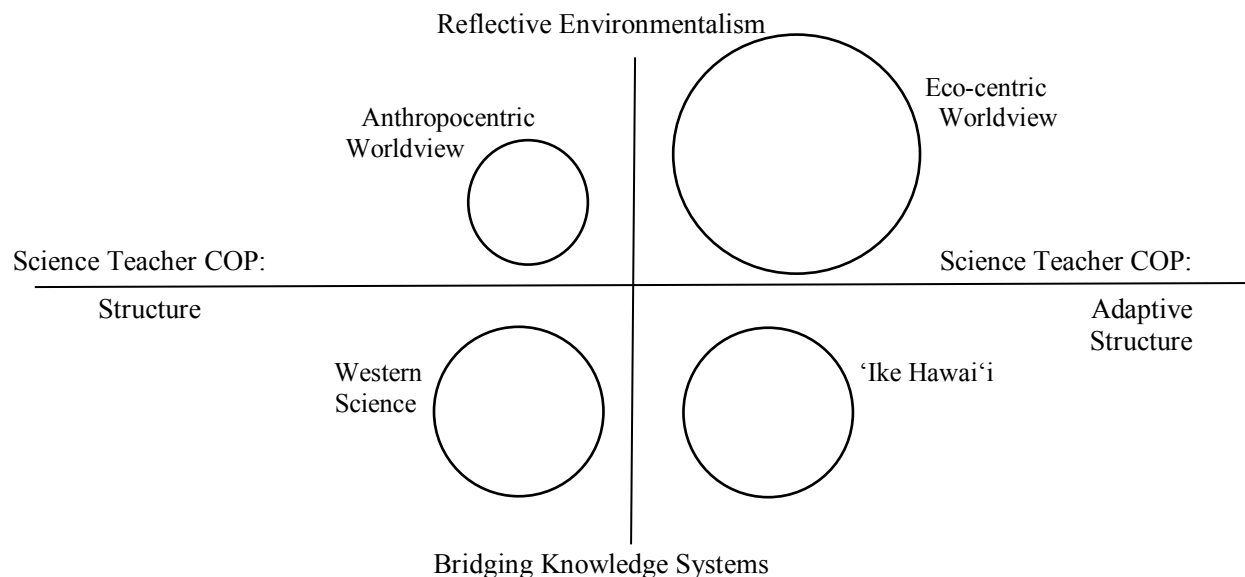
Reflective Environmentalism. Eddie's eco-identity map reveals a strong eco-centric Worldview (upper right quadrant) when it comes to environmental values and beliefs. He has a strong attachment to Hawai'i because of the tropical climate and surrounding ocean, a reminder of where he grew up in Africa.

Raised and schooled in Kenya under a British educational system, Eddie was exposed to the dichotomies of the wealthy and the very poor. He was also heavily influenced by his private, Catholic schooling. Consequently, Eddie's environmental values and beliefs were influenced by the privileges of a sound education and comfortable living conditions, and a deep understanding and empathy for those in Kenya who did not have such opportunities and resources.

Surrounded by ocean environments and with his curiosity to study natural environments, Eddie was continuously aware of his senses and emotions as both a scientist and teacher. He shared a novel tool for collecting jellyfish on his way to work (living in Waikīkī with beach access) that revealed his understanding of the natural world and how he made science accessible for his students in the high school classroom:

> See? I use it to scoop the jellyfish, and it's amazing. So as long as you don't touch it, these things are quite interesting to watch in the water, you know? As long as you don't touch it, you're okay, but I've touched them and never got stung. You see hundreds every month. (Interview, 6/28/13)

A strong sense of place in Hawai'i has emerged for Eddie and he calls this place home. He was not born and raised in the Islands, but embodies a deep care and respect for the natural environment and sees himself as an integrated part of nature. While raised and schooled in Catholic system Eddie has experiences with respect to negotiating worldviews. In fact, he has a less dominant anthropocentric worldview (upper left quadrant).

Evolving Science Teacher Community of Practice. Connected to an eco-centric Worldview (upper right quadrant) is Eddie's understanding of his role as a science teacher that is influenced by the Catholic school system. Eddie has preferred teaching high school in the Catholic school system for over 30 years and has had to negotiate between structure and an adaptive structure within the Catholic educational system. He admitted to not being an authoritative figure nor disciplinarian in the science classroom and quickly moved out of teaching middle school because he does not envision his role as being a "babysitter." "I'm more into doing the actual teaching parts. So, I enjoy [private high school] because I have the freedom to do what I want to do," he shared. A sense of agency was balanced with maintaining structure and protocols of the Catholic classroom.

Scientific literacy and writing up laboratory reports with attention to the processes of science from a Western perspective were stressed (as noted by the lower left quadrant on his eco-identity map):

> You know, using science vocabulary in the form of the hypothesis and as they address the hypothesis. I'm teaching them the scientific process. I think that it's very important. You assume that the students know about the scientific process, you know. Asking questions, observing, and stuff…but do they actually know what they are doing when it comes to the scientific process? (Interview, 6/28/13)

Eddie attended the Hawai'i Science Teachers Association (HaSTA) conferences throughout the years and saw it as an opportunity to gain further knowledge in science and strategies for engaging his students. Structure and institutional expectations were important to Eddie but the ability to effect change in his students and teach in a variety of ways that were oftentimes open-ended and spontaneous was his predominant approach (upper right quadrant). When doing a crab dissection, next "messing around with shrimp," and then realizing that brine shrimp were not found in the ocean, he did not stick to a curriculum and instead took the lesson in another direction:

> So, we explored the whole business about brine shrimp, that I didn't know that brine shrimp were not found in the ocean. They're found in lakes in Utah. Did you know that? It's things like this, the sense of place, help me in my teaching. They like to touch, see, smell, and observe, and think. For science, that's absolutely important. (Interview, 6/28/13)

Bridging Knowledge Systems. While Eddie operates predominantly from an eco-centric world view and teaches in a less conventional and structured form of practice (upper right quadrant dominance), even in the Catholic school setting, he is still negotiating teaching from a predominantly Western science perspective (lower left quadrant). In his remaining years of teaching marine science at the high school Eddie has immersed his students in Hawaiian cultural practices at a fishpond and taro patches to connect 'ike Hawai'i with Western scientific practices. Through his experiences with teaching in Africa and his continued connections through the Marianist society, Eddie adapted to places and cultures in order to provide for cultural sustainment as well as empowering youth and adults with the knowledge of science and skills to problem solve in their own communities.

Eddie wants to learn more about the Hawaiian culture and language, the history, and the natural places in the Islands in order to take his students on field trips to Hawaiian cultural sites, integrating science with 'ike Hawai'i. He admits,

> I wish I could speak the language, but...for example, I play in the church and I can play the Hawaiian music...I can play along. I think we live in such a unique place in the world, that we should take full advantage, you know? And I don't think our school is doing enough. (Interview, 11/16/14)

Eddie is now retired from teaching but continues to immerse himself in the culture, such as playing Hawaiian music every Sunday at the local church.

Island Biogeography. Coming to Hawai'i and teaching in the private Catholic School system in Honolulu for 15 years, Eddie's eagerness to learn about the flora and fauna of Hawai'i and its geography are reflective of his developing eco-identity. The importance of scientific literacy and the processes of inquiry are stressed and he also sees the importance of understanding the Hawaiian culture and traditional practices that have kept the people living sustainably on an island ecosystem. Eddie shares his knowledge of Hawai'i's ocean environments and connections to this place with his students and a need to be ecologically literate in today's world. He connects local knowledge with Western science whenever possible and practices culturally relevancy upheld with a land ethic. Through his practices as a high school science teacher he exhibits thinking like an island and living like an island.

Case Study #3: Karen's Eco-Identity Negotiation

Figure 5.3: Karen's Eco-Identity Map
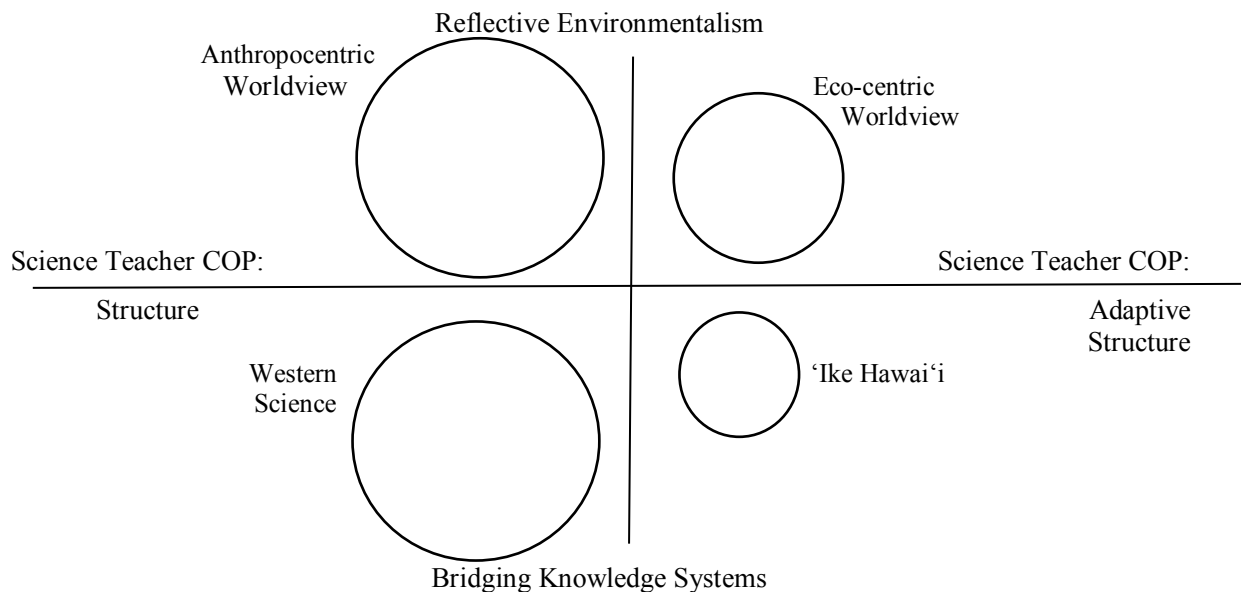
Reflective Environmentalism. Karen's environmental values and beliefs take on a stronger anthropocentric worldview (upper left quadrant), influenced by her Christian identity and how she views humans apart from nature and less as part of nature (upper right quadrant). As a mother of three young children, she is closely connected to her family and cares deeply about their social welfare. As a reflective environmentalist she is human-centered and sees the environment and its resources as part of what God has provided for her and her family and all others in the community. She is also concerned about issues of climate change and her teachings come from a structured science teaching practice purporting an anthropocentric worldview and a kind of education reflected in an ESD framework.

Family and a strong sense of place in Pauoa Valley where she grew up and where her parents still live add to a reflective environmentalism that is associated with caring for family and her students and specific places. Having a deep sense of place in the ahupuaʻa of Honolulu with strong family connections, she exudes care and concern for this particular environment, her and her family.

> They still live where I grew up. They take one of the kids out twice a week. So, we
> have lots and lots of help which makes it nice. My husband's the only child so his
> parents can devote their time to our children. (Interview, 9/4/13)

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Karen's Christian beliefs and family values were nurtured throughout her childhood and continue to guide her ways of knowing and doing in her personal and professional lives. In addition to her roles as a mother and contributing family member she also identifies with being a Christian. Karen had been attending one of the New Hope congregations in Honolulu and worked as a stage manager and sound assistant there on the weekends, where she eventually met her husband. Her religious identity is strong and it continues to be validated through her participation at the church on Sundays, which happened to be on the school's campus auditorium where she taught at for nine years.

Evolving Science Teacher Community of Practice. Karen's priority as a stay-at-mom is evident, but she also negotiates her science teacher identity which is still very strong: "Right now, I see myself as a…I am stay at home with my kids…and I do my part time teaching." Karen's science identity is grounded in the Western perspective (lower left quadrant) and has further strengthened over time, including with her time at home raising her children and teaching physics online. Karen's ways of teaching physics with as much objectivity as possible, can stem from her experiences growing up in a Western-based framework for education and the instilling of hard work and perseverance and competition.

Not only does she keep her personal and cultural perspectives out of the science classroom, but her religious beliefs as well. Karen enjoys teaching the subject of physics online and feels confident with the material. Karen has adhered to the roles and expectations of a science teacher from a structured and mostly Western perspective, as evidenced in her eco-identity map (dominant upper and lower left quadrants). Her identity as a mother is well-established and she is currently negotiating her role as a science teacher that has now become a part-time commitment until her youngest enters kindergarten.

Bridging Knowledge Systems. According to Karen's eco-identity map, the dominant anthropocentric worldview stemming from a Christian perspective and her experiences in the Western science system of education for K-16 schooling have influenced both how she teaches and the subjects she teaches. Her affinity for the physical sciences and her teacher education background influenced her structured style. Karen upholds a science teacher community of practice involving objectiveness, empiricism, and laboratory practices in the classroom (see lower right quadrant).

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While Karen has afforded her students field trips doing stream clean-ups, storm drain stenciling, and conducting service work at the taro patch, her focus has been on preparing her students for college/career readiness in STEM.

Karen acknowledges the importance of connecting science lessons to the Hawaiian culture, but her preferred, more dominant approach to teaching science in the classroom and online is practical and standards-based.

Island Biogeography. Karen's continuing life story has revealed multiple identities that have influenced and shaped the kind of science teacher she is today. Her place-connection and eco-identity are present in her personal life, as she considers her family, her home environment, and her Christian religion to be the foundations influencing and guiding her actions in daily life. Being a high school science teacher is also at the heart of her work role in life, and she will continue to teach in ways that do not challenge her existing beliefs and values as a science teacher. Karen cares about the welfare of her students and is concerned about global environmental issues and the local impacts, especially with living on an island. Her personal and professional practices embody an individual who is mindful of her ecological footprint and she lives like an island in order to perpetuate resources in Hawai'i with the understanding of taking only what is needed to survive.

Case Study #4: Ed's Eco-Identity Negotiation

Figure 5.4: Ed's Eco-Identity Map
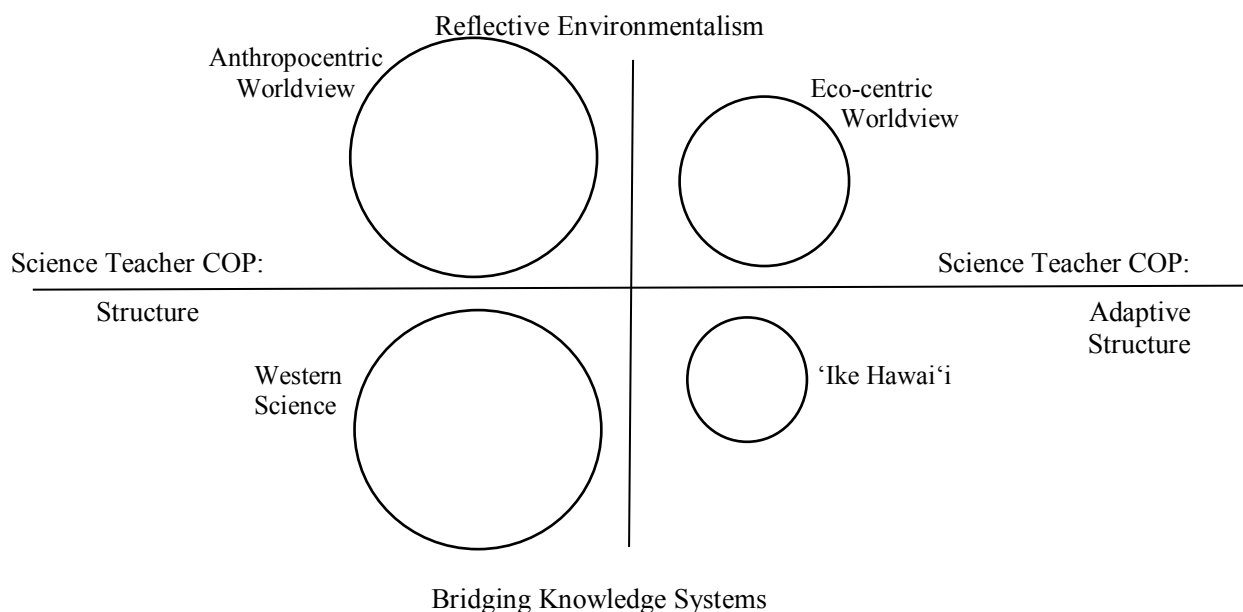
Reflective Environmentalism. Ed's values and beliefs about the environment come from his educational and personal experiences living on the plantation in Maui where his parents modeled hard work and perseverance. Ed experienced challenges with socializing and learning as a child growing up on the Puʻukoliʻi plantation village: "When you grow up on the plantation it's kind of unusual of an upbringing, with friends living farther away." He was self-motivated as a teenager and stood up for himself in order to receive the kind of rigorous math and science education that he felt he deserved. His experiences living and working in different parts of the U.S. and world for college and military service, gave him a different perspective on how he would become a science teacher. What critically changed his perspective on how he viewed relationships with students was a personal experience with his adopted daughter. Ed was influenced early on in his career to see his role as an authentic carer not only of the environment but also his family members and his students.

While not connected to any specific place(s) on Maui, he considers himself a steward of the planet (upper right quadrant) and more importantly an advocate for students (upper left quadrant). For Ed, a sense of place and the attachment to places and things in nature is attributed to the Earth as a whole, as a place to live mindfully and to care for with the understanding that there are abundant natural resources, and that humans need to know how to harness and manage these resources wisely and not be greedy. When talking about changes in his own community of Kīhei on Maui, Ed describes his concerns about human-mediated environmental changes. Ed does not identify strongly with any religion and therefore did not experience any conflicts growing up and later in life as a practicing science teacher.

Evolving Science Teacher Community of Practice. Having a dominant anthropocentric worldview (upper left quadrant), Ed approaches science teaching from a Western science framework (lower left quadrant) that he was schooled in. Work and schooling experiences outside of Hawaiʻi gave him an appreciation for the community-based efforts he received from his parents, high school teachers, military colleagues, and professors throughout his life. Ed's teaching philosophy as a science teacher became one of student advocacy. While he cared deeply about the environment and current issues globally and locally, he was most focused on public school students like himself getting a solid science and mathematics education, in order to compete in the national marketplace.

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His competitive nature, his individualism, and preparing students college/careers in STEM are dominated by an anthropocentric worldview that also impacts his approaches to teaching science from a Western perspective (lower left quadrant):

> To a certain degree, this happened to me in the classroom. While I started teaching in 1972, my first student asked me to write him a recommendation to MIT. Fortunately, he got in. After that initial success we've had students apply and attend MIT, Stanford, Harvard, Yale, CIT, Military academies, etc. It establishes an environment and establishes goals that many students don't believe that they can attain until the first one does. (E-mail correspondence, 1/26/14)

Ed's science teacher identity is influenced strongly by his anthropocentric worldview, thereby influencing his community of practice as one who is preparing his students not only to achieve academically, but also to get accepted into prestigious universities and eventually go into STEM related careers. Ed's formal teaching career of 31 years focused on closing both the achievement and opportunity gaps in science education. What opportunities he had to fight for with his own schooling, he did the same for his students. He continues to have a strong sense of belonging to the science teacher community of practice that is anthropocentric and structured (upper and lower left quadrants) and based upon the post-plantation era of education in Hawai'i today.

Bridging Knowledge Systems. Ed's focus on teaching chemistry and mathematics for his 30-plus years at the same Maui high school was comfortable for him because according to him, it made it easier with respect to finding truths with physical evidence and proving mathematical problems with theorems, and how "chemistry is a little bit more tangible." Ed is proud of his students' accomplishments with Ocean and Science Bowl competitions and how many of his former students will enter prestigious universities such as MIT and Stanford. Looking at his eco-identity map there is less emphasis on 'ike Hawai'i with respect to his practices as a science teacher (lower right quadrant) and he does see himself as an agent of change with respect to how he integrates real world problems of global climate change, managing natural resources, and overdependence on fossil fuel (upper right quadrant). His teaching of oceanographic principles when preparing students for competitions and AP exams makes learning relevant and empowering.

While not overtly addressing ʻike Hawaiʻi with his Western-based science teaching practices, Ed understands that teaching not only involves having students experience and learn science through studying concepts, daily practice, and relevancy, but also entails building relationships with students through compassion and an understanding of their life experiences. His teaching philosophy involves a care for his students and the perspectives they bring to the classroom (upper left quadrant):

> It's funny, we go to college to learn to teach but it's not at all like that and how we actually teach. I'm not sure if we still have all the answers because we know that teaching ability varies from person to person. But, I still feel that the strongest driving force behind what we teach and how we teach has to do with the philosophy on how you treat people. (Maui Community College, 2010)

Island Biogeography. Like his approach to teaching science with review, practice, and relevancy with oceanographic principles and environmental issues, Ed shows how he thinks like an island. Moreover, in his personal life, he also exhibits this kind of thinking and acts upon his eco-centric worldview by practicing sustainability at home with gardening, having solar panels to lessen his dependency on fossil fuels, etc. How he addresses sustainability further is through science education and preparing youth with skills of critical thinking, problem solving, and deeper conceptual understandings of how the world works. Throughout the 30-plus years of teaching at the same high school, Ed spent weekends coaching students to prepare for such events, and also for the AP exams. After retirement in 2000, he continues to volunteer coach high students for competitions and the AP chemistry exam (upper and lower left quadrants).

Case Study #5: Malia's Eco-Identity Negotiation

Figure 5.5: Malia's Eco-Identity Map

Reflective Environmentalism

Anthropocentric Worldview

Eco-centric Worldview

Science Teacher COP: Structure

Science Teacher COP: Adaptive Structure

Western Science

'Ike Hawai'i

Bridging Knowledge Systems
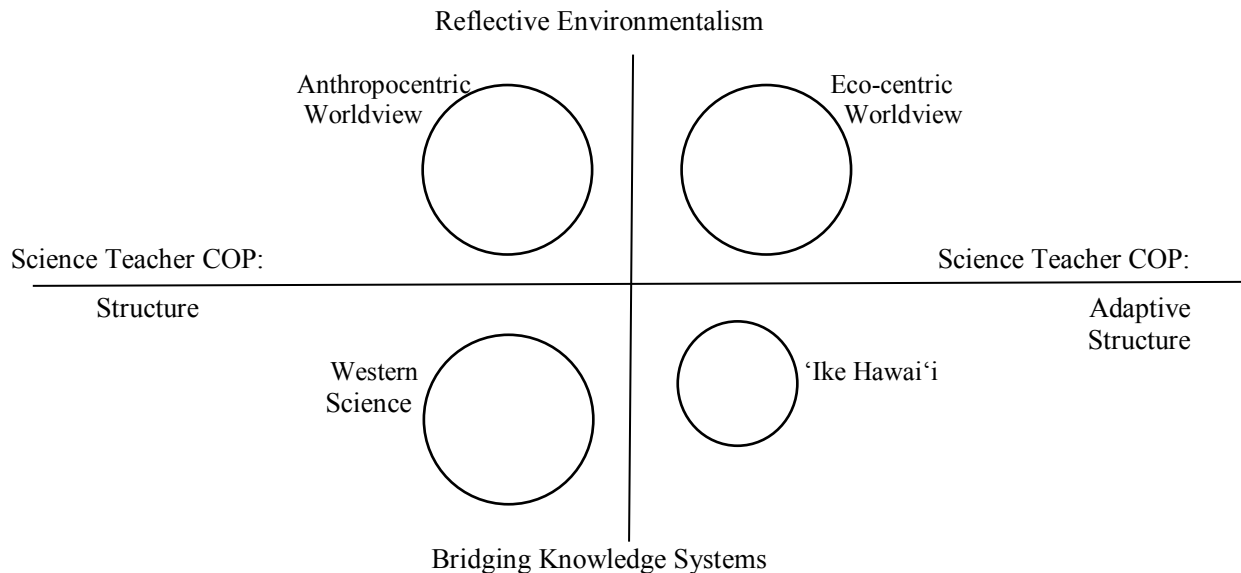
     Reflective Environmentalism. As a science teacher and Christian, Malia is highly reflective of her environment and the dilemmas that she has faced throughout her high school teaching career (now 17 years) based upon her Christian beliefs of creationism and her scientist beliefs of evolution. Her ambivalence is expressed in her eco-identity map in the upper left and right quadrants (of equal size), whereby her religious beliefs transcend to an anthropocentric worldview and her scientific understandings promote an eco-centric worldview. At times these opposing views have influenced her practices as a science teacher. She shares her belief that humans have the resources on our planet to use, provided by God. Malia shares her feelings about the environment from both a religious Christian perspective expressing how God has created the Earth and its resources for humans to use and from an anthropocentric worldview that supports stewardship and sustainability practices for the benefit of humans.

Conflicted by her beliefs in God as a provider of resources for human beings to steward, she also cares for the state of the environment and is concerned about how we are mistreating it:

> I think it just means figuring out how to live…growing food and stuff like that. The whole concept of having land to grow their food. I don't know enough to make a decision but I'm just saying, I think we do have...I feel that we humans...I don't know if we have the right, but we do need to change. I don't know necessarily if it's a right, but we do need to do it in order to live. I don't think we do it well, but I think we need to. (Interview, 3/1/15)

Evolving Science Teacher Community of Practice. While a strong believer of God Malia also sees the importance of teaching science from a Western perspective as she had experienced growing up. Her role as a science teacher is one based upon eco-centric worldviews and principles of stewardship, and as a teacher who is preparing her students to think critically about their actions with respect to how they live their lives in Hawai'i. With respect to the science teacher community of practice in Hawai'i she is also negotiating adhering to the institutional structure of Western science and preparing her students for college and/or careers in science (lower left quadrant) with an adaptive structure that is evolving into one that includes an agential focus in environmental education (upper right quadrant). As evidenced in her eco-identity map are three areas of interaction that are contentious at times for her: anthropocentrism, eco-centrism, and Western science.

As a science teacher in the public school system, Malia understands her position as a science teacher who was to keep religion out of her science classes. At times she was questioned by students about her beliefs and why she answered their questions from a Western science perspective. She felt challenged on several occasions. Until today, Malia negotiates her personal beliefs of Christianity with those as a scientist, including evolution (upper left and right quadrants) as a public high school teacher:

> I don't know. So I guess you can because you're at a private school, right? You can be selective about it but I know how I would not do very well there, because I don't...I feel…evolution, too, right? I would hope that they still *gotta* know about evolution, '*cause* I can't see how you can deny all that evidence. I'm a science teacher, too! I don't know. I won't even go there, thankfully. (Interview, 3/1/15)

In addition to being both a believer of God and a scientist, Malia is also challenged with prioritizing her time between teaching full time and being a mother who needs to care for her child with medical issues present since birth. Malia is committed to her role as a science teacher at the specific school where she continues to practice but realizes that her time spent with family is as important as providing for relevant and rigorous lessons in chemistry. The balance between home life and caring for her son with what she feels is her role as a secondary science teacher has not always been easy to manage, when comparing this with her focus on teaching prior to her son's birth.

As a new teacher she advocated implementing an AP chemistry course at her school and also has worked with her colleagues to adopt a community-based model for teaching when student yearly progress was not meeting standards. While an advocate for a rigorous chemistry experience in her classroom, Malia still questions her purpose as a science teacher and why students learn chemistry in high school. An evolving science teacher community of practice in Hawaiʻi, along with national mandates in science education has prompted Malia to think about her past and current roles:

> So, what I've decided in the last five to ten years…I've decided that I need to prepare them for college. *'Cause* I don't know who in my classroom is *gonna* go on in science in college. So for me, when I talked to the parents coming in for the open house, I told them that in this class they will have a firm foundation for college chem. That's what I see my goal to be: that they would go to...if they decide to take chemistry in college, that they would be successful there. But I don't think it's a goal for every kid in my class. So then it makes me question, why do they take chemistry? (Interview, 3/1/15)

Malia has had the patience to work with different perspectives over the years and understands the rules of the teacher tenure process. Sometimes, "this is what you *gotta* teach," and these initiatives bring up a "constant struggle in education," notes Malia.

Bridging Knowledge Systems. According to Malia, human beings realize that they are altering their natural surroundings and should be mindful and practice sustainability as Native Hawaiians have done in the past and continue to do today. Her understanding of the importance of ʻike Hawaiʻi is supported by her views on how science should be taught today: in an integrated, holistic manner like they do in the ninth grade.

While highly structured in her practices and with her expectations of students receiving a rigorous science education from a Western perspective (lower left quadrant), she also understands the need to integrate her teachings with real-world and place-based science experiences, situated within the Hawaiian cultural context. She has attempted many times to integrate the learning in chemistry and include real-world scenarios but has not had the time to continue to plan for these experiences consistently, with her son to care for and the many mandates, initiatives, and changes in administration over the years.

Having taught the Engineering Technology I course this past school year (2017-2018), Malia has been open to integrating her courses to address environmental issues through traditional Hawaiian cultural practices. She is moving forward with including her engineering students with place-based projects at the nearby ancient pond, Waikalua Loko. Malia understands the amazing engineering and technological feats that ancient Hawaiians accomplished with respect to what we know as modern aquaculture today. Her enthusiasm with connecting such understandings of Hawai'i's past to her engineering lessons reveals an emergent bridging of 'ike Hawai'i with Western science (lower right quadrant).

Island Biogeography. Malia understands that living on an island and the reality of climate change, pollution (i.e. vog from Hawai'i island), and overuse of natural resources can impact her, her family, and her students. She feels a sense of belonging to the public school system in Hawai'i and the community of science teachers. Her acknowledgement of Hawaiian culture and practices as a valid knowledge system is often countered by her structured approach to learning and doing science (tension between lower left and right quadrants), but she is making efforts to utilize real-world connections in order to teach students the principles of sustainability and thinking like an island.

Case Study #6: Lynne's Eco-Identity Negotiation

Figure 5.6: Lynne's Eco-Identity Map
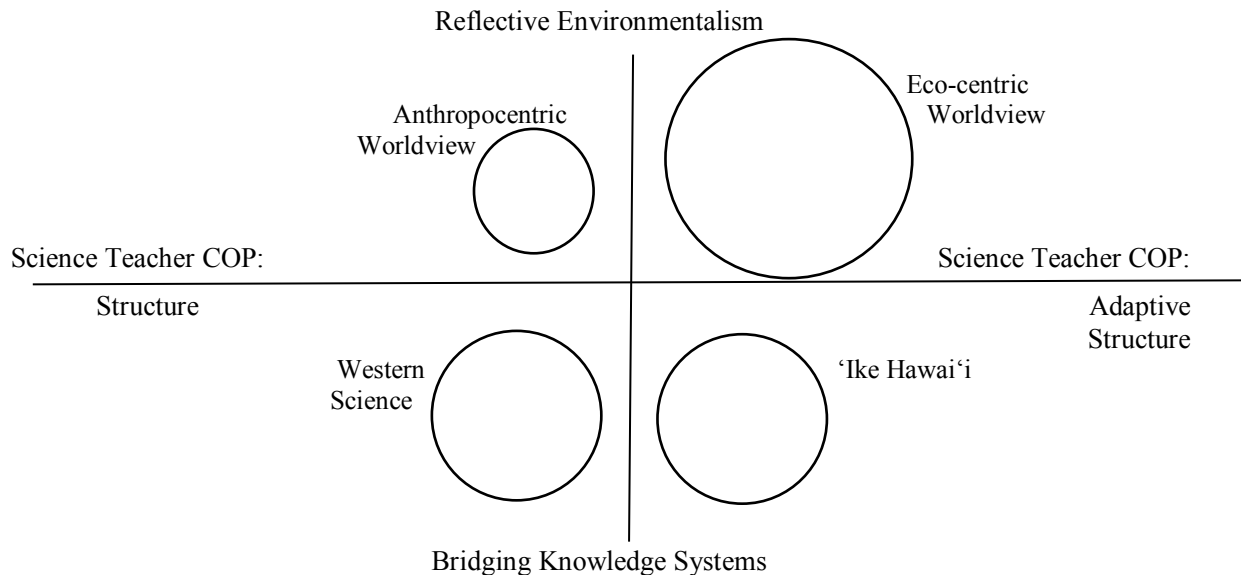
Reflective Environmentalism. Lynne's eco-identity is grounded by her environmental values and beliefs developed at a young age while growing up exploring the outdoors informally and engaging in science in the classroom and being inspired by her teachers. This is evident in her eco-identity map in the upper right quadrant. For Lynne, eco-centrism and biophilia have led her to develop a sense of place in Hawai'i, even if not born and raised here. Her love for the ocean and natural environments began when she was growing up in New Jersey, as she was encouraged to explore and take risks. Her natural love and fascination developed quickly and are exemplified by her responses to what she was learning in grade school through high school:

> I was like…until we had that class, it was "A tree is just a tree." It's a tree, you know? And all of a sudden, he's teaching us about the different trees, and I'm like, "Holy crap, there's a lot of different types of trees!" I didn't realize that there were this many plants. Different kinds of plants, you know? (Interview, 6/29/15)

Lynne is also a vegan who cares deeply about all living things. She has a dominant eco-centric worldview compared to an anthropocentric one (upper left quadrant). Her sense of place in Hawai'i, her veganism, and her connection to the ocean with swimming and surfing have spilled over into her teaching practices.

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She is honest with her students about her beliefs and inspires them to take risks and to fight for what they believe in (upper right quadrant).

Evolving Science Teacher Community of Practice. Lynne was trained as a teacher in New Jersey where she grew up and she experienced a diverse school setting throughout most of her K-16 schooling. Trained from a Western tradition in science and focusing on plant science as an undergraduate, she was initially planning on continuing plant research after college. Lynne instead was drawn into the science teaching community of practice and while exposed to standardized curricula and Western models of science teaching, she adopted a style that was less structured in terms of institutionalized roles set for teachers. She credits her mentor teacher for allowing her to make mistakes as a practicing teacher and giving her the freedom to create hands-on learning experiences for her students that went beyond the traditional textbook learning, laboratory exercises, and tests.

As a new teacher, Lynne experienced multiple contexts of New Jersey, New Zealand, and finally Hawai'i, where she considered the challenges to be a "huge learning curve" for her to adapt to each time. Her understandings with what science should look like from a Western perspective were met with alternative epistemologies when working with Pacific Islander students (points of contention between lower left and right quadrants). In New Zealand she was set in a foreign place and culture that she quickly familiarized herself with, in order to make the science learning relevant for her students. With an eco-centric worldview and positive experiences with being in nature, Lynne quickly adapted her teaching to meet the needs of her students. This kind of adaptive structure was supported by an openness to new things, new people and places, and new cultures and languages. Lynne made it a point to learn the local places, the native flora, and some of the Maori language while teaching science in New Zealand for three years. She was challenged with being an outsider at first but was quickly accepted into the culture and practice as a science teacher. Having a dominant eco-centric worldview put her into the position of being very humble wherever she traveled and taught. She was never confronted with negotiating anthropocentric or religious ideals as a practicing science teacher (non-dominant anthropocentric worldview).

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Coming to Hawaiʻi was not such a shock to her system and she quickly adapted to the laid back style of the local culture and was soon teaching science in ways that reflected her understandings of the importance of student voice and bringing real-world examples into the classroom. Her teaching practices, while relatively new to the profession, were already developed and multifaceted. Like her role models, Lynne included personal examples of travel and practices with her science lessons, breaking down that role as teacher as all-knowing:

> I feel like that really helped me in my teaching and then with technology, being able to show photos of the places I'm talking about, or even with genetics and explaining, with showing photos of all of my family members. And you know, the kids love that. They get to see a little bit of insight into your life, you know? And so, that way you can have a conversation in class about these things and it's related to the teacher and the kids are all invested because they all know you and then we can have a conversation about it. (Interview, 6/29/15)

Lynne embraced diversity and wanted her students to bring their own experiences and understandings to the classroom.

Bridging Knowledge Systems. Identifying herself as a risk-taker, Lynne accepted the job teaching science at a Catholic, all-girls school in New Zealand where the culture shock immediately took effect but also quickly diminished. Because of her love for nature and for diverse people and environments she humbled herself by admitting to her Pacific Islander students that she knew very little of their culture, their languages, and their natural environment. She was willing to become the novice who would learn from her students. As a young woman building up her science teacher identity from a Western perspective, she was met with a new way of knowing in a different environment. Being indoctrinated into an evolving science teacher community of practice Lynne expressed an openness towards learning about the cultures and languages of her students along with the local flora and fauna, where the learning then became student- and content-driven.

This transformational learning experience for Lynne prepared her for teaching science in Hawaiʻi. She has developed a sense of place in Hawaiʻi with deeper connections to the Hawaiian culture through practices of hula and surfing. She admits that while the Hawaiian culture is not the same as Maori culture in New Zealand she does see similarities tied to Pacific Islander ethnicities and cultures.

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Her eco-identity map represents a balance between Western science and ʻike Hawaiʻi in this evolving science teacher community of practice (equally sized circles in the bottom left and right quadrants), as she is still learning the ways of not only Native Hawaiians but also the local culture. Lynne's intentions to learn more about the Hawaiian culture is evidenced by learning hula and the Hawaiian language and *moʻolelo* (stories, legends told orally). ʻIke Hawaiʻi is emergent and steadily developing (bottom right quadrant) in her personal and professional practices

Island Biogeography. While not teaching high school science anymore, Lynne has continued to make local connections with her professional life. As an administrator at the same school, she sees her role as one making greater impacts with respect to honoring place, the natural environment, and local cultures. At this point in her career, Lynne was highly cognizant of her abilities as a teacher and had the ability to know when she was not putting in that 100% effort anymore, and that it was time to consider doing something else. As the Dean of Curriculum and Instruction at the public charter school she is confident in this role as and knows that she is having a broader impact in education with her work with teachers. Lynne now sees her role of one supporting teachers, and most especially being a mentor to new and practicing science teachers.

Lynne is embracing this leadership role and still retains her eco-identity with what she does as a community member of educators, how she continues to inspire new science teachers and serve as a role model with strong place connection to Hawaiʻi, and a commitment to making this island ecosystem sustainable in terms of natural resources and the Hawaiian culture. Thinking like an island and living like an island are now embodied in Lynne's new role as an administrator.

Science Teachers as Negotiators of Complex Eco-Identities

Comparing these science teachers' talk about their teaching practices and their beliefs about how students best learn and what they consider to be important to know and be able to do, reveals the complexity of science teacher eco-identities. While I was not able to observe teachers in their respective classrooms and outdoor settings, the storying process revealed the dilemmas which challenged their eco-identities at the time and they shared with me how these disruptions and conflicts resulted in changes to, or sustainability of, teaching practices.

In adhering to the grounded theory methodology, I delayed the majority of the literature review until after data collection and preliminary analyses so that I could commence this study with no preconceived problem and no preconceptions (Glaser, 2016). The persistence of four common factors influencing the meaning making process of eco-identity emerged naturalistically from their stories and prompted me to review the literature for similar existing problems and contexts with respect to science teacher eco-identity. A brief summarization of the collective narrative for these secondary science teachers' lived experiences and negotiations of eco-identity will become conceptual. This narrative summary will focus less on the individual teacher stories and instead on existing theories in the literature that inform my emergent grounded theory. The collective narrative and existing literature will connect to the grounded theory explained in Chapter 6.

CHAPTER 6: CONCLUSIONS

Eco-Identity as a Meaning Making Process Supporting the Science Teacher Calling

In the literature, eco-identity has not been extensively studied as connected to science teachers. To reiterate, my study focused on the following question and sub-question on the topic of eco-identity:

- Focusing research question: As a secondary science teacher in Hawai'i what does it mean to have an eco-identity and why might this be important?

- Related sub-question: How do secondary science teachers negotiate their eco-identities over time and space and how does this impact their practices as situated in the sociocultural contexts of Hawai'i?

Emerging from the data of science teacher narratives was the common theme running throughout the storied lives of each: Eco-identity as a meaning making process supporting one's calling as a science teacher. This theme produced a common, collective narrative guided by for areas of influence and interaction with the meaning making process of eco-identity for these six science teachers. The four areas of negotiation were: (a) reflective environmentalism, (b) evolving science teacher community of practice, (c) bridging knowledge systems, and (d) island biogeography.

Collective Narrative of Science Teacher Eco-Identity in Hawai'i

Reflective Environmentalism. Unlike a pinnacle point in one's life that is self-actualized, becoming conscious of and negotiating a complex and dynamic eco-identity (and other identity forms) is not a static endpoint. Each teacher had many life experiences that shaped their eco-identities into what they are today. Through identity work that was co-constructive between researcher and participants, they were able to reflect during the storying and restorying process. They have become self-aware in terms of having an eco-identity and coming to know their purpose as secondary science teachers in Hawai'i. They are also deeply connected to their natural environment on multiple levels which includes spirituality, religion, anthropocentrism, and eco-centrism. Teachers feels accomplished and proud with what they have done as secondary science teachers and how they have made impacts on the lives of their students and the environment. They understand that as science teachers and environmentalists their work is a collective effort involving the entire community.

To date, no one is slowing down with respect to advocating for both the environment and the communities in which they live. Retirement for Doc Burrows, Eddie, and Ed have not meant that they have ceased to continue their life's work and calling as science teachers. Lynne and Karen who have changed their roles from classroom science teachers to other areas/modes of education also continue to be reflective practitioners. Malia continues to teach at the public high school where her career started and continues to reflect on her practice as a science teacher who is also an environmentalist. While not reducing these unique stories to a single classification, the following list depicts what each of these science teachers has shown with this process of coming to know themselves as reflective environmentalists:

- Self-aware people with eco-identities embrace the unknown and ambiguous, and embrace change and challenges with science teaching with a can-do attitude;
- They accept themselves, together with their flaws, and they are highly reflective of any shortcomings and willing to work with experts in the fields of science and Hawaiian language and culture to achieve their goals;
- They see their science teaching experiences as part of the journey to further learning and further strengthening of their eco-identities;
- Self-aware people with eco-identities have a mission in life as not only science teachers, but as individuals with goals for the greater good of society and the natural environment; and
- Having an eco-identity is characterized by a humbleness as a science teacher who realize that s/he doesn't know everything and that multiple knowledge systems that include both Western science and Indigenous knowledge systems are critical in education today.

These six science teachers have shared their appreciation for Hawai'i's diversity and why they address local and global environmental issues through science education. They have all come to know intimately the places in which they live and practice and call home and embody what E.O. Wilson calls biophilia. This is to the point of promoting a Hawai'i sense of place which goes beyond their identities as scientists and science teachers.

Evolving Science Teacher Community of Practice. By revealing reflective environmentalism these individuals are indoctrinated and firmly grounded in what is now an evolving Hawaiʻi science teacher community of practice. Within sociocultural, historical, and political contexts of the teaching practice in Hawaiʻi there has been a shift with respect to what is expected of science teachers in the State today. The move past NCLB (2001) and into ESSA (2015), and the adoption of national science standards (NGSS) have impacted the science teacher of community of practice. Studies in science education and the impacts on learning and belonging to a community of learners has been extensively explored (Calabrese Barton, 1997, 1998; Calabrese Barton et al., 2008; and Shanahan, 2009). This concept of communities of practice with respect to the dynamic eco-identities of these individuals has revealed what Lave and Wenger (1991) describe as "what we learn transforms who we are, and who we are transforms what we learn" (p. 29).

In addition, their eco-identities were mediated by the teaching community of practice and how one sees her/his role in society as a teacher and scientist governed by both an institutional, scientific (structured, Western) knowledge system and an agential one (adaptive structure) based upon an eco-centric worldviews and critical pedagogical practices supporting a land ethic. An evolving practice exists in Hawaiʻi today, whereby science teacher and scientist identities can co-exist, as exemplified by these individuals.

While science teachers in Hawaiʻi could join local (Hawaiʻi Science Teacher Association, or HaSTA) and/or national (National Science Teacher Association, or NSTA) organizations ascribing to Western science framework for curriculum development, learning, and instruction, none of these teachers emphasized being strongly associated with these communities. With the exception of Eddie who occasionally went to the conferences and gained some resources and strategies for teaching science, these teachers have instead sought out the island landscape, the Hawaiian culture, ʻike Hawaiʻi, their personal spaces, and their families and community members to associate with, ascribing to a re-envisioned science teacher community of practice.

The six teachers I've come to know over the five years for my dissertation research didn't focus on challenges with science curricula and assessments, as dictated by different State and national models introduced over the years.

The implementation of high stakes testing in science was not a persistent or critical issue these teachers shared with restorying. Instead, through successful negotiation of their eco-identities they were able to overcome any challenges and dilemmas with teaching science in an evolving professional landscape.

Bridging Knowledge Systems. As part of the evolving science teacher community of practice includes the connecting, or bridging, of two knowledge systems in Hawaiʻi: ʻike Hawaiʻi and Western science. Epistemology, defined as the beliefs about how people know what they know, including assumptions of the nature of knowledge and the process of "coming to know" (Clayton, 2007), was varied and multifaceted for these individuals. Based upon unique lived experiences, each teacher has brought varied knowledge systems to their practices, with differing levels of Western science and Indigenous knowledge systems influencing and further shaping their eco-identities. As reflective environmentalists and through their storying processes, understandings of how one learns and how one comes to define her/his teachings based on essential knowledge, skills, and values have surfaced.

In addition, the Nā Hopena Aʻo and HĀ framework of Hawaiian cultural characteristics and values were adopted in June 2015 by the State of Hawaiʻi Board of Education. The bridging of Hawaiian cultural values, mindsets, and practices in the State public educational system with standardized Western expectations has therefore supported this shift in the science teacher community of practice. These science teachers have also acknowledged and embraced this shift with respect to their practice as co-constructors of knowledge with their students. What each has come to know as essential to learning is: it's not just the content and skills associated with "science," but also the rich cultures and knowledge systems from which their students operate. An evolving science teacher community of practice in Hawaiʻi therefore embraces ʻike Hawaiʻi and all other epistemologies, which reflects a culturally sustaining pedagogy of an asset model rather than a deficit model.

Island Biogeography. In the last decade there has been an increasing awareness of global environmental changes impacting island ecosystems on local scales influencing not only educators but other community members to begin embracing this thinking like an island mindset (Chirico & Farley, 2015).

The biogeographic nature of Hawai'i being an island ecosystem has supported a thinking like an island mindset influencing eco-identity development for these science teachers in unique and complex ways. Hawai'i is biogeographically isolated and unique, and thus Hawai'i science teacher eco-identities are unique. Their lived experiences, both formal and informal, spanning from childhood and throughout their teaching careers, were critical to understanding the content that they teach and the means through which they support culturally relevant, experiential, and critical learning, that acknowledges multiple epistemologies with a thinking like and island mindset.

At times, irrespective of a teacher being employed at a private or public institution, there were challenging situations and events that contested and affirmed existing epistemologies of these teachers. How each perceived her- or himself as part of an ecosystem in human-human and human-environment relationships and how each engaged with both natural and human-constructed environments influenced her/his eco-identity over time and space.

As noted by Chirico and Farley (2015) the acknowledgment of 'ike Hawai'i to address sustainability issues in Hawai'i today the science teacher community of practice is shifting and evolving to adopt the thinking like an island mindset that includes ancient and modern Hawaiian cultural practices embodying 'ike Hawai'i. An evolving science teacher community of practice in Hawai'i supports these teachers' eco-centric worldviews, their personal forms of eco-justice education, and culturally sustaining pedagogies. From this study it became evident that these individuals have adopted both thinking like an island and living like an island mindsets in their professional as well as personal lives.

Grounded Theory of Secondary Science Teacher Eco-Identity in Hawai'i

To conclude my research, I propose a grounded theory emerging from the processes of in-depth qualitative interviewing, constant comparative analysis of the data, and the co-construction of what it means to have an eco-identity as a secondary science teacher in Hawai'i. What has occurred in an organic and conversational manner over a period of five years, is the "seeing of the world through their eyes and understanding the logic of their experience," (Charmaz, 2006, p. 54) which has brought each of us (myself included) to insights on our unique and dynamic eco-identities. A grounded theory emerged to reveal how through identity work, these science teachers were able to gain awareness of what it means to have an eco-identity.

The importance of studying science teacher eco-identity today, with implications of re-imagining science teacher education programs and science teacher professional development, will be discussed at the end of this chapter.

Proposed Grounded Theory

Eco-identity is a meaning making process that supports science teachers with developing a strengthened sense of self as a science teacher, scientist, and reflective environmentalist, in order to continue in the profession and successfully negotiate challenges and dilemmas in an evolving community of practice in Hawai'i.

Eco-Identity Situated in Hawai'i's Sociocultural and Biogeographical Contexts

Eco-Identity Redefined. This kind of identity is about having a profound sense of oneself in relationship to natural and social ecosystems that is reflective, compassionate, emphatic, and informed by multiple epistemologies. Eco-identity as a meaning making process requires shifts in attitude toward the environment through lived experiences promoting a sense of place, deep spiritual connections to the environment, and a sense of agency. Eco-identity positions oneself as being an integrated part of nature and understanding how human beings can impact their surroundings and how their surroundings affect them. Eco-identity is about being a reflective environmentalist.

Hawai'i's Uniqueness Promoting Unique Eco-Identities. Eco-identity meaning making through restorying involved deep self-reflections by these six science teachers and their willingness to retell and essentially re-live events and situations with me. This included high and low points of their lives as interactionists and learners in their personal and professional environments. The co-construction during the narrative research led each teacher and myself to negotiate and redefine emergent eco-identities influenced by Hawaiian ways of knowing and practicing, a Hawai'i sense of place, and an eco-centric worldview that is historical, agential, and politicized. What I've come to know about these six teachers collectively is that they embody a sense of caring and understanding of how they impact the environment today and how their roles as science teachers in Hawai'i involve the practice of being "reflective environmentalists" (Thomashow, 1995).

For these six secondary science teachers I can surmise that a unique eco-identity situated in Hawai'i's sociocultural and biogeographical contexts exists. In Table 6.1 on the following page I summarize these findings as they relate to the grounded theory.

Table 6.1

Unique Characteristics of Eco-Identity for Science Teachers in Hawai'i

Context	Characteristics of Eco-Identity
Cultural, Historical	• Utilizes situated learning (Lave & Wenger, 1991) in historical and Hawaiian cultural contexts, as part of one's science teacher community of practice, to create cultural relevancy and to also address real issues today
Cultural, Ecological, Biogeographical	• Supports Hawaiian cultural ways of knowing that are experiential, embedded in real-life purpose and content, highly interpersonal, and focused on cultural values and practices relevant to place (Meyer, 1998)
Evolving Science Teacher COP	• Not only sees the need to prepare students with 21st century skills and knowledge based in both Western science and Indigenous ways, to build thoughtful, informed, competent, and reflective environmentalists, but they also take on roles of "authentic carers" (Savage et al., 2011) with a sense of agency, to help the young become empowered through healing of the Earth
Evolving Science Teacher COP, Multiple Epistemologies	• Scaffolds learning upon existing knowledge and prior experiences, and uses an apprenticeship model whereby the important end goal is mastery of learning of 'ike Hawai'i, along with 21st century skills that promote conservation and sustainment of Hawaiian cultural practices along with agential critical thinking and problem skills
Eco-centrism, Biophilia, Sense of Place, Island Biogeography	• Weaves spiritual, intellectual, emotional, social-cultural, and physical experiences together, embodying 'ike Hawai'i, living on an island ecosystem

Note. Community of Practice (COP)

Educational Significance and Implications

Contribution to Future Eco-Identity Studies

Eco-Identity, Transformative Learning, and Pro-Environmental Behaviors.

What my grounded theory emphasizes is the need to understand how one type of identity, an eco-identity, can be utilized as lens through which further studies elucidate how multiple epistemologies from which prospective and current science teachers operate from. Through a teacher identity in general, an individual will self-dialog based upon experiences and interactions with others and the environments. In addition, studies by Sfard and Prusak (2005), Aydeniz and Hodge (2011) and Akkerman and Meijer (2011) emphasize how internal and external dialog and interactions with others and the environment can influence teacher identity through transformative learning.

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Transformative learning as a process can then influence how a teacher as known-by-self and teacher as known-by-others can promote lasting changes in behavior and practice. Hence, an eco-identity can be influenced by the lived experiences, self-dialog, and interactions with others and the environment to enact or prevent pro-environmental behaviors. In my study, eco-identity in science teachers was thus outwardly expressed through teacher choices of content and pedagogical practices. In a case study approach, the connections between eco-identity, teacher identity, and pro-environmental behaviors are introduced.

In Hawaiʻi we are geographically isolated in the Pacific Ocean and therefore our island ecosystem follows principles of island biogeography with being unique and biologically diverse. In addition, the sociocultural contexts of Hawaiʻi have created unique experiences impacting science teacher eco-identity development. Science teachers with eco-identities embodying the mindset of "thinking like an island" and practices of "living like an island" were shown to influence changes in curriculum and instruction. Models of sustainability science, critical pedagogies of place, and land education that are inclusive of ʻike Hawaiʻi have emerged in public, public charter, and private schools in the State today. Science teachers as curriculum developers and enactors are becoming part of this evolving community of practice.

Reflective Environmentalism in Eco-Identity. Throughout my research process and especially after conducting the interviews with teachers and analyzing the narratives, I came upon very few references in the current literature relating to an ecological or eco-identity as I've focused on for my study. Thomashow's work (1995, 2002) reveals his personal understanding and negotiation of a dynamic eco-identity and how it has impacted his teaching as an environmental science professor. For these six teachers and myself, being mindful of a unique eco-identity when one teaches, can positively influence *what* one teaches in science and *how* one teaches science and experiences afforded her/his students.

From my focused study on six individuals living and practicing in Hawaiʻi, it has been shown how an eco-identity that includes a strong sense of place in Hawaiʻi can promote reflective environmentalism that in turn supports an eco-centric worldview. In an era of national and international reforms in science education, both kinds of worldviews (anthropocentric and eco-centric) can connect environmental education and education for sustainable development curricula.

This was shown with all teachers in my study and highlighted in their eco-identity maps. Some of the science teachers also embrace the local Indigenous knowledge system of ʻike Hawaiʻi at higher levels, which strengthened their eco-identities and promoted eco-justice pedagogies and a land education framework in their curricula.

Valid Research Methods and Instruments to Study Eco-Identity. Indeed, while teacher identity studies are numerous and the methodologies utilized are also varied and validated in their approaches, eco-identity study in secondary science teachers, and the study of secondary science teacher identities as they relate to eco-centric worldviews and pro-environmental behaviors, is a complex arena in need of further study. It is also necessary to consider the validity of narrative inquiry and the process of storying and the co-construction of knowledge between the storyteller and researcher. Secondary science teacher eco-identity is rooted in a myriad of sociocultural factors and the landscapes in which teachers are situated.

What is needed in eco-identity study of science teachers is further research on viable instruments to measure their beliefs about environmental education (EE) and education for sustainable development (ESD) (often viewed as competing ideologies) and also the viability of critical pedagogies of place and land education as part of their community of practice. The New Ecological Paradigm Scale questionnaire (Dunlap et al., 2000) was used as a tool for discussion on environmental values and beliefs. While useful, there is still a need to measure and understand science teacher conceptual understandings of the following: cultural relevancy and responsiveness, Indigenous knowledge systems, Western science, environment, nature, and sustainability. These conceptual understandings are essential to becoming self-aware and awakened in terms of recognizing one's eco-identity as unique and dynamic. If teachers, local community members and experts, administrators, higher education professionals, and policymakers cannot first understand these key concepts and if they cannot themselves reflect upon how/why they act in a pro-environmental way or not, then we cannot move forward with addressing the need to change the way we educate our youth.

I reiterate here the questions that persistently came up throughout my study and what led me to develop my present grounded theory, which needs to be revisited and researched further:

Questions to revisit and address:

- What is an eco-identity and does every science teacher, or possibly every individual have such an identity? Can it diminish and reappear over time?

- Is this kind of eco-identity measurable and comparable since it is unique to an individual like other forms of identity? Can there be generalizations made about secondary science teacher eco-identity in Hawai'i?

- How do issues that secondary science teachers face as they traverse the educational, personal, and biogeographical landscapes while living and practicing in Hawai'i impact eco-identity?

- To what extent does eco-identity influence curriculum and instruction in science education across all subject areas in natural and physical sciences?

Implications for Teacher Education Programs

This qualitative case study focused on six secondary science teachers in Hawai'i reveals how science teacher environmental values and beliefs were based upon personal sociocultural factors, ethnic identities, lived experiences, and personal epistemologies. The connections of environmental values and beliefs with science teacher eco-identity and pro-environmental behaviors therefore reveal a critical need to revisit teacher education programs. With science teachers Ed, Karen, and Malia, I came to understand how teachers with dominant anthropocentric worldviews and stronger Western science perspectives saw their roles as science teachers preparing their students for career and college in STEM. For Doc Burrows, Lynne, and Eddie, there were constructivist and culturally sustaining approaches from a more dominant eco-centric worldview that took place in their science classrooms. Finding a balance and bridge between 'ike Hawai'i and Western science is part of this evolving Hawai'i science teacher community of practice. While all teachers in this study actualized and exhibited eco-identities, they were in varied forms and unique in their areas of dominance (see eco-identity maps in Chapter 5).

These differences with how teachers revealed their eco-identities leads to question of how teacher educators and secondary science teachers can more mindfully do the same as Doc Burrows has done in his 40 years of teaching and how Lynne and Eddie continuously strive for this kind of eco-identity development across their personal and professional landscapes. Colleges of education in the secondary science sector and all other areas can benefit from providing pre-service teachers with experiences of a co-constructive nature to support the negotiation of a teacher candidate's own eco-identity and multiple epistemologies that he/she brings to the college program and future classroom. Knowing this will support the acknowledgment of the multiple epistemologies that our students will bring to the classroom and that this kind of science teacher community of practice will support eco-identity awareness for all. What it means to know and understand the world, how one can see him or herself as part of nature and not separate from, nor consider oneself above nature, can influence how teacher education program goals and objectives—especially for secondary science teachers—are developed. In the science teacher community of practice eco-identity exploration and confirmation of such a unique identity can support critical pedagogies of place rooted in the specific histories of the land. Eco-identity awareness for pre-service science teachers can support an understanding of an ecosystem embodying interactive and integrated communities of humans in nature.

Science educators at the secondary level are also unique in that they have developed separate and compartmentalized identities with respect to their teaching and scientific identities (both which are subsumed under their eco-identity) and other identities of motherhood, religion, culture, and ethnicity. Teacher training and professional development may need to not only be subject-specific but also one that takes into account personal/emotional, sociocultural, and biogeographical factors that influence eco-identity development. Our Islands are geographically isolated, biologically diverse, and rooted in the Hawaiian host culture and its Indigenous knowledge system of ʻike Hawaiʻi. There is not a one-size-fits-all model that can be prescribed for secondary science teacher training.

Re-Imagined Teacher Education Program on Eco-identity. With personal reflections and a co-constructed process of storying, eco-identity understanding can inform teacher education programs and professional development with ʻike Hawaiʻi and the thinking like an island mindset.

As Chirico and Farley (2015) suggest a model for navigating sustainability on an island ecosystem like Hawai'i, I suggest we look to a reformed model for secondary science teacher education programs in Hawai'i that can serve to support the unique and dynamic eco-identities driving the thinking like an island mindset, along with living like an island practices. As a model, Hawai'i State science teacher education programs can take the lead with confronting and even disrupting the Western educational system models currently in place. Such a re-imagined model can be implemented with looking to the community of cultural practitioners, *kahuna* (practitioners/experts of a certain field), and *kūpuna* (elders), along with educators, Western-based scientists, historians, administrators, and politicians. A collective of eco-centric individuals who are awakened to their eco-identities, who understand that we are all a part of the natural environment and that knowledge comes from multiple systems, can work together to effect positive changes locally and globally.

With respect to a re-imagined teacher education program focused on eco-identity awareness, I would structure a course that includes the following processes that support the meaning making of eco-identity work. With an understanding that Hawai'i's sociocultural and biogeographical factors can influence and be influenced by a person's eco-identity educational models of critical pedagogy of place and land education can be utilized to frame such a course. These mediating processes with respect to continued eco-identity negotiation can become the tools that help pre-service teachers become aware of their own developing eco-identities and how this can impact how Western science and 'ike Hawai'i are construed. This is in turn will influence future curriculum development and enactment.

I propose a course focused on the following processes to support pre-service teachers with eco-identity awareness and awakening to potential teaching as reflective practitioners and environmentalists. Table 6.2 on the following page explains how the following key processes are a part of the meaning making that occurs with identity work: (a) self-dialogic process, (b) narrative process of storying and meaning making, (c) evolving science teacher community of practice in Hawai'i, (d) dialectic and interactive relationships with others and environment, and (e) experiential and transformative learning processes.

Table 6.2: *Teacher Education Course Focused on Eco-Identity as a Process*

Self-Dialogic Process	• Environmental values and beliefs beginning to form early in life through religion, cultural norms and practices, and place connections and place meanings (an overall sense of place). This is an internal, self-dialogic process of negotiation when challenges to one's eco-identity arise. Through written reflection and group discussions self-dialog can be expressed, shared with others, and rethought in order to learn how multiple epistemologies can promote different ways of thinking about the environment.
Narrative Process of Storying & Meaning Making	• The act of "talking story" and engaging in discussion, as with the interviews conducted in narrative inquiry research, promotes not only reflection on past events but also the making of new stories, of stories retold. The narrative process therefore promotes a co-construction of re-imagined meanings of what has led to the development of and continuous shaping of an eco-identity. In the course, interviewing of colleagues, family members, scientists, cultural experts, etc. can take place with the practice of active listening and oral history writing to document stories.
Evolving Science Teacher Community of Practice (COP) in Hawai'i	• The transformative process of learning one's role as a science teacher in Western society and living and teaching in Hawai'i can be tumultuous at times with teachers wanting to make changes to existing curricula and science pedagogy. The sense of agency and providing for culturally responsive/sustaining experiences for students, with an understanding of ecological and social justices/injustices is a challenging task for a new teacher. Teachers with an eco-identity awareness can better overcome challenges and maintain their eco-identities in a Western COP. A potential course would involve field experiences for pre-service teachers in varied cultural and biogeographical settings. As part of the service learning experience, they would also need to reflect.
Dialectic and Interactive Relationships with Others and Environment	• Anthropocentrism is characterized by a strong human-to-human relationship and the valuing student needs at all levels, including the social and emotional. Eco-centrism purports a strong valuing for nature and the restoration, conservation, and protection of living things in an environment. The love for the environment goes beyond just a type of place like a stream or forest in general but also the specific places (lands) that hold historical meaning and value. Through reactions of like-minded others to one's pro-environmental behaviors and through witnessing positive changes in the environment, eco-identities become meaningful and strengthened. Interviewing and working with community members through service learning projects can become powerful tools.
Experiential and Transformative Learning Processes	• Not only does the meaning making occur during the storying process but also through personal experiences from childhood and up to the present. The learning becomes transformative when one's eco-identity is confronted with reaffirming or conflicting events and situations that can influence and further shape how one views her- or himself within an ecosystem. In a re-imagined program, all of the above coursework and field experiences can support pro-environmental behaviors as science teachers.

Hence, science teacher education programs need to be rethought and re-imagined with these paradigm shifts in mind, in order for teachers (both pre-service and in-service) to experience learning that is transformative and building upon their existing eco-identities. In Hawai‘i, in both the public and private school sectors, educational models of place-based education, culture-based education, and land education, integrated with educational models promoting environmental education and education for sustainable development are in existence today. Current programs need to be studied further with science teacher eco-identities in mind, to better understand how teachers with certain mindsets can impact curriculum implementation and instruction.

I conclude that teacher education programs and professional development courses for science teachers that support the thinking like an island mindset and address eco-identity awareness, include the following key characteristics: (a) they provide for hands-on, experiential learning with real-world connections; (b) they address local environmental and social justice issues, (c) they embrace ‘ike Hawai‘i as a valid knowledge system and bridge this with Western science, and (d) they provide opportunities for reflecting upon and negotiating eco-identities that can impact curriculum and practice. This rethinking of science teacher education in Hawai‘i is a reform movement that can occur at all grade levels and not just with secondary science teacher education and professional development.

Future Studies on Secondary Science Teacher Eco-Identity

In their 2015 book, *Thinking Like an Island: Navigating a Sustainable Future in Hawai‘i,* editors Chirico and Farley share current strategies to make living in the Islands more ecologically, economically, and socially resilient, which draw from ‘ike Hawai‘i (the Hawaiian knowledge system) and cultural practices of the Hawaiian people over thousands of years.

Thus, I conclude with key areas that need further study, with respect to unique and dynamic science teacher eco-identities situated in biogeographical and sociocultural contexts of Hawaiʻi:

1. Continue to utilize the narrative inquiry process as a means for understanding and authentically reporting on what science teacher eco-identity looks like in biogeographical and sociocultural contexts;

2. Develop a valid and reliable instrument for measuring science teacher eco-identity, with the understanding of key factors influencing such an identity's development and change over time;

3. Continue to refine and transform K-12 science teacher education programs and professional development for in-service teachers that support integrated, relevant, and experiential approaches to land education; and

4. Study how such reformed teacher education and professional development programs can influence a fluid and unique science teacher eco-identity and understand how an eco-identity can impact their community of practice situated in Hawaiʻi.

Lessons Learned

Teacher Narratives as a Valid Source of Data

In educational research today the process of reciprocation, wherein researcher and the researched mutually benefit from the results and conclusions, is not always present. I had initially approached my teachers with the proposal of a kind of study that involved reciprocation with my involvement in the classrooms of these science teachers. This would have occurred through support with place-based, field studies. However, I did not obtain a Hawaiʻi Department of Education (HIDOE) approval for conducting my research in the classrooms with teachers and students, thus I submitted a revised research application to the University of Hawaiʻi's Institutional Review Board (IRB).

What I subsequently learned with my revised research methods under a qualitative framework was that with narrative inquiry, I found the essential evidence of science teacher eco-identity to be emerging from their stories. I soon realized the importance of a single source of data provided for by the detailed stories of these six individuals, as they were told and re-told, and re-imagined.

The thick descriptions of the data would come from their own voices. In studying this complex and dynamic process of eco-identity development and evolution, I've come to realize the value of a single source of information (teacher narratives), as it helped me to focus on the uniqueness of each teacher.

Additionally, I came upon the work of Jessop and Penny (1999) and their use of a four-quadrant matrix with cameo analysis. As an alternative way to visualize the teacher narratives, I was able to adapt their process to create eco-identity maps. These maps accompanied the eco-identity narratives and provided an engagement at a deeper level with each person's storied life as a science teacher. Tensions and contradictions were visualized in these eco-identity maps through the axes derived from common categories and themes from all of the narratives and the use of circles to represent levels of each category existing for each teacher (each quadrant was filled with a circle). Using the narratives and matrix in tandem, I was able to authentically represent each science teacher's story in a more three dimensional way. While eco-identity, like other identities, is not static, I was able to capture them visually and add to the richness of the narratives.

Hence, narrative inquiry with the use of identity work through mapping became central to discovering what an eco-identity may look like for science teachers in Hawaiʻi and how these storied lives showcasing eco-identity can be potential tools for understanding how the meaning making process for science teachers need to be considered when designing teacher education and professional development programs.

Grounded Theory as an Appropriate Methodology for Honoring Teacher Voices

While I was not too familiar with the grounded theory perspective of Glaser and Strauss, I was drawn to this methodology as a means to conduct qualitative data analysis. What I was not aware of initially was the understanding that theory generation was not necessarily a given by the end of the research (Saldaña, 2013). Moreover, I learned that the majority of the literature review should come *after* data collection and conceptual development. This perspective of "starting off knowing nothing" (Glaser, 2016) and not having any preconceptions was difficult for me at first since a literature review in preparation for the comprehensive exam (prior to obtaining approval to conduct research) was required by the university. The uncertainty with not knowing what problem(s) would emerge from my study made me uneasy at first.

Doing more research on the grounded theory perspective and what Barney Glaser, founder of the school of thought of grounded theory, would identify as "inauthentic methodologies" purporting to be a grounded theory framework, left me further perplexed. Coming upon the work of Kathryn Charmaz (2006) and the constructivist grounded theory methodology proved to be the direction I needed to understand how I was going to analyze the narratives of my six science teachers in ways that were respectful, authentic, and reciprocated in terms of research benefits.

It has been a lengthy process of coding, memo writing, categorizing, conceptualizing, member-checking, utilizing the constant comparative method, and eventually going back to do a more extensive but focused review of the literature. Time consuming and unclear for me at many points along the way, I conscientiously worked through my teacher narratives using this methodology of constructivist grounded theory to arrive at my grounded theory.

Using Reliable and Valid Tools in Qualitative Research

The revised New Ecological Paradigm (NEP) Scale questionnaire (Dunlap et al., 2000) was a tool for measuring environmental values and beliefs on a large scale. There were several studies utilizing the revised NEP Scale questionnaire which questioned its validity, since it was purported to be coming from a Western worldview characterizing pro-environmental and dominant social paradigm perspectives in developed countries. Other studies, however, exemplified its effective use in slightly modified versions, to address different age groups and populations. The reviews in environmental psychology on the validity and reliability of the NEP Scale questionnaire are mixed.

I had initially set out to use this revised NEP Scale questionnaire with students of the science teachers I was interviewing, to study potential science teacher impacts on students' environmental values and beliefs. Without HIDOE approval to conduct my study as initially proposed, I was unable to administer the questionnaire. Instead of throwing out this instrument I chose to administer the revised NEP Scale questionnaire to the science teachers I had interviewed at two points in time during the data collection process. While I could not collect statistical information with respect to science teacher values and beliefs with a small number of participants (six teachers), I did want to see how this questionnaire could support discussions in environmental values and beliefs during the interviews, which it did.

Additionally, I added an open-ended question regarding sense of place for each teacher (where this connection was, and why). The NEP Scale questionnaire was useful for starting conversations on values, beliefs, and pro-environmental behaviors that led to reflections and self-realizations of an existence of an eco-identity. Through two, separate administrations with each science teacher I discerned that values and beliefs about the environment can change, like one's eco-identity, even within a relatively short time period (two to three years).

Limitations of the Study

Generalizability and Transferability in Grounded Theory Research. With grounded theory and constructivist grounded theory I was limited with respect to making generalizations and claims beyond the six teachers in my research. Avoiding epistemological discomforts with respect to my position as a former science teacher and a teacher of non-Hawaiian background, I was careful when conducting myself as part of the meaning making process with each teacher. I worked to avoid reductionism with respect to characterizing science teacher eco-identities collectively and understood the subjective nature of the reiterative narrative and restorying in narrative research. While my study of analysis took on a constructivist approach, there were instances of self-doubt with respect to my findings and I addressed them by going back to the source—the science teachers—with a point of saturation in the data collection process.

While I could generalize with these science teachers' experiences only as they are situated within Hawaiʻi, I note the importance and appropriateness of a case study approach to study a complex phenomenon such as eco-identity. Moreover, narrative inquiry as a method of primary data collection and the grounded theory process of analysis values teacher voices and their interpretations of these stories. This can offer critical insights of a wider significance with respect to science teacher eco-identity in Hawaiʻi. In fact, Glaser (2016) contends that with grounded theory methodology, conceptual generality that is abstract of time, place, and people can be generated. "This kind of assumption need not be applied to the specific data itself but modified conceptually to suit the data it is being applied to in current time and space" (Glaser, 2016, p. 4). Again, I still needed to be mindful with respect to grounded theory arrival and the potential for transferability.

Reciprocity in Research. As I had begun my research with this notion of reciprocity, and due to the fact that my study's design needed to be revised, I feel that another limiting aspect of my research was the inability to fully give back to the science teachers as a researcher. Unable to interact with each science teacher in their classrooms and on field projects, I was unable to observe and support teachers with the implementation of outdoor, service-based, and culturally relevant experiences. In this manner I was unable to give back as a researcher. At the start of my study I had felt included in the science teacher community of practice as a former secondary science teacher but my absence from the classroom in the past ten years warranted the immersion and support that I had initially proposed. It was the lack of this inclusion that limited my research, and the reciprocation that I felt necessary to become that "insider" of this community again.

While I was not able to give back in this way with my research, I was able to support teachers with the meaning making process of eco-identity. The eco-identity maps and co-constructed narratives were beneficial for the science teachers as they were reassured that their life's calling as science teachers were valuable in science education today. To further acknowledge their work and highlight the importance of eco-identity in science teachers, I hope to reciprocate these benefits through future publications of these rich stories.

APPENDIX A:

UH IRB Exemption Approval for Research

UNIVERSITY
of **HAWAI'I**
MĀNOA

September 26, 2012

TO: Sheri T. Fitzgerald
        Principal Investigator
        College of Education - Curriculum Studies

FROM: Denise A. Lin-DeShetler, MPH, MA
        Director

Re: CHS #20546 - "Eco-Identity: Secondary Science Teachers' Experiences that Cultivate Place-Based Teaching in a Native Hawaiian Context"

This letter is your record of the Human Studies Program approval of this study as exempt.

On September 26, 2012, the University of Hawai'i (UH) Human Studies Program approved this study as exempt from federal regulations pertaining to the protection of human research participants. The authority for the exemption applicable to your study is documented in the Code of Federal Regulations at 45 CFR 46.101(b) (2).

Exempt studies are subject to the ethical principles articulated in The Belmont Report, found at http://www.hawaii.edu/irb/html/manual/appendices/A/belmont.html

Exempt studies do not require regular continuing review by the Human Studies Program. However, if you propose to modify your study, you must receive approval from the Human Studies Program prior to implementing any changes. You can submit your proposed changes via email at uhirb@hawaii.edu. (The subject line should read: Exempt Study Modification.) The Human Studies Program may review the exempt status at that time and request an application for approval as non-exempt research.

In order to protect the confidentiality of research participants, we encourage you to destroy private information which can be linked to the identities of individuals as soon as it is reasonable to do so. Signed consent forms, as applicable to your study, should be maintained for at least the duration of your project.

This approval does not expire. However, please notify the Human Studies Program when your study is complete. Upon notification, we will close our files pertaining to your study.

If you have any questions relating to the protection of human research participants, please contact the Human Studies Program at 956-5007 or uhirb@hawaii.edu. We wish you success in carrying out your research project.

Revised and Approved (1/9/13) Exempt Research

Sheri T. Fitzgerald
819 Kinau Street, Apt B3
Honolulu, HI 96813
808-457-9116

UH IRB Committee
University of Hawai'i at Mānoa
1960 East-West Road, Biomedical Bldg B-104
Honolulu, HI 96822

Thursday, December 13, 2012

Dear UH IRB Committee:

My name is Sheri T. Fitzgerald and I am writing with respect to my current study, CHS #20546, entitled "Eco-Identity: Secondary Science Teachers' Experiences that Cultivate Place-Based Teaching in a Native Hawaiian Context," which was approved on September 26, 2012, for exempt status. I am requesting to make changes to my study and have submitted proposed changes to the project title, research questions, and methods of data collection to my dissertation committee on November 10, 2012. This proposal revision was approved and signed by my dissertation committee members on November 26, 2012. Dr. Pauline Chinn is my committee chairperson.

Three areas of proposed changes to my study are: (1) the title; (2) deletion of third related question; and (3) the extended timeframe for data collection and the methods of data collection and in the methodology section.

Proposed change number 1: For the title, I proposed a change from the original listed above to: "Eco-Identity: Secondary Science Teachers' Experiences that Cultivate Place-Based Teaching in a Hawaiian Cultural Context." This amended research title is noted in the newly submitted application for exemption status (see attachment #1).

Proposed change number 2: The main research question remains the same, along with the first two related questions posed in my proposal. The third related question has been deleted. All questions will now read as such:

Research Questions

Overarching research question: In this qualitative case study of purposefully selected secondary science teachers in Hawai'i, are there common characteristics tied to ecological identity (or what I will refer to as "eco-identity") and sense of place that can emerge over time and space as these teachers traverse the multiple landscapes of science teaching in Hawai'i?

Related questions:

- What/how do communities of practice in Hawaiʻi tied to a Native Hawaiian traditional ecological knowledge (TEK) system embodying ʻIke Hawaiʻi, influence place-based science education and culturally relevant pedagogy in the secondary schools, to promote a critical pedagogy of place here in Hawaiʻi?

- What are the stories and narratives that are lived by secondary science educators, and how do these experiences and critical reflections of these experiences influence, if at all, teacher eco-identity and sense of place that are rooted in the Native Hawaiian host culture?

Proposed change number 3: I also propose changes to the methods of data collection, with attention to The Belmont Report, to continue to follow under the designation of exempt status for my study. In addition to these proposed changes in methods, I will need to extend the dates for the data collection period. I have not proposed any changes to the data analysis process of my study.

Proposed Timeline and Selection Criteria

Due to logistics with proposal acceptance and approval, and the approval of for conduction of such a study by the UH Human Studies Program at the University of Hawaiʻi at Mānoa, I propose to begin the data collection process in December 2012 and continue with this process of data collection from January 2013 through June 2013. The member-checking and constant comparative processes will take place throughout this period as well, along with data analysis that will continue on through the summer months of June through August of 2013. I will then propose to complete my analyses and share my findings with the science teachers (six to eight research participants) and dissertation committee members in September 2013.

With respect to the changes in data collection process, I propose to also include a pre-interview to not only gather background information, but to also gather responses from the science teachers with respect to place-based science teaching. To triangulate my data, I also propose to conduct a teacher observation (focused solely on the behaviors of the science teacher) in an outdoor setting with students for a service and/or problem-based project. I will record this teacher observation solely through researcher field notes (no video/audio recordings will take place). Another component that I would like to add to my methods of data collection is the gathering of teacher artifacts in the form of completed projects, student work, participation in professional development programs, etc. I will attach an amended consent form with these approved changes to the data collection process in Appendix A.

As with the interview process, I will not attribute any identifying information (i.e. schools, student/teacher names, location of project site) with the field notes and teacher artifacts. With each event (interviews and teacher observation), I will conduct post-discussions with teachers to validate data and transcriptions. Like the interviews, I will audio record the conversations, and destroy (erase) all recorded materials once the transcription and member-checking events are completed. I have not proposed any changes to the data analysis process of my study.

What follows are the proposed changes to data collection as noted in my proposal revision to the dissertation committee on November 10, 2012:

Pre-Interviews. Prior to the first formal interview I will ask to meet with each teacher at a location of his/her choice. At this time, I will also explain my roles as researcher and participant-observer to confirm an understanding of an agreement to participate in my research, stressing the process as collaborative and in the spirit of ecological inquiry (Espino & Trickett, 2008; Kelly, 1986). This informal contact will be made in person, to discuss the nature of my study, methodology and methods, and to answer any ethical concerns that the science teacher may have about being a participant in my research. At this time, I will review the adult consent form will with the selected science teacher, and if agreed upon, then we (researcher and participant) will sign the form. (See Appendix A for a revised copy of the adult consent form.)

I will gather background information through the use of a short questionnaire. This questionnaire will elicit personal information such as: cultural and ethnic backgrounds, place of birth, past and current residences, K-12 schooling, undergraduate schooling and subjects studied, careers prior to teaching, teacher training, etc. I will then gather information with respect to science teaching with questions such as: years of teaching science, subjects taught, places/districts/states working as a science teacher, and current place of teaching science (and number of years at current school/district). All names and DOE/private school names that I gather from each science teacher will not be reported in the final dissertation—confidentiality will be upheld. There will be three open-ended questions related to place based education models and teaching for sustainable development in Hawai'i, and they are:

- In what ways do I use resources and teaching strategies to promote culturally relevant and meaningful learning experiences for my students?
- What are some key concepts and skills in science that I feel my students should develop in science education that will help promote sustainable development in Hawai'i today?
- How important is it to me as a science teacher to address not only environmental/ecological issues in the classroom, but also socio-cultural and political issues?

Interviews. The primary instrument for data collection for this proposed study will come in the form of audio recorded interviews, notes, and memoing. The interview process in case study research is an effective means to gathering these life stories of the science teachers and used primarily in qualitative inquiry and the narrative process (Alsup, 2006; Chase, 2005; Clandinin & Connelly, 1988, 1993, 1998; Hatch & Wisniewski, 1995; Lincoln & Guba, 1985, 2005). I propose to conduct open-ended, semi-structured interviews with each science teacher in two sessions, with one interview taking place at his/her respective school and the other taking place at a location of his/her choice, to reflect the individual's sense of place. This will take place over the course of six months (December 2012, and January through June 2013). Each interview will be followed by a post-interview discussion to review topics and transcriptions, to take further notes (elaborations), and to make clarifications and/or changes to the transcribed information. I will conduct these post-interview discussions (two of them) with each science teacher at locations of his/her choice.

This process will be conversational and collaborative in nature, as I will be asking each science teacher for feedback and further insights on connections to place and experiences as a science teacher.

All of these interviews in the narrative inquiry process will be open-ended and semi-structured and follow a protocol that is sensitive to the teacher being interviewed, in terms of socio-cultural, historical, political, economic, and environmental contexts with which the teacher is coming from. I will uphold confidentiality with this process of data collection, utilize proper ethical protocol as a researcher, and be mindful of my practices as a naturalistic researcher, whereby my values, beliefs, feeling, and assumptions may unintentionally interact with those of the person being interviewed (Lincoln & Guba, 1985). In following the standard protocol for conducting interviews utilizing the narrative inquiry process, I will: (a) gather background information of the interviewees; (b) ask guiding, open-ended questions with respect to teacher experiences and the focus of my study (i.e. teacher identity, place-consciousness, place-attachment, sustainability science education, policies and mandates related to science curriculum and pedagogy); (c) transcribe recorded interviews (two interviews per interviewee) and return these transcriptions to the interviewee for corrections and changes (member checking as a form of validation); and (d) share final copies of these interviews and the final outcome of the study in general with the interviewees. Guiding questions for each interview will be attached at the end of this document in Appendix B.

Teacher Observations. Again, utilizing that notion of ecological inquiry as part of narrative inquiry, I will ask each science teacher about observing and participating (as an accompanying adult aid/chaperone) in at least one event involving a place-based community project (selected by and designated as such by the teacher). It is with the intent of building a relationship and ensuring reciprocity with my research, that I will ask to observe each teacher as he/she interacts with students and other community members in such a science project. For this observation, I will focus on the teacher's lesson, pedagogical processes, student-teacher interactions, and student reactions and behaviors during the lesson. Field notes will be taken during this observation, and I will serve as a participant and observer in the community setting for the place-based science project/event(s). No overt interactions with the students will take place. In a post- observation discussion, I will share my written field notes (no audio recordings will be produced) with the teacher to get feedback, as part of the validation process in member checking. I will take written notes for this post-observation discussion and also audio record the conversation at a location that is suitable to the science teacher. Once these notes and are validated by the science teacher, I will destroy the audio recordings.

Teacher Artifacts. A third component to this data collection process will include teacher artifacts in the form of previous and current lessons and units of study, completed student projects, grant writing, service learning projects completed, participation in science workshops, involvement with school and/or community organizations related to place-based science education, etc. After the completion of the first post-interview discussion, I will also ask each teacher to create an identity timeline. In this identity timeline, teachers will notate key events and moments in time associated with feelings and reflections leading up to any developing, changing, and shifting perspectives on their personal and collective identities as science teachers. I will ask them to share whatever they are most comfortable with sharing, and I'll ask that they have this timeline prepared for the second interview. During the two semi-structured interviews, I will be asking teachers to share artifacts as they relate to place-based science teaching, also teaching for sustainability and sustainable development.

APPENDIX C:

1/9/13 E-Correspondence Approval from CHS for Revision to Research

Below is an E-mail correspondence received from the Committee on Human Studies at UH Mānoa, on January 9, 2013. This is regard to my application for proposed changes to my study (CHS # 20546). This message was sent by Kristen Bacon (kbacon@hawaii.edu) with the UH Committee on Human Studies.

Dear Sheri,

Thank you for sending in the revised documents. The revisions look good.

I have saved the revised consent form in your study file, and your study title has been changed in the database.

I will also save a record of our correspondence.

You now have approval to proceed with the changes.

Please let us know if you have any more questions.

Aloha,
Kristin

*Proposed changes received by the Committee on Human Studies were accepted under the continued status of "exempt." I will attach this document in this section as well.

Adult Consent Form

Agreement to Participate in Science Education Research:
*"Eco-identity: Secondary science teachers' experiences that cultivate place-based teaching in a
Hawaiian cultural context"*
Sheri T. Fitzgerald, Principal Investigator
University of Hawai'i at Mānoa, College of Education
Department of Curriculum Studies
1776 University Avenue, Honolulu, HI 96822
(808) 457-9116

Aloha,

My name is Sheri Fitzgerald, and as part of my final, culminating study leading up to the
completion of a doctoral dissertation for the PhD degree in Education at the University of
Hawai'i at Mānoa, I am conducting research on how secondary science teachers develop a
sense of place through place attachment (emotional domain) and place meaning (cognitive
domain), and how their lived experiences as science teachers can help to inform and influence
the development of an ecological identity, or what I will refer to as an "eco-identity." I am also
interested in the socio-cultural aspects of living and working here in Hawai'i as a science
teacher, and how being situated in a Hawaiian cultural context, along with other potential
influences (i.e. economics, politics, educational reform, global issues), can also help to shape
the professional knowledge landscapes of science teachers today.

My data collection process, to begin in December 2012 and continuing from January through
June 2013, will include: (1) an informal pre-interview to gather science teacher background
information (i.e. subjects taught in science, where born and raised, years of teaching, etc.),
which will take approximately 20 to 30 minutes of your time; (2) two, individual interviews
about educational practices as a science teacher, with particular emphasis on sense of place
and participation in place-and community-based sustainability science projects over the period
of your teaching career, meeting twice in the given time period; (3) one or more (as you are
willing to allow) observations of a place-based science lesson/project in progress, preferably
outside of the classroom; and (4) gathering teacher artifacts during the interviews that you are
willing to share with me, in the form of completed projects, student work, participation in
professional development programs/workshops, awards, etc.

For the interview participation I will ask for your permission to be audio recorded for the two
sessions and, also for the post-interview discussions. During these interview sessions (the first
one taking place at your school and the second one at a location of your choice) I will be asking
you to share with me any artifacts that can help to reveal your connections to place and your
development of a sense of place through your lessons, projects, student outcomes,
participation in workshops, etc. During this time-period, I would also like to have you do some
identity work in the form of creating a timeline of your eco-identity development, which can
take the form of a map, or "sense of place" map. We will discuss this identity timeline during
the second interview. I will also be taking notes during these one-on-one interviews. I will
then transcribe the audio recordings and provide each set of interview drafts to you for member
checking, feedback/corrections, and final approval before then destroying the recordings.
During the interview and transcription process, I will keep these recordings in a safe, locked
place in my home as part of researcher confidentiality. When the member-checking and
corrections are made to the transcribed documents, I will return the corrected copies of
interviews to you for approval, prior to destroying the audio recordings.

In addition to the interviews and post-interview discussions, and gathering of teacher artifacts,
I would like to also observe you teaching and interacting with your students for a single event
(or more) of your choice, that you would define as place-based and problem-based in nature. I

would like to observe the ways in which you cultivate the learning of science through relevant, meaningful, and place-based experiences for your students. During this time, I will also offer to serve as an adult chaperone and teacher aide, as I feel that my role of researcher should go beyond one as an outside observer. I believe that this process should be one of a reciprocal nature; thus, I am more than willing and obligated to become that participant as well as observer. I will focus in on your pedagogy and interactions with students during this observation and will take field notes. No audio recordings will be made, and no photos will be taken during this observation.

The results of these interviews and observations, along with analyses and co-construction of potential knowledge and theories (I will be asking you to help me with this process, as a grounded theory approach and means to representing science teacher voices respectfully and accurately), will be shared with you and with the greater community as I complete the dissertation and defense as part of the requirement for completion of the doctoral program in education at University of Hawaiʻi at Mānoa. The target date of dissertation defense and program completion will be in fall 2013, which at that time I will provide you with a final report.

As a former secondary science teacher in Hawaiʻi, and, currently, as a researcher and university educator in science education, I promise to uphold good ethical conduct throughout the data collection process. I also guarantee that I will not reveal your name, the names of the schools you've attended and worked at throughout your teaching career, teachers and administrators, and other places of work/internship at any time in the reporting and sharing of results (both orally and in written form). If you wish, I will keep you informed of the progress of my study throughout. If, at any time during the study, you wish to withdraw from participation, then please contact me immediately. Participation in this study is strictly voluntary.

As the principal investigator, I believe that there will be little or no risk to your participating in the interview sessions, member checking for validity of information reported, and for the co-construction process of knowledge, understandings, and potential theories specific to secondary science teaching in Hawaiʻi today. During the interview sessions, we will review general practices of respect and allow for ample time for critical self-reflection and sharing of feelings, beliefs, ideas, etc. as they come about in the talk story fashion of these interviews. Again, mutual respect and confidentiality will be upheld. As an educational researcher and science teacher myself, I foresee the benefits of your participating in this study to be empowering and encouraging for you to continue doing what you are doing in the arena of place-based science teaching in Hawaiʻi. While the results of this study may not be generalizable to the entire teaching population, nor science teaching population, in Hawaiʻi, this study can certainly inform your individual practices as a science teacher and can shed some light on how to conduct future research in a collaborative, communities of practice framework, with the Hawaiian cultural knowledge and practices (ʻIke Hawaiʻi) in mind. Moreover, this study can inform future studies of science teacher retention in Hawaiʻi with respect to eco-identity development.

Thank you for your support. I look forward to working with you in the coming months. Sincerely,

Sheri T. Fitzgerald

If you have any questions regarding this research project, please contact me, Sheri Fitzgerald, at (808) 457-9116. You may also E-mail me at sheritf@hawaii.edu

If you have any questions regarding your rights as a research participant, please contact the UH Human Studies Program, University of Hawai'i, 1960 East-West Road, Biomed B-104, Honolulu, HI 96822. Telephone: (808) 956-5007.

"I certify that I have read and that I understand the foregoing, and that I have been given satisfactory answers to my inquiries concerning project procedures and other matters. I also certify that I have been advised that I am free to withdraw my consent and to discontinue my participation in the study at any time without prejudice. I hereby agree to participate in this research project with the understanding that I will be audio recorded during the interview sessions, and that I do not waive any legal rights herein."

_____   _____   _____
    Your (Printed) Name   Signature   Date

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

APPENDIX E:

Guiding Interview Questions (Interviews #1 and #2)

Interviews—I will conduct two, one-hour long, semi-structured interviews at the school of each teacher, whereby artifacts can also be shared during these interviews.

- Interview #1: Teacher timeline up to this point in time—Sharing own experiences with "science," including preK-12 and college experiences with respect to science education and cultural/home experiences with respect to learning about and interacting with the environment. Pivotal moments in time will be asked about, and results of these experiences/events will be asked to be shared, based on the comfort level of each teacher. Guiding questions:

  1. What are some events in your life as a child and student (K-12) that you feel has made you more conscious about your surroundings?
  2. Have you always had a connection to where you lived, and now where you work and live?
  3. What does "sense of place" mean to you?
  4. What factors and events have influenced you to become a science teacher?
  5. Share with me any experiences up to this point in time with respect to science teaching and utilizing place based education models.
  6. Elaborate on your responses to the three questions posed in the pre-interview questionnaire.
     a. Relevance and meaningfulness of science to daily life? (Hawaiian cultural context)
     b. Teaching science for key concepts and skills promoting sustainable practices and development in Hawai'i?
     c. Teaching science not only for ecological justice, but also for social justice?

- Interview #2: This session will focus on the notion of a science teacher eco-identity and connections to place, and also what it means to have a critical pedagogy of place and a science curriculum that is culturally relevant and/or responsive. Teachers will be asked to share any artifacts that they feel represent culturally relevant/responsive place based education.

  Also, the teacher identity timeline will be shared and discussed at this time. Guiding questions:

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1. Please share your identity timeline with me and go over these key events and moments in time and why you've selected these experiences. With each event, how did you feel at the time? How do you think that each experience has helped to change your sense of self as a science teacher?

2. As a science teacher, what do you feel are your roles as a community member outside of school, and as an educator in Hawai'i? Are these roles the same? Different? Explain.

3. What do you think an eco-identity is? Do you feel that you have an eco-identity? (I will share the documents from "A Manifesto for Earth" (Mosquin & Rowe, 2004) and the International Earth Charter Initiative (2000) with each teacher at this time.)

4. What are some of the conflicts and dilemmas over time, which may have influenced the way that you see yourself (with respect to this eco-identity)?

5. Have you considered changing careers and/or retiring all together during your ___ years of teaching science? What do you feel may have been factors prompting you to feel this way? Have you shared such feelings with other science teachers? Family and friends?

6. Do you have any final thoughts on your process of forming such an eco-identity as a science teacher? Do you feel that having an awareness of an eco-identity has influenced your relationships in the professional community? How so? Any thoughts on the impacts that your eco-identity and sense of place may have on the experiences and learning outcomes for your students?

APPENDIX F:

New Ecological Paradigm (NEP) Scale Questionnaire

Dear educator, this NEP Scale questionnaire is not a test, but a measure to see how you view the world today, given your experiences and background up to this point in your life. Please select one response for each of the 15 statements below. There are no "right" or "wrong" answers for this questionnaire, so your honest answers based on what you are feeling right now, are most appreciated. All information will be kept confidential.

School:_____   Grade Level(s) & Subjects Teaching/Taught:_____

Gender: Male/Female (circle one)   Age:_____   Ethnic background:_____

Born and raised (State, Country):_____   Number of years living in Hawai'i:_____

ITEM	RATING SCALE (Circle one answer for each item.) **SA**=Strongly Agree **A**=Agree **Neither A or D**=Neither Agree or Disagree **D**=Disagree **SD**=Strongly Disagree **?**=I don't Know				
1. We are getting close to having too many people on Earth.	SA	A	Neither A or D	D	SD	?
2. Humans have the right to change the natural environment to fit their needs.	SA	A	Neither A or D	D	SD	?
3. When humans disturb nature it often produces terrible results.	SA	A	Neither A or D	D	SD	?
4. Human cleverness and skill will make sure that we do NOT ruin the Earth.	SA	A	Neither A or D	D	SD	?
5. Humans are greatly mistreating the environment.	SA	A	Neither A or D	D	SD	?
6. The Earth has plenty of natural resources if we just learn how to use them.	SA	A	Neither A or D	D	SD	?

RATING SCALE (Circle one answer for each item.)
SA=Strongly Agree
A=Agree
Neither A or D=Neither Agree or Disagree
D=Disagree
SD=Strongly Disagree
?=I don't Know

ITEM						
7. Plants and animals have as much right as humans to live.	SA	A	Neither A or D	D	SD	?
8. Nature is strong enough to handle the bad effects of modern developed countries.	SA	A	Neither A or D	D	SD	?
9. Even with our special abilities humans must still obey the laws of nature.	SA	A	Neither A or D	D	SD	?
10. The so-called 'environmental crisis' facing humans has been blown out of proportion (exaggerated).	SA	A	Neither A or D	D	SD	?
11. The Earth is like a spaceship with very limited room and resources.	SA	A	Neither A or D	D	SD	?
12. Humans were meant to rule over the rest of nature.	SA	A	Neither A or D	D	SD	?
13. Nature is very delicate and easily harmed.	SA	A	Neither A or D	D	SD	?
14. Humans will someday learn enough about how nature works to be able to control it.	SA	A	Neither A or D	D	SD	?
15. If things continue as they are going, we will soon experience a major environmental disaster.	SA	A	Neither A or D	D	SD	?

Question: Where do you feel most connected? This place could be specific (your house, a particular park or beach, your school, etc.) or a broader type of place like beaches, forests, parks, cities, or towns. Explain briefly as to why you feel connected to this place. *(We can also discuss this during the interview.)*

APPENDIX G: Doc Burrows' Background vand Lived Experiences Supporting and Challenging Eco-Identity

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicities: Hawaiian, Chinese, German	Ahupuaʻa of Kailua on Oʻahu Island (raised)	**Formal Science Teaching:** Four years: Seventh/eighth grade sciences (Portland, Oregon)	• Practicing Christian faith since childhood and raised by Hawaiian grandparents; Sunday bible training in high school
Years living in Hawaii: Born in Nuʻuanu, and raised in Kailua on Oʻahu Island	Kawainui and Hāmākua Wetlands; Ulupō Heiau, Nā Pōhaku O Huawahine	Kamehameha School (1964) Seventh and eighth grade sciences (few years); high school biology, marine science, chemistry, physical science, and environmental science (retired in 2000)	• Attending Kamehameha School high school, taking biology course and learning Hawaiian language at the Bishop Museum (Hawaiian language forbidden in Standard English School at time)
Schooling: Public school K-8; Kamehameha School grades 9-12	Kapālama Campus of Kamehameha School, Oʻahu	**Years of formal science teaching:** 40 years	• Training and traveling across continental U.S. while in Coast Guard, with continued interests in science and strengthening of sense of place in Hawaiʻi
B.A. degrees in biology & chemistry (Oregon);		**Post-retirement:** Environmental and Hawaiian cultural education work with religious and spiritual groups (local, national, international); Kawainui-Hāmākua Master Plan Project in the ahupuaʻa of Kailua	• Affording high school students with Hawaiian cultural and scientific field studies on main Hawaiian Islands, and archaeological research trips to American Southwest, Cook Islands, Alaska, New Zealand, Tahiti, and Easter Island
M.Ed. & M.S. in biology & earth sciences (Oregon);			• Starting up environmental science and hiking club Hui Lama for Kamehameha high school students to conduct field studies working with scientists and cultural practitioners
Ed.D. in instructional development and research (Indiana)			• Taking several trips to Kahoʻolawe Island, one of them involving Hōkūleʻa's Nainoa Thompson and astronaut Lacey Veach, whereby navigators from different realms would connect and inspire his students to restore and protect native ecosystems
			• Supporting the Church of the Crossroads "Green Congregation"
			• Building Hawaiʻi Interfaith Power and Light and spiritual connections to eco-justice pedagogy
			• Planning and advocating for the Kawainui-Hāmākua Master Plan Project to protect the area and obtain designation as a National Wildlife Refuge and a Hawaiian and cultural environmental center

APPENDIX H: *Eddie's Background vand Lived Experiences Supporting and Challenging Eco-Identity)*

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicity: Indian	Kampala, Uganda, Africa (born and raised up through early childhood years)	**Formal Science Teaching:** Three years: Secondary science teaching at Catholic, all-boys National High School, Mang'u High School, in Thika, Kenya	• Relocating to coastal town of Mombasa, Kenya, where days spent appreciating natural beauty of coastline, and playing music on beach
Years living in Hawaiʻi: 15 years	Mombasa, Kenya, Africa (latter childhood and adolescent years)	Taught briefly at a public elementary school in Ohio; Seven years: Secondary science at private Catholic school in Florida; Few years teaching biology at Florida college in nursing program at same time	• High school biology teacher, a naturalist, taking outdoors for studying local flora and fauna; invitations to his home for studying native plants
Schooling: Private, Catholic schooling K-12 in Kenya, Africa	Hawaiʻi in general (now living)	Ten years: Vancouver, British Columbia, teaching secondary science in private, Catholic school setting	• Not knowing what to do with life after high school, thinking of playing music (piano) like father, and being encouraged by neighbor (teacher) to try teaching; ending up teaching ninth grade poetry at a small Kenyan school
Teacher Education program in secondary science in Nairobi, Kenya, at private, Catholic college	Coastal areas and marine environments	Three years: Seventh and eighth grade AP Biology at private, all-boys Catholic school, in Hawaiʻi	• Teacher training in Nairobi, Kenya with inspirational British teacher (biology) transporting in his personal off-road vehicle on field trips to studying cheetah behaviors
Master's degree in biology, with chemistry minor from private, Catholic University in Dayton, Ohio		Twelve years: Chemistry, biology, and marine biology teaching at another private Catholic high school, retiring in 2017	• Summer 2011 trip to South Africa working with math and science teachers for six weeks, conducting professional development workshops with practical, place-based applications of chemistry and math
		Total years of formal science teaching: 36 years	• Summer 2013 trip to Catholic-run elementary school in the slums of Nairobi, Kenya providing direct support and resources for teachers and students
		Post-retirement: Five-month stay in Bangalore, India to work with Marianist brothers, teaching English	• Being given freedom to reconstruct and teach place-based marine biology course for remaining four years of science teaching career, focused personal area of interest
			• Traveling back to hometown of Kenya in summer of 2015 with current wife, and then to Goa, India where parents were born, and meeting relatives and beginning to understand ethnic Indian roots
			• Second trip to India (Bangalore) in fall of 2017, to living in monastery and teaching English writing to Marianist brothers, further connecting with his ethnic Indian cultural identity and understanding knowledge system of Ayurvedic medicine

APPENDIX 1: *Karen's Background vand Lived Experiences Supporting and Challenging Eco-Identity*

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicities: Japanese, Chinese, Hawaiian, and German	Pauoa Valley, Oʻahu (born and raised, and where parents still live)	**Formal Science Teaching:** One year: Ninth grade physical science and marine science for upper grades at public high school in Honolulu where student taught	• Humbling third grade incident, learning not to assume classmate's cheating, now realzing individual epistemologies impacting learning styles
Years living in Hawaiʻi: Born on Oʻahu and raised in Pauoa Valley	Honolulu, Oʻahu (living and working)	Six years: single line of ninth grade physical science working with special education inclusion teachers	• As child/adolescent, reading science magazines and playing with chemistry set at home; spending summers indoors at home with siblings, reading books
Schooling: K-2 Public schooling in Honolulu, Hawaiʻi		Two years: Biology (tenth grade) and marine science (upper grades) until spring 2014 to go on maternity leave	• Feeling "humiliated" by middle school science teacher for being called out for defending creationism
Teacher education program (B.Ed.) with emphasis on physical science at the University of Hawaiʻi at Mānoa		Two years: Online physics courses (two years) through Hawaiʻi State DOE E-School while teaching science full time	• Playing chess with father, and developing skills of strategy and problem-solving; father providing books on creationsim and evolution during adolescence
		Current job: Four years (as of 2017-18): Stay-at-home mom since fall 2014, teaching AP Physics online for the E-School program	• Taking AP Chemistry, but lacking confidence to take AP exam, and learning concepts and principles on own as high school student
AP physics teacher training to become certified to teach through online E-School program at Hawaiʻi State DOE		**Current number of years of science teaching:** Nine years (on-ground) Six years (online)	• Feeling disappointed in self for lack of effort put into studying and making up missed laboratory assignments in high school honors physics class
			• Deciding to become secondary science teacher during second year of education program, after discouragement from father's former teacher to enter dual certification program in elementary and special education
			• Working with at-risk and special needs students teaching ninth grade physical science in inclusion classrooms and feeling supported by administration
			• Continuing to attend church and practice Christian faith
			• Renewing interest in biology teaching upper grades with less classroom management issues
			• Becoming stay at home mom in the fall of 2014, with the birth of third child, and feeling comforted and supported by family; continuing to teach physics online and enjoying freedom of teaching and being a mother

APPENDIX J: Ed's Background vand Lived Experiences Supporting and Challenging Eco-Identity

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicity: Okinawan	Pu'ukoli'i Plantation, Maui, near Lāhaina	**Formal Science Teaching:** Two years: science teaching in California secondary public school	• Born and raised on small plantation in Pu'ukoli'i, Maui, with parents and siblings sacrificing for family; parents as role models of perseverance and hard work
Years living in Hawai'i: Born and raised on Maui	Lāhaina (born and raised)	One year: High school science (chemistry) in 1971 Maui public high school	• Standing up for self, with administrator help, to get back into Algebra class after being kicked due to overcrowded conditions and potential bias
Schooling: K-8 schooling in Pu'ukoli'i Village plantation on Maui	Kīhei, Maui (currently living)	Twenty-eight years: Second Maui high school teaching chemistry. AP chemistry, physics, physical science, mathematics, retiring in 2000	• Experiencing rigorous education in high school, with supportive teachers, to pursue science and mathematics
Public high school in Lāhaina near plantation village, on Maui		One year: Volunteered Praxis secondary teacher preparation course for mathematics content exam; taught science methods course for undergraduate education majors at Maui Community College	• Mother's persistence to attend college (first in family), rather than join Army after high school (father's wish) • Drafted into Army (Vietnam War) and traveling to Germany as Russian linguist; military experiences teaching about collaborating with diverse people
Colorado college for B.A. in chemistry, with physics and mathematics minor		Throughout teaching career: Volunteer coaching students for Science and Ocean Bowls, and Science Olympiad; also coaching students for AP exams	• Being recognized as State Science Teacher of the Year in 1988, and recognized by the American Chemical Society as outstanding chemistry teacher • College counseling course introducing philosophy of "I'm OK, you're Ok", and learning that teaching also about building personal relationships with students • Dealing with socioemotional issues with adopted daughter; drawing upon "I'm Ok, you're OK" philosophy working with students • Entering high school students into national Science, and then Ocean bowls in mid-90s, using teacher voice to advocate for continuance of program and empowering students with building knowledge and self-confidence
Master's degree in education for science teaching from same Colorado College		**Total years of formal science teaching:** 31 years **Post-retirement:** Continued volunteer (17 years now) science bowl and AP exam coaching	• Traveling to Okinawa inn 2016 with younger sister, to begin gathering stories of parents' Okinawan roots • Supporting students with entry into prestigious universities and entering STEM-related careers; HI public school students can be ready for schools like MIT

APPENDIX K: *Malia's Background vand Lived Experiences Supporting and Challenging Eco-Identity*

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicity: Okinawan	**Hālawa, O'ahu** (born and currently living in parents' former home)	**Formal Science Teaching:** Three quarters: High school chemistry at public high school in Hilo	• Positive move to Hilo in fifth grade, making friends easily and feeling sense of belonging in Hilo
Years living in Hawai'i: Born and raised as a child in Hālawa, O'ahu; and also raised in Hilo, Hawai'i	**Hilo, Hawai'i** (raised)	One semester: Ninth grade physical science at the current high school in the Windward district (fourth semester of MEdT program at UHM)	• Middle school incident regarding episode with science teacher, being labeled as "disruptive", learning importance of acknowledging all students in classroom
Schooling: K-4 schooling at public elementary school in Hālawa, O'ahu	**Kāne'ohe, O'ahu** (current place of teaching)	Fifteen years: Chemistry and AP chemistry (2017-2018 school year)	• Tracking in Gifted and Talented program from upper elementary through middle and high school as positive learning experiences with cohort
Fifth grade and middle through high school at public schools in Hilo, Hawai'i		**Current number of years of science teaching:** 16 years	• Shown movie about scientist racing to find cure for cancer in Amazon, in AP chemistry class, sparking interest to learn about cancer research; positive experiences in AP calculus, with math relevancy
B.A. degree in chemistry from University of Washington		**Current job:** Continues to teach chemistry, AP chemistry, and one class of Engineering Technology I at same public high school in Windward district of O'ahu	• Realizing secondary education career path after volunteer high school math tutoring in city outskirts (Seattle, Washington) where students predominantly African American
Master of Education in Teaching (MEdT) from UH Mānoa, with emphasis on secondary science teaching			• Supportive mentor teacher for student teaching practicum teaching physical science
			• Petitioned and started AP chemistry course at high school, now standard part of science offering
			• Experiencing changes in administration and program changes and being the voice for other teachers
			• Raised in Christian household and continues to practice religion; challenged at times; overcoming confrontations by keeping religion out of science classroom
			• Caring for son born with birth defect; less time spent in school; after school clubs and leadership roles eliminated
			• Currently teaching the Engineering Technology I class to 11th graders and enjoying program and ability to apply chemistry into course, and consider applications in Hawaiian cultural contexts (i.e. fishpond)

APPENDIX L: Lynne's Background and Lived Experiences Supporting and Challenging Eco-Identity

Teacher Background	Place Connections	Teaching (Formal and Informal)	Significant Events and Situations Impacting Eco-Identity
Ethnicity: Mixed Caucasian ethnicities	New Jersey (born and raised)	**Formal science teaching:** One year: Seventh grade life science teaching at New Jersey public school	• New Jersey: informal outdoor/ocean experiences exploring nature and summers with grandparents at beach home, going into the water, swimming, etc.
Years living in Hawai'i: Ten years	O'ahu, Hawai'i (teaching and currently living)	Three years: Teaching varied grade levels (five different levels) of science at K-12 all-girls, Catholic school in New Zealand	• Negative experiences with kindergarten through second grade schooling at private Catholic school, feeling restricted and unsupported • Change to public school in third grade with relevant, hands-on science experiences throughout rest of elementary and middle school years
Schooling: K-2 private Catholic school in New Jersey	Ocean and other marine environments	Six years: Secondary science (predominantly 12th grade biology) at Honolulu public charter school	• Humiliating experience in ninth grade remedial physical science class; taking advanced courses rest of high school years, realizing passion for life sciences
Third through 12th grade public schooling in New Jersey		**Current number of years of science teaching:** Ten years	• Experiencing negative first year in college, realizing lack of student diversity; attending Rutgers University and meeting diverse peoples and continuing plant science • Positive experiences with dynamic science teacher role models for student teaching, realizing own teaching style of sharing life experiences with students
One year at University of New Hampshire studying plant biology		**Current job:** Dean of Curriculum and Instruction at same Honolulu public charter school	• Taking semester off to teach snowboarding in Vermont, connecting with future husband from New Zealand (NZ) • Traveling to NZ, staying three months, and learning local Maori knowledge of places, plants, and history
B.S. degree in plant science with minor in education from Rutgers University			• Returning to New Zealand to teach science at all-girls Catholic school for three years, learning more about the local culture and flora and fauna • Arriving in Hawai'i, using experiences in New Zealand to teach high school science six years at public charter using culturally relevant pedagogy and local places
Master's degree in biology curriculum and instruction in Florida			• Shifting from teaching to administration, in seventh year at charter school to become Dean of Curriculum and Instruction

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