

EVALUATION OF FACTORS CONTRIBUTING TO THE ACHIEVEMENT OF
STUDENTS PARTICIPATING IN A CULTURALLY RESPONSIVE CURRICULUM
IN HAWAI‘I PUBLIC SCHOOLS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAI‘I AT MĀNOA IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

EDUCATIONAL PSYCHOLOGY

MAY 2013

By

Scott A. Bowditch

Dissertation Committee:

Lois A. Yamauchi, Chairperson

Ronald H. Heck

Seongah Im

Alice J. Kawakami

Michael B. Salzman

Keywords: Culturally responsive curriculum, Hawai‘i public schools, science, evaluation

UMI Number: 3572414

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



UMI 3572414

Published by ProQuest LLC (2013). Copyright in the Dissertation held by the Author.

Microform Edition © ProQuest LLC.

All rights reserved. This work is protected against unauthorized copying under Title 17, United States Code



ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

© Copyright 2013

by

Scott Anderson Bowditch

ACKNOWLEDGMENTS

I would like to acknowledge everyone who supported me throughout my graduate program and am thankful for the encouragement of the members of my committee, particularly Lois Yamauchi, for her tireless guidance and patience in helping me to complete this project.

ABSTRACT

This research explored the effectiveness of *Ka Hana 'Imi Na 'auao*, a culturally responsive science curriculum developed for Hawaiian and other students in Hawai'i high schools. An instrument, The Culturally Responsive Science Perception (CRSP) inventory was developed to measure students' (a) perceptions of their science self-efficacy, (b) perceived frequency of behaviors valued by members of the Hawaiian community and (c) frequency of perceptions of behaviors conducive to learning. Initial validation for the three-factor construct was obtained using Exploratory Factor Analysis and further validated utilizing Confirmatory Factor Analysis with an oblique rotation and 24 items were found to measure the three aspects with a multicultural group of 332 students on Oahu and Hawai'i island. A multi-level analysis was conducted by (a) testing for internal consistency and growth patterns over time utilizing Confirmatory Factor Analysis, (b) developing a 2-level model using a Growth Curve Modeling approach as the final method of measuring growth over time and analyzing the differences between treatment and control groups. Results indicated a significant change ($p < .05$) in *science self-efficacy* and frequency of *pono behaviors* ($p < .05$), as well as significant gains in overall GPA ($p < .01$) in the treatment group. These positive findings suggest that when curriculum developers in Hawai'i are more culturally conscious, it may benefit all learners.

TABLE OF CONTENTS

Section	Page
List of Tables	vii
List of Figures	viii
List of Footnotes	ix
List of Appendixes	x
Introduction to the Research Problem.....	1
Purpose of the Study.....	1
Background.....	2
The Educational Setting in Hawai‘i.....	2
Literature Review.....	5
Cultures in Transition: Theoretical Foundations	5
Bridging Cultures in the Hawaiian Classroom	12
Research Addressing Hawaiian Culture in School	19
Culturally Responsive Teaching of Science	22
Culturally Responsive Teaching of Science in Native Communities.....	23
Science Education in Hawai‘i.....	27
Culturally Responsive Teaching of Science in Hawai‘i.....	31
The Present Study.....	38
The “STEM Crisis”	41
Science Self-Efficacy.....	44
Methods.....	49
Research Questions and Design.....	49
Participants.....	50
Instrumentation.....	52
Initial Validation of the Instrument using Exploratory Factor Analysis.....	52
Procedures and Internal Consistency of the CRSP Inventory.....	53
Further Validation of the Instrument Using Confirmatory Factor Analysis.....	54
Examining the Factor Means Over Time.....	59
Examining Treatment Effects Over Time.....	61
Multivariate Growth Formulation.....	64

Results.....	68
Examining Treatment Effects Over Time.....	68
Discussion, Conclusions and Implications.....	74
Confirmatory Factor Analysis.....	75
The Multilevel Model.....	76
Limitations of the Study.....	86
Implications for Future Research.....	87
References.....	89
Footnotes.....	107
Appendix A.....	108-110
Appendix B.....	111

LIST OF TABLES

Table	Page
3.1 Demographic Information, <i>Ka Hana 'Imi Na 'auao</i> Sample, 2006-2009 School Years.....	50
3.2 Factor Means, Standard Errors and Level of Significant Change by Time Point.....	60
4.1 Type III Tests of Fixed Effects	68
4.2 Estimates of Fixed Effects	69
4.3 Estimates of Covariance Parameters.....	70

LIST OF FIGURES

Figure	Page
2.1 Berry's (1990) coping strategies in acculturation.....	7
2.2 Instructional sequence of the Native science connections supplemental curriculum....	25
3.1 Results of Confirmatory Factor Analysis (Maximum Likelihood estimation, standardized solution) illustrating structure matrix of CRSP inventory with factor loadings, inter-factor correlations and item variance.....	58
4.1 Estimated Marginal Means of Behaviors Conducive to Learning.....	71
4.2 Estimated Marginal Means of Science Self-Efficacy.....	72
4.3 Estimated Marginal Means of Pono behaviors.....	73

LIST OF FOOTNOTES

Footnote	Page
¹ In this study, all students who reported being Native Hawaiian or part Hawaiian were included in the Hawaiian sample.....	107
² Hawaiian ethnicity was included in the first analysis but found to have no significant effect on any of the variables and therefore was omitted from the final model.....	107

LIST OF APPENDIXES

Appendix	Page
1. The Culturally Responsive Science Perceptions (CRSP) Inventory.....	108-110
2. SPSS Syntax Used in the Multi-level Model.....	111

CHAPTER 1

INTRODUCTION TO THE RESEARCH PROBLEM

This study explored the effectiveness of *Ka Hana 'Imi Na 'auao*, a culturally responsive science curriculum developed for Hawaiian and other students in Hawai'i high schools. An instrument was developed to measure students' behavior valued by members of the Hawaiian community, perceptions of science self-efficacy, and frequency of behaviors conducive to learning in the classroom. The purpose of the curriculum was to change the attitudes and behavior of participating students. When conceptualizing how to gauge whether a culturally responsive curriculum was effective in teaching science to high school students living in Hawai'i, curriculum developers felt that it was important to determine whether the curriculum helped students to be less apprehensive toward learning science and led them to be more confident that they could succeed and do well in science class.

High school educators previously working in Hawaiian public schools that gave input to the curriculum said they had observed students' consistently low confidence in their ability to do their science work. Secondly, these educators deemed it important to see if the curriculum's culturally responsive nature influenced the behaviors of students; or if it caused behaviors valued as correct or proper by the Hawaiian community (roughly translated; pono behaviors) to increase, and if students' classroom behavior deemed as proper by their teachers would be influenced.

Purpose of the Study

The purpose of the study was to evaluate the effectiveness of the culturally responsive curriculum implemented over the course of the school year to a group of

students in Hawai‘i public schools.

The following research questions were utilized to explore students' growth over time, in addition to the difference between treatment and control groups: *Will students' perceptions of science self-efficacy improve as a result of participation in a culturally responsive curriculum, particularly for Hawaiian¹ participants? Will being exposed to the curriculum result in significant gains in students' perceptions of pono behaviors particularly for Hawaiian participants? Will students' perceptions of behaviors conducive to learning improve as a result of participation in a culturally responsive curriculum, particularly for Hawaiian participants?*

Background

The Educational Setting in Hawai‘i

The Hawai‘i State Department of Education (HDOE) is the most centralized and only statewide public education system in the United States (Meyer, 2012). Established by Kamehameha III in 1840, it is the oldest school system west of the Mississippi River and the only system established by a sovereign monarch. As the official state education agency, the Hawai‘i State Department of Education oversees all 283 public schools and charter schools and over 13,000 teachers (Hawai‘i Department of Education, 2003).

In 2009, the year in which data for this study were collected, eighth grade students in the State of Hawai‘i fell below the national average for reading with only 22% at or above proficient and 1% scoring at the advanced level (National Center for Education Statistics, 2010). Compared to all other states, Hawai‘i was lower than 46 in average scale scores, with marks equivalent to other under-performing states such as New Mexico, Nevada and Alabama. Hawai‘i student performance in science (based on eighth

grade scores) were among the lowest in the country. In 2010, eighth grade students in Hawai‘i fell below the national average for science with only 15% at or above proficient and 1% scoring at the advanced level. Among average scale scores for the 45 states that reported, Mississippi was the only state to score lower than Hawai‘i in science assessment.

Hawaiian students attending public schools tend to show poorer outcomes compared to other major ethnic or racial groups on a range of indicators, including standardized test scores, grades, placement in special education, school attendance, grade retention, suspensions, dropping out, substance abuse, juvenile arrests, and transition to postsecondary education and/or gainful employment (Hawai‘i Department of Education, 2005; Hewitt, 2003; Kawakami, 1999; Sato, 1989; Schrag & Johnson, 2002).

Furthermore, the student literacy rate in the State is among the lowest in the country (National Center for Education Statistics, 2010).

Some researchers believe the negative educational and employment outcomes experienced by Hawaiians are a result of the conflict between succeeding academically and remaining true to themselves and their culture (Hewitt, 2003; Kana‘iaupuni, & Ishibashi, 2003; Kawakami, 1999; Sato, 1991). Researchers of Hawaiian education inform us that Hawaiian parents have sometimes taught their children to “leave your Hawaiianess at home” [sic] (Sing, Hunter & Meyer, 1999, p. 12). Meanwhile, public schools rooted in the Western experience and traditions (Kaestle, 1990) may inadvertently or deliberately further promote this thinking, forcing students to subordinate their culture in order to succeed in the mainstream (Chapman, Davison & Panet, 2002). Classroom instruction, lacking a connection to the local culture and

physical surroundings, increases the challenges for Hawaiian students to engage in learning and to be valued for the knowledge and experiences they bring with them (Rosebery, McIntyre & Gonzalez, 2001). Yet, evidence is mounting that curricula, teaching, and instruction that link schooling to the surrounding cultural and physical environment produces positive results on all indicators of student and school performance (Au & Kawakami, 1994; Hollins 1996; Suryanata, & Umemoto, 2002).

CHAPTER 2: LITERATURE REVIEW

In this review of the literature, I will start with an explanation of how different theorists have defined how people adapt to cultures that are in transition, and then I will explore the “bridging cultures” framework and how it relates to Hawaiians today. In the next section, research addressing Hawaiian culture in school will be discussed after first explaining the learning environment in Hawai‘i and the influence Hawaiian culture and philosophy has had on education there. I will then discuss culturally responsive science education in Native communities and the ways educators and researchers in Hawai‘i have endeavored to be culturally responsive when teaching science. This chapter closes with an exploration of the current “STEM (Science, Technology, Engineering and Math) crisis” in the US and how this may be related to poor and minority students’ negative self-efficacy regarding science.

Cultures in Transition: Theoretical Foundations

Laosa (1999) conducted research for over 30 years focusing on the alterations that occur in individuals as a consequence of cultural contact situations. He named the term *intercultural transition* to refer to this phenomenon and saw these alterations as occurring on many levels, ranging from the most superficial to the deepest and most lasting. After the US colonized Hawai‘i at the turn of the last century, the first intercultural transition imposed on the people of Hawai‘i entailed a process that attempted to distort, disfigure and ultimately destroy the past of the native people (Hewitt, 2003; Irwin, 1924).

Hawaiians were given a model to follow that “the West is best” (Hewitt, 2003). Laosa (1999) called this subtractive intercultural transition. He considered intercultural

transition as essentially a process of change in which individuals bridge two different cultures that can be subtractive, additive, or transcending. Transition is seen as subtractive if an element of one culture is lost when an element of another culture is acquired. Transition is considered additive if no loss occurs when an element of another culture is acquired. A transcending transition occurs when two cultures come into contact and then this situation becomes a catalyst for some characteristic that is not typical of either culture.

Transition of any of the above types can be unilateral, or multilateral (Laosa, 1999). When two cultures come into contact and change occurs in one of the parties, transition is considered unilateral, if change occurs in both, it is bilateral. Laosa (1999) makes the case that in the United States, intercultural transitions are usually subtractive and unilateral because of false perceptions that a transition cannot possibly be additive and multilateral. Researchers in Hawai'i agree that in the past, educators have been operating within a unilateral, subtractive framework and intercultural transition in the schools must become multilateral and at least additive in order to raise the level of academic achievement of Hawaiian students (Sato, 1991; Hewitt, 2003).

Laosa's (1999) work is related to the research of Berry (1990; 1997) who coined the term "acculturation attitudes" for how individuals from one cultural group relate to another group. Berry theorized that people form their cultural identity using four distinct coping strategies (Figure 2.1). An individual whose experience involves two different cultures must operate along two cultural continuums, one representing their primary or home culture and one representing the dominant or host culture.

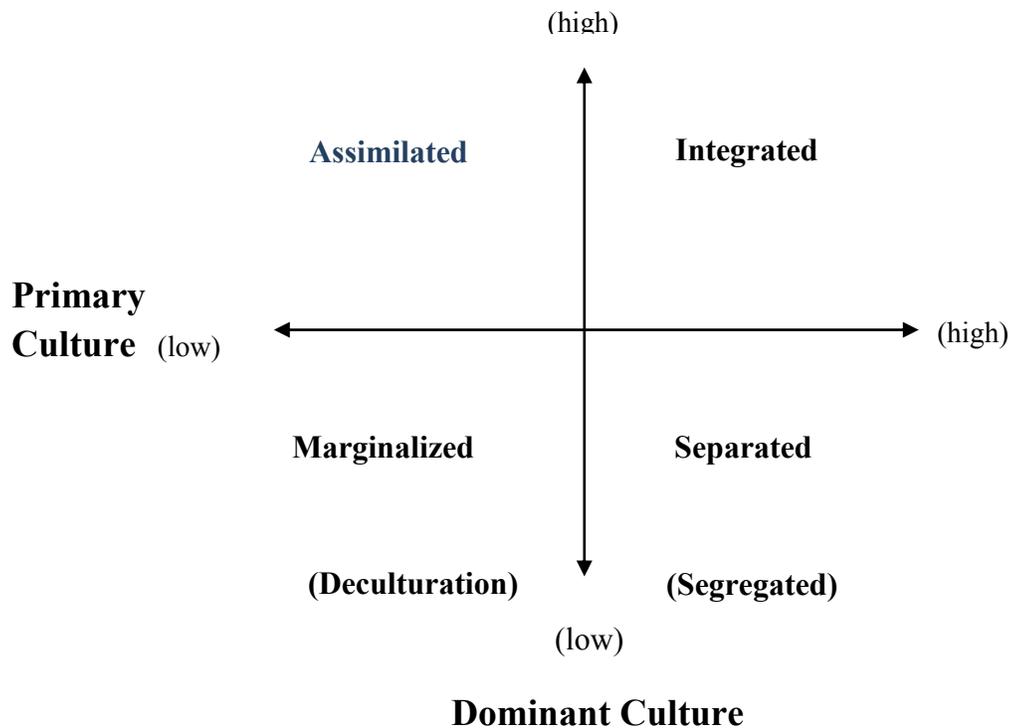


Figure 2.1. Berry's (1990) coping strategies in acculturation

Some individuals who do not wish to maintain their primary cultural identity (along with other elements of their primary culture), seek to function fully in the dominant culture. The goal for these individuals is assimilation. When this trajectory is freely chosen, the model is considered a melting pot, but when forced by the dominant group, the trajectory is referred to as a pressure cooker (Berry, 1990; 1997).

Ogbu (1994) pointed out that the experiences of involuntary minorities such as Native Americans or Hawaiians are strikingly different from those of voluntary minorities who chose to immigrate to the US. For involuntary minorities such as Hawaiians, Berry's (1990; 1997) assimilation model may hold particular significance

compared to Laosa's (1999) model. For example, if an individual has adopted an assimilated cultural identity, Laosa would consider both the melting pot and pressure cooker models of assimilation to be unilateral and subtractive. Although Laosa would label the pressure cooker model as *maladjustive*, he does not emphasize, as Berry does, on the force the dominant group applies to coerce people into relinquishing the norms and values of their primary culture.

Gordon (1964) may have been the first to make the distinction that individuals may become highly assimilated in one regard, and yet remain unassimilated on other dimensions. Gordon recognized nuances of cultural adaptation and the possible levels and combinations of integration and assimilation. His work led to the recognition that assimilated individuals can remain "ethnic" and loyal to their cultures of origin, rather than "leaving their home cultures behind" and fully adopting the dominant culture, joining the ranks of the marginalized. The idea that students can wear different "cultural hats" to suit the situation in which they find themselves holds important implications for teachers in Hawai'i, because students may need to "code switch" between knowing how to behave at home versus knowing how to behave in school in order to succeed in their academic life (Ledward, 2007; Reed, 2001).

The second of Berry's categories (1990; 1997) includes persons who place a high value on maintaining their primary culture and wish to avoid interaction with the dominant group. The goal for these individuals is *separation*. A subcategory of separation occurs when the person's group is otherwise kept at a distance; the resulting model is *segregation* (Berry, 1990; 1997). Irwin's (1924) musings on "the race problem" in

Hawai'i are a good example of the dominant society wanting to keep another group at a distance through employing the coping strategy of segregation.

In Berry's (1990; 1997) third category are people with little or no interest either in maintaining their primary culture or in having relations with the other cultural group. Berry theorized that this situation leads to *marginalization*. When the dominant culture, through forced cultural loss combined with forced exclusion, puts individuals in this situation, they are engaging in what Berry considered *deculturation*. When deculturation is brought to an extreme, it constitutes *genocide*. The Hawaiian researcher Hewitt (2003), at least partially disagreed with Berry, and considered the pressure cooker model of assimilation to be a form of deculturation. She argued that the successful attempts the dominant culture has made in replacing the Hawaiian culture's values and norms with those of the United States, has resulted in the (at least partial) deculturation of the Hawaiian people.

According to Hewitt (2003), many Hawaiian students think of education as just another process of colonization. That many have adopted a separatist coping strategy in dealing with acculturation (Berry, 1990; 1997) should not come as a surprise, considering the conflict Hawaiian students have had between succeeding academically and remaining true to themselves and their culture (Hewitt, 2003). Berry's coping strategy of separation corresponds with Laosa's (1999) subtractive, unilateral transition. However, this act of withdrawing back to the ingroup or leaving attributes of your primary culture behind to embrace the outgroup has been shown to have deleterious effects for other cultures. For example, researchers working with Pueblo, Navajo, and Korean-American/Canadian groups supported this position and concluded that neither the preservation of the ancestral

culture through isolation and rejection of the dominant culture, nor the giving up of ancestral cultures through complete accommodation to the dominant culture leads to good mental health outcomes (Suina & Smolkin, 1994).

In the fourth category are individuals who wish both to maintain their primary culture and to function fully in the dominant culture (Berry, 1990; 1997). Their goal is *integration*. This is possible only when the dominant group is open to and accepting of the group seeking integration. Although the two terms have often been used synonymously, Berry (1990; 1997) has been clear in making the distinction between integration and assimilation; cultural continuity is sought in integration, whereas little or no continuity is sought in assimilation.

Involuntary minorities have been shown to stand in contrast to immigrants who may have voluntarily chosen to come to a foreign country (Hewitt, 2003; Skilton-Sylvester, 2002). The educational research of Ogbu (1994) also supported this position, indicating that perceptions and responses of involuntary minorities to the educational system are different from those of voluntary minorities. To use Berry's (1990; 1997) terminology, when non-native teachers devalue or negate the cultural experiences of their involuntary minority students, they are imposing a pressure cooker model of assimilation, forcing their students to choose between academic success (by assimilating) and maintaining their cultural identity (by separating).

Hewitt's (2003) writings reflect this opinion, suggesting that in this post-colonial era there is no one way to be *Hawaiian*. She posits that Hawaiians have to work out their own versions of cultural identity and that this reflects a uniqueness that only comes from living successfully in two worlds. Perhaps with this in mind, Laosa (1999) asked the

questions: “What realistic options and opportunities for making intercultural transitions do individuals have?” “How do conflicting demands for intercultural change put students at risk for educational failure?” (p. 6). Western educators in Hawai‘i are faced with these questions.

Sociocultural theories integrate historical, social and cognitive processes (Oakes & Lipton, 1999; Skylton-Sylvester, 2002) and recognize that there are multiple ways of thinking and defining knowledge. The predominant school of thought in the United States has focused on the individual and has been referred to both as an *independent* and *individualist* value system, the cornerstone on which the American school system has been built (Greenfield, 1994; Trumbull, Rothstein, Fisch, Greenfield & Quiroz, 2001). On the other hand, there is an alternative belief system held by nearly 70% of the world’s population (Triandis, 1989). It has been referred to alternately as *interdependence* or *collectivism*, and is typified by traditions where the focus is not on individuals but on *relationships*.

Research regarding cultural congruence suggests that when teachers engage in interaction and communication patterns that are familiar to students, children and youth are able to more actively engage in classroom tasks (Au & Kawakami, 1994; Gay, 2002; Hollins, 1996; Tharp & Gallimore, 1988). The literature also indicates improvements in students’ engagement and participation when teachers use familiar cultural artifacts, analogies, examples and community resources as part of classroom instruction and when children’s home-language resources are utilized in the teaching process (Moll, Diaz, Estrada, & Lopes, 1992; Sato, 1991).

Bridging Cultures in the Hawaiian Classroom

As the cultural groups that comprise Hawai‘i are almost entirely Asian or an Asian/Hawaiian/Pacific Islander mix (Friary & Bendure, 2003), students in Hawai‘i tend to be collectivist in their orientation (Greenfield, 1994; Hewitt, 2003; Dela Cruz, Salzman, Brislin & Losch, 2006). The schools to which they send their children, however, may be based more on an individualist design (Trumbull et al., 2001; Yamauchi, 1998). Researchers have speculated that these two opposed orientations create an indisputable value conflict between the independent script required for academic success in school on the one hand, and the collectivist script required for social success in the family on the other (Greenfield, 1994). The challenge of creating educational communities that maintain school success while supporting the development of cultural identity of Hawaiians has been a complex and evolving issue (Au & Kawakami, 1994; Dela Cruz et al., 2006; Gay, 2002; Hollins, 1996; Kawakami, 1999; Tharp & Gallimore, 1988).

Theorists are quick to point out that collectivism and individualism are not mutually exclusive concepts and that every cultural group selects a different point on the collectivist/individualist continuum as its developmental ideal (Greenfield, 1994; Trumbull et al., 2001). Considering the diverse cultural composition of Hawaiian classrooms, it is important for teachers in Hawai‘i to keep this theoretical distinction in mind and be careful when making assumptions regarding the socio-cultural makeup of their classes. Their students may tend to be collectivist in their orientation, but this does not mean they are devoid of an individualistic point of view or that the two points of view are incompatible.

One feature of identity appellation in Hawai‘i that may not be readily apparent to those unfamiliar to the islands is the distinction made between “Native Hawaiian,” and “local” identities. Local, as the term implies, simply means “from here” and it is used as an umbrella term for all individuals born in Hawai‘i who may or may not necessarily be of Native Hawaiian descent (Ledward, 2007; Reed, 2001). However, the “local” group may represent one, but more often several ethnicities, usually of Asian or Pacific Islander descent representative of the Hawaiian Islands, perhaps including Hawai‘i. Therefore, “being Hawaiian” signifies different things for different people born in Hawai‘i, and the level of an individual’s “Hawaiian-ness” is not always represented by appearance or behavior.

In 1995, the Native Hawaiian Educational Assessment report noted that Native Hawaiians have become more “multi-ethnic” as a result of interracial marriages, developing different values and different ways of doing things (Takenaka, 1995). However, several “core” Hawaiian cultural values remain strong in the community. A 1993 Native Hawaiian Educational Assessment report described Native Hawaiian cultural values in an incorporation of five dimensions: *lokahi* –harmony and balance; *aloha* -spirit of caring; *malama ‘aina* –caring for the land; *kokua* –helping others; and *ohana* –family unity (Minerbi, McGregor & Matsuoka, 1993). Although Hawaii’s youth experience a diverse multi-ethnic cultural environment in the public school environment, the traditional “Western” classroom environment tends to be the norm (Yamauchi, 2003). Researchers suggest that this has created a dichotomy or “gap” between the school and home cultures, discouraging Native Hawaiian students’ participation and interest in school (Tharp & Gallimore, 1988).

The Hawaiian Cultural Influences in Education Study. The Hawaiian Cultural Influences in Education (HCIE), study analyzed data from 600 educators, nearly 3000 students and over 2000 parents to provide new evidence about Hawaiian students and their peers from both private and public schools (Kana'iaupuni, Ledward & Jensen, 2010). Using hierarchical linear modeling to conduct multilevel analyses, researchers found a set of nested relationships linking the use of culture-based education strategies by teachers and schools to positive student outcomes.

The goal of the HCIE study was to understand how educators can provide more engaging and relevant educational experiences for all Hawai'i's children. (Kana'iaupuni et al., 2010). In this context, culture-based education refers to the grounding of student learning and instruction in the norms, values, knowledge, beliefs, practices, experiences, places and language that stand as the foundation for Native Hawaiians (Kana'iaupuni & Kawai'ae'a, 2008). Culture-based education is identified by five key components that include family, community, content, context, and assessment.

The results of the teacher analysis revealed that culture-based education was implemented to varying degrees across the classrooms in the sample and that Hawaiian culture-and language-based schools were quicker to adopt culture-based education strategies (Kana'iaupuni et al., 2010). But results also indicated that there were strong culture based education users teaching in mainstream settings. It was also found that culture-based education was not limited to Hawaiian teachers. Although Hawaiians were found to subscribe more often to culture-based pedagogy, these approaches were also embraced by non-Hawaiian teachers, particularly in those schools that emphasized culturally-relevant education. Finally, across all school types, teachers reported regular

use of the strategies that were generally considered best practice in teaching and instruction, suggesting that in culture-rich environments, teachers go above and beyond, achieving relevance and rigor via culture-based strategies in addition to what is considered best practice.

The results of the student analysis suggested that culture-based education positively influenced student socio-emotional well-being in the areas of identity, self-efficacy, and social relationships, and these positive outcomes, in-turn, positively affected math and reading test scores (Kana'iaupuni et al., 2010). Furthermore, culture-based education was positively related to math and reading scores for all students, particularly for those with low socio-emotional development, and especially when supported by overall use of CBE strategies within the school. Results also revealed that students of teachers who utilized culture-based education reported greater Hawaiian cultural affiliation, civic engagement, and school motivation compared to those teachers who did not employ culture-based education strategies. Students whose teachers tended to use culture-based education were also more likely to have strong community ties, e.g., they worked to protect the local environment and attended public meetings about community affairs. They were also more apt to know stories and facts about their communities, more likely to put cultural skills to use in their communities, and reported higher levels of trusting relations with teachers, emphasizing a deeper sense of belonging to the school.

These results are consistent with findings of a previous study (Yamauchi, Billig, Meyer, & Hofschire, 2006) that compared high school students who took part in a Hawaiian studies program to those who were not involved in the program. In the Hawaiian Studies Program, teachers integrated the learning of Hawaiian culture with

more traditional secondary curricula, and students participated in weekly community service-learning. Results indicated that, compared to other peers, the Hawaiian Study Program students tended to report feeling more connected to their school and community and tended to agree that they possessed career-related skills. Participants believed that service-learning contributed to these outcomes by making connections between their school and community life and that it exposed students to a variety of careers. However, the study by Yamauchi et al. (2006), while yielding valuable information, only provided a snapshot of relationships at one point in time. Kana'iaupuni, Ledward and Jensen (2010) also measured student outcomes at one time point, and noted that a future longitudinal study would add greatly to the current understanding of positive relationships observed between culturally based education and student outcomes. The present study is one attempt to fill this gap in the research.

Hawai'i Learning Environments: *Nā Honua Mauli Ola*. The Native Hawaiian Education Council created guidelines for culturally responsive education with the first edition of the *Nā Honua Mauli Ola, Culturally Healthy and Responsive Learning Environments* (NHEC, 2002). This consisted of a set of sixteen Hawaiian cultural guidelines with strategies to assist educators, learners, families, schools and communities in order to examine the educational and cultural well-being of students in Hawai'i. In 2006, a second edition was published (NHEC, 2006) where these 16 guidelines were distilled into nine cultural pathways or *nā ala 'ike* as an educational framework for fostering culturally healthy and responsive places of learning and living.

The foundational wisdom described in these nine *nā ala 'ike* was based on a broad collection of rich Hawaiian heritage and cultural experiences (NHEC, 2006). The cultural

pathways describe and honor the ancestral wisdom that is practiced throughout Hawai‘i today. These pathways act as a framework for developing a comprehensive support system promoting community and student-centered learning environments which support experiences that foster and shape the development of learners to become responsible, capable, caring, healthy *kanaka* (human beings). By instilling a strong cultural identity and sense of place, students are able to better reach their full potential --spiritually, intellectually, emotionally, physically, and socially.

The nine *nā ala ‘ike* support culturally relevant approaches that also embrace learning through the Hawaiian language, culture, tradition and history in order to support state mandates that recognize Hawaiian as an official language of public education; fostering efforts that revitalize the Hawaiian language and culture (NHEC, 2006). The first *nā ala ‘ike* is *‘Ike Pilina*, the Relationship Pathway which encourages students to build respectful, responsible and strong relationships, connecting them to God (*akua*), the land (*‘āina*) and each other through the sharing of history, genealogy, language and culture.

The second *nā ala ‘ike*, *‘Ike ‘Ōlelo*, or the Language Pathway encourages students to become proficient in speaking the Hawaiian language in order to instill personal connections to Hawaiian culture, values, history and spirituality in order to perpetuate indigenous ways of knowing and sharing (NHEC, 2006). In the third *nā ala ‘ike*, *‘Ike Maui Lā hui*, the Cultural Identity Pathway, students are inspired to look to their future with confidence in their cultural identity, perpetuating Native Hawaiian cultural identity through practices that strengthen knowledge of culture, language and genealogical connections to *akua*, *‘āina* and *kanaka*.

The fourth *nā ala 'ike*, *'Ike Ola Pono* is the Wellness Pathway meant to inspire students to lead healthy, vibrant and happy lives as contributors to family and community (NHEC, 2006). By caring for the wellbeing of the spirit (*mauli*) and body (*kino*) through culturally respectful ways, the *mauli* is strengthened in order to build responsibility for healthy lifestyles. In the fifth *nā ala 'ike*, *'Ike Piko*, or Personal Connection Pathway, students are encouraged to take action that reflects a personal identity that is *kūpono* (honest, proper and fair), promoting personal growth, development and self-worth to support a greater sense of belonging, compassion and service toward one's self, family and community.

In the sixth *nā ala 'ike*, or *'Ike Na 'auao*, the Intellectual Pathway, students are engaged in fostering the cycle of joyous learning through curiosity, inquiry, experience and mentorship in order to nurture the innate desire to share knowledge and wisdom with others (NHEC, 2006). The seventh *nā ala 'ike* is *'Ike Ho 'okō*, the Applied Achievement Pathway. Here, students are inspired to demonstrate academic, social and cultural excellence that supports families, communities and future generations; helping them to attain academic, social and cultural excellence through a supportive environment with high expectations.

'Ike Honua, the eighth *nā ala 'ike*, or the Sense of Place Pathway, fosters students accepting responsibility (*kuleana*) for their world (*honua*), and expressing a strong sense of place, including a commitment to preserve the delicate balance of life and protect it for generations to come (NHEC, 2006). The ninth and final *nā ala 'ike*, is *'Ike Kuana 'ike*, the Worldview Pathway, where students are encouraged to promote their local and global

communities through a Hawaiian perspective that honors all things -past, present and future, providing a solid grounding in a Hawaiian worldview.

Research Addressing Hawaiian Culture in School

The following section describes some of the efforts made to address Hawaiian culture in Hawai'i's classrooms.

One of the earliest projects concerned with bridging the gap between home and school cultures in Hawai'i began at the Kamehameha Schools in the mid-1970s (Darvill, 1981) with the Kamehameha Early Education Program (KEEP). This program developed an effective language arts curriculum for Native Hawaiians and encouraged students' sense of ownership and community. KEEP organized classrooms to facilitate peer teaching interactions and encouraged focused discussion of textbook subjects to make meaningful connections to the lives of the students. (Tharp, Jordan, Speidel, & Au, 2007).

Later research included Native Hawaiian worldviews and epistemology, or a *context-dependent* perspective where learning is situated, or located in a sense of place, emphasizing a view of connectedness across time and in relationships with family members (Kawakami, 1999). Kawakami (1999) and colleagues surveyed Hawaiian educators and found that curriculum components that included Hawaiian values, knowledge, behavior, identity and sense of place were the most successful. For example, activities such as developing stewardship of the land, learning and practicing Hawaiian protocol, dance and chant or creating Hawaiian artifacts using plants and materials from their locale helped connect students' academic learning opportunities to their communities.

Additional programs were implemented throughout the 1980s and 1990s (Kawakami, 1999). *Na Pua No 'eau*, the University of Hawaii at Hilo's Center for Gifted and Talented Native Hawaiian Children was established in 1989 as an enrichment program with the aim of raising educational achievements and aspirations of Native Hawaiian children in Grades K-12. The Wai'anae High School Hawaiian Studies Program was an integration of school and community resources designed to create a center for cultural learning. The *Ka Lama O Ke Kaialulu* (the light of the community) program was a pre-service teacher education program designed to recruit students from the Hawaiian community and assist them in completing their degrees.

These programs have typically fallen into two categories: Hawaiian medium education and programs designed for Hawaiian students in an English language instructional environment. However, human resource issues have been a challenge to operations in Hawaiian immersion schools where the supply of curriculum specialists, school administrators and licensed teachers, fluent in Hawaiian, continue to fall short of the need. Unfortunately for these programs, only a small number has demonstrated success and many remain under constant threat of losing funding and other support (Kawakami, 1999). Kawakami (1999) identified bureaucratic barriers and limited funding as the main problems undermining these programs, but perhaps the most telling sign of the lack of recent programs' effectiveness is the low performance indicators that continue to plague students in Hawaiian public schools. For example, The Wai'anae High School Hawaiian Studies Program evidenced gains in teachers' ability to implement Hawaiian school standards and manage their classrooms. Attendance was significantly higher among Hawaiian Studies students compared to other peers, but there was no difference

between groups on scholastic outcomes such as GPA (RMC Research Corporation, 2004). Researchers concluded that the control group, which tended to include more college-bound students, was not necessarily a good match.

Makawalu: Standards, curriculum, and assessment for literature through an indigenous perspective (Kaiwi & Kahumoku III, 2006) challenged the Western theoretical perspective prevalent in Hawai'i schools by introducing the *Kanaka Maoli* (Native Hawaiian) concept of *Makawalu* or "having eight eyes," or "numerously spreading out from a firm foundation" (p. 184). *Mokawalu* placed emphasis on the fact that indigenous students can use "native eyes" and a native paradigm to access and analyze literature; empowering students by acknowledging and validating their indigenous voice.

Kaiwi and Kahumoku (2006) recognized that the schools in Hawai'i were dominated by a White, Anglo-Saxon system of education, and that students in Hawai'i had been restricted by this philosophical template for teaching and learning. They advocated for the development of standards that reflect both Western and indigenous approaches to literature curriculum development. Kaiwi and Kahumoku posited that if the current, traditional educational paradigm does not include native educational practice, place, and position, the achievement of indigenous children will continue to decline, and educators will continue to be at a loss to explain why.

Kaiwi and Kahumoku (2006) pointed out that researchers (D'Amato, 1988) have long articulated that strong cultural identity and understanding of heritage to help build pride and confidence in native children, and that Hawaiian children's acting out behavior could be a result of an educational culture that is inconsistent with their home culture.

They placed importance on acknowledging and utilizing the *kanaka maoli*'s interconnection between place, space, spirit, and others to enhance learning, and that their indigenous experience should be the place to establish a foundation on which to grow and learn, rather than using the English language and Western culture and knowledge as the originating point for exploring all literature.

In their case study, Kaiwi and Kahumoku (2006), studied the effects of *makawalu* in teaching *kanaka maoli* students by utilizing eight basic themes for creative writing: Connection to ancestors, appreciation for ancestors, appreciation for *kūpuna* (elders), appreciation for *mākuā* (parents), increased desire to learn, a sense of *kuleana* (responsibility), traditional versus indigenous, and creativity and freedom of expression. They found that applying a concept like *makawalu* to the teaching of American literature, changed the perspective from which literature could be examined. These researchers discovered that starting from an indigenous; Native Hawaiian grounding could be used as a springboard (*papakū*) for further literary exploration. Moving outwards (*makawalu*), to other “cultural” literature can indigenize a Western discipline, equalizing the literary playing field. Students felt stronger once they learned more about their cultural backgrounds and felt more appreciative and connected to their ancestors. They commented that making learning into a real life example made it more interesting, compelling them to learn more.

Culturally Responsive Teaching of Science

Roth and colleagues studied the role of teachers and students, and their research challenged science educators' rigid boundaries between expert and novice scientific explanations (Roth, 1996; Roth & Bowen, 1995; Roth & Lucas, 1997; Roychoudhury &

Roth, 1996). Leach and Scott (2003) conducted research that demonstrated the benefits of employing both the individualist and collectivist views of learning in teaching science. Building on Loving's (1998) multicultural empowerment model, Leach and Scott's research points to how both individualist and collectivist views can usefully be drawn upon by science educators.

Meyer (2003) noted a contemporary shift in science education from a traditional emphasis of adding more facts to students' understanding to a conceptual-change view of learning where learning is considered to occur when a student's mental model, or *schema* is modified to adapt to the new information or is replaced with a new one (Piaget, 1952). In this way, students' naïve misconceptions of science that conflict with science taught at school may be replaced with new conceptions, or more appropriate mental models. When teachers engage students in the process of forming new conceptions, the cultural context for which learning takes place and the personal experiences of students should not be overlooked.

Ballenger's (1997) research suggests that notions of science and culture are inextricably tied, and unless time is taken to renegotiate the classroom to explicate cultural notions of learning and content, teachers and researchers alike will misjudge students' intended meanings. Gallas (1994) argued that a significant portion of children's sense making is constrained if students are not allowed to express themselves freely, advising that children's personal narratives should be utilized to enable them to discover the interrelationship between their world of experience and what they study in school.

Culturally Responsive Teaching of Science in Native Communities

Ethnic/racial and linguistic minority students are better able to learn science when their linguistic and cultural knowledge is utilized as learning resources (Chambers, 1999; Kubli, 2005; Lee, 2002; Lee, Deaktor, Hart, Cuevas, & Enders, 2005; Loving, 1998; Leach & Scott, 2003; Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). Chambers (1999) examined the role of engaging American Indian students in a dialogue while teaching science. Chambers used innovative teaching strategies that required students to compare art and science to American Indian indigenous knowledge structures as a means of seeing and understanding nature. Considering their shared status as involuntary minorities (Ogbu, 1994) and people who have been colonized, Native Hawaiian students may benefit from Chamber's methods of teaching science to American Indians.

The Learning Cycle. One approach to a Native American way of life deals with the connections between all the elements of the Universe (Gilbert, 2011). Native Americans understand life as a reflection of cycles (Renner & Merek, 1988). The cycles of life, the elements and nature are circles without beginnings or ends. When examined closely, cycles can reflect the Native American perception of optimal learning, and when developing science curricula for Native Americans, curriculum experts Renner and Merek (1988) found that the learning cycle was relevant to the Native American perception of education.

Every lesson plan developed by Renner and Merek (1988) adheres to the "hands on" activities approach, and as with the cyclical approach to learning, I find this directly pertains to Native Hawaiian views of gaining knowledge. Renner and Merek purport that

teachers need to be knowledgeable in the concepts to insure that any questions asked or raised can be answered and describe the Learning Cycle (Figure 2.2) in such a manner that the students become the focus of learning:

The learning cycle, therefore, is not a method of teaching science, the learning cycle comes from the discipline itself; it *represents* science. If science is to be taught in a manner that leads students to construct knowledge, they must make a quest. The learning cycle leads students on that quest for knowledge. (p 170)

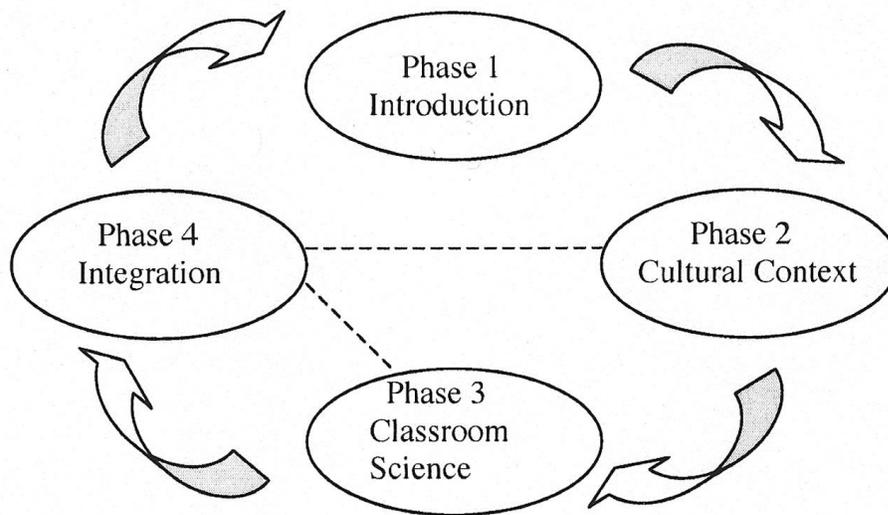


Figure 2.2. Instructional sequence of the Native science connections supplemental

Students engage in observing, measuring, experimenting, interpreting, model building, and predicting as they experience the Learning Cycle (Figure 2.2) and these essential elements of learning science should be implemented in all phases of the cycle (Gilbert, 2011). Each cycle starts with an ‘Introduction’ that allows the teacher and students to get a general understanding of prior knowledge of the subject at-hand and to directly or indirectly motivate students’ interest in a concept. The introduction needs to

be relevant to the Native American child's environment in order for the student to understand the general purpose of what is to be learned.

In Phase 2, the Cultural Context, Native cultural knowledge as it pertains to the science topic is examined and taught. This should include a vocabulary of specific words in the Native language with translations in English. Additional information in this phase includes traditional Native practices, stories and teachings (Gilbert, 2011). In Phase 3, Classroom Science, the focus is on communicating ideas, concepts and honing skills through exercises taught in science texts and kits. In Phase 4, Integration, students engage in integrating the newly learned cultural knowledge with other related (Western) concepts. In this phase, the terminology of the new concept needs to be utilized consistently to ensure that students are accommodating the experiences learned; and it is important to expand with activities that will be well connected with the Native concepts in order to reinforce the link between the new, Western theory and Native concepts. By following the learning cycle, gaining new knowledge can become relevant to the Native American students' because the process is consistent with the Native practice of making connections between all the elements of the Universe.

This holds true in the ethos of Native Hawaiians, especially in regards to the deep connection Hawaiians have to the land (Gon, 2005; Kanahele, 2009). However, the history of Western science being taught in Hawaiian classrooms has been shaped by Descartes' view that knowledge of reality, or metaphysical knowledge is gained through intellect alone, not the senses (Gon, 2005). This separation of culture and nature can be antithetical to a Hawaiian world view that connects humans and nature in spiritual and familial relationships (Chinn, 2008). In the following pages I explore the different efforts

that have been made in Hawai‘i to move away from this Western viewpoint and toward models that embrace Native culture, knowledge and traditions in school.

Science Education in Hawai‘i

Perhaps the most telling of recent outcome assessments is the number of students who have the opportunity to learn science in Hawai‘i compared to other US states. According to the National Assessment of Educational Progress (HDOE, 2003), in 2002, two percent of Native Hawaiian students were enrolled in 8th grade science, compared to the national average of 98%. This national survey revealed that of all high school students polled, 34% of students in Hawai‘i reported that they received science instruction compared to the national average of 92%. Also, 46% of high school respondents stated that they did not take an 8th grade science course, compared to the national average of 3%. These numbers may suggest that traditional science education is not working well in Hawai‘i, as the State is ranked among the poorest performing states in the country on average science scores (National Center for Education Statistics, 2010).

However, it is important for readers, particularly science educators in Hawai‘i, not to jump to conclusions when interpreting these results, especially in regard to research vis-à-vis the conflict Native Hawaiian students potentially feel between succeeding academically and remaining true to their culture (Hewitt, 2003; Sato, 1991). Recently, Native Hawaiian researcher Gon (2005) argued that science and Hawaiian culture are compatible. He pointed to the growing desire of scientists and environmentalists to promote and use appropriate Hawaiian traditional knowledge in land use and management decisions. While admitting to epistemological differences between “classical Western science” and “Hawaiian traditional knowledge,” Gon pointed to their

many similarities. For example, both scientific approaches are highly empirical, rooted in repeated observations of phenomena in the world and both approaches are based on detecting and expressing correlations and testing predictions.

Gon (2005) believes the two epistemologies to be not only compatible, but that the Western conception of science could be greatly enhanced by integrating Hawaiian concepts such as embracing intuition and feeling when testing hypotheses rather than conducting experiments in the “coldly objective” manner typical of Western science. Gon suggested that this latter “objective” approach, divorced from emotion, could be considered a great drawback of Western science, particularly since it has allowed for amoral and immoral developments in the past.

In the next and subsequent sections I discuss indigenous Hawaiian ways of knowing, that have recently become available to scholars. Much of this information is not well cited in the literature; therefore, the following is largely based on conference, lecture presentations and anecdotal accounts.

Papakū Makawalu. *Papakū Makawalu* is one interpretation of a philosophy or ancient Hawaiian epistemological system that focuses on a more holistic picture of the knowledge that is being sought (Kanahele, 2009). More formally, it is the system ancient Hawaiians utilized in order to understand their universe. To begin to understand this, we must first re-conceptualize the way we think about space. In a 2009 lecture, Kanahele explained that we need to explore ancient systems of knowledge, and subsequent methodologies therein, and apply them today.

In explaining *Papakū Makawalu*, Kanahele (2009) started with the *papakū*, or “foundation.” The *papakū* acts as a stabilizing force, something that you can depend on,

something that will always be there, as in the earth. In a sense, *papakū* is permanent, but it is also used by Hawaiians to define “home,” “birthplace,” or it can be used to mean where your ancestors come from. Next there is *makawalu*, which roughly translates to “movement outwards,” or “growing out from the foundation.”

Translated literally, *makawalu* is a combination of *walu* meaning “eight,” and *maka* which means “eyes,” so to be accurate, *makawalu* means “eight eyes” (Kanahele, 2009). To ancient Hawaiians, the number eight is very important because it is related to the number four, which relates to the changing of the seasons, denoted by certain stars that are visible at different times of the year. These are the summer and winter solstices and vernal and autumnal equinoxes, which were in turn broken in two seasons, making eight distinct time points Hawaiians used for marking time, such as the time in which certain crops should be planted or harvested. Therefore, *makawalu* is used to describe something that is numerous.

The concept of *Papakū Makawalu*, comes directly from the *Kumulipo*, the substantial ancient Hawaiian literary work and chant containing over 2000 lines (Kanahele, 2009). It is thought that much of the *Kumulipo* was initiated by females, because it had to do with giving birth, with spirituality and cycles. Of the 16 *paukūs*, the thirteenth is concerned with *Papakū Makawalu*, which tells the genealogy of *Haumea*, an Ancient Hawaiian Goddess, analogous to Mother Earth or Mother Nature (Kanahele, 2009).

Expanding on the concept of *Papakū Makawalu*, each line is concerned with a separate foundation containing different components, and each is a combination of three

sub-words (in Hawaiian chants, there usually is a lot of information condensed into a few words per line). *Papahulihonua* is broken into *papa*, *huli*, and *honua*. *Papa* stands for “foundation,” but also denotes the different levels of foundations, or strata (Kanahale, 2009). *Huli* is the notion “to turn,” or “to turn over,” or change; as illustrated by the changing of seasons or the turning of the earth; “earth” being what *honua* means, or “land,” with its subsequent layers. Ancient Hawaiians were very aware of the turning of the earth and conscious of the fact that the earth, as with the sun and the moon, was in suspension in a vast space that itself was turning. *Papahulihonua* is not only a concept, but also the name for a class of experts, those who deal intellectually, physically and spiritually with the earth and that which comes from the earth.

Papahulilani deals with the space above us, *lani* meaning “sky,” or the atmosphere. It is concerned with the space from above our heads to the stars, and all the things that exist in that realm (Kanahale, 2009). In this class are those who deal physically, intellectually, and spiritually with the space above. Within that class, there are separate groups of experts who deal with specific components of that realm, such as those that use the stars in order to gauge the change of seasons, or experts that use the stars to navigate, etc.

Papahanaumoku starts with layers or strata and foundations (*Papa*) but the components to this foundation have to do with childbirth and being fertile, laying eggs; the meaning of *hanau* (Kanahale, 2009). It also includes *moku*, which means “to sever,” or “island.” The concept of *Papahanaumoku* is concerned with every living thing that perpetuates itself, procreates or reproduces and has offspring, and in this way, a genealogy is created. However, not just human, but the genealogy of all living things;

things that live in the sea, on the land, in the air, and that grow from the land. Being an island (or islands), this land is cut off from other lands and surrounded by water, which is why the concept of “severed” is included in the word *moku*, which also stands for “district,” because each one is cut off by surrounding boundaries.

Papahanaumoku is concerned with keeping track of all things that give birth, and in this class of experts are those who deal spiritually, physically and intellectually with not only all those things that give birth, but the habitats containing and nourishing all life (Kanahele, 2009). These experts are able to make connections between that which grows in one habitat to those that grow in another, making parallels between the birth and growth cycles of different living things in the uplands, the lowlands and the sea; enriching their environment by understanding these parallel growth processes.

Culturally Responsive Teaching of Science in Hawai‘i

In the following section I review research conducted in Hawai‘i exploring the benefits of including culture in the curriculum when teaching science.

Mālama I Ka ‘Āina. The *Mālama I Ka ‘Āina* program (Caring for the land, or sustainability) was a P-12 professional development program focused on joint activity toward common goals and cultural dialogues mediated by cultural translators (Chinn & Silva, 2002). It was based on the idea that building knowledge entails building relationships among individuals from different cultural backgrounds. The program aimed to improve and expand education in Hawai‘i by developing and disseminating culturally relevant, standards-based science curricular materials based on an understanding and appreciation of the ways in which traditional Hawaiians interacted with their environment for sustainability. Key concepts included a culture-based sense of place that included

knowledge of and connection to the land, and the role of water and the *ahupua`a* (traditional Hawaiian system of land management). Curriculum developers, scientists and cultural experts worked together to develop and implement curricula that are especially relevant to a particular school's science program and issues.

Chinn (2003) examined the results of 60 P-12 pre and in-service teachers who participated in the *Malama I Ka 'Aina* program. During a five day culture-science immersion program, Native Hawaiian instructors and teachers from a wide range of ethnic backgrounds lived and worked together, meeting several times at school, university, and community sites to build knowledge and share programs. Teachers learned to connect cultural understandings (e.g., a Hawaiian sense of place and curriculum development), and highly valued collaborating with peers on curriculum development and implementation.

Chinn (2008) suggests a Hawai'i-oriented framework with four process elements: (a) developing a Hawaiian sense of place, (b) *mālama*, caring for/monitoring/restoring a familiar place; (c) *kuleana*, acknowledging that the right to use resources comes with responsibility; and (d) conducting inquiry oriented to sustaining a healthy social ecosystem. She contends that this framework can be adapted for other places, cultures, and issues.

Pikoi Ke Kaula Kualena. *Pikoi Ke Kaula Kualena*, Focus on the Essential Core, grew out of the *Mālama I Ka 'Āina*, Sustainability Project (Chinn & Silva, 2002). In this four-year case study, Chinn observed and interviewed 5 female Native Hawaiians and 10 lead teachers who participated in the *Mālama I Ka 'Āina* project the previous year. The five participants worked in roles ranging from Hawaiian studies *kupuna* (elder) to

community-based educator/home schooling mother to a high school teacher.

The teachers involved themselves and their students in issues that directly affected and benefited their local communities while engaging with the *Pikoi Ke Kaula Kualena* curriculum (Chinn & Silva, 2002). For example, one teacher involved her students in a long-term study to identify fish, remove invasive seaweeds, and record ecosystem changes using GPS and underwater photography. Students learned about the land by cultivating plants brought by Polynesians, learned astronomy and meteorology in the context of sailing, and learned marine science by caring for marine resources.

New Opportunities through Minority Initiatives in Space Science (NOMISS).

NOMISS combined traditions of Hawaiian culture with astronomy for kindergarten through Grade 12 teachers, university professors, and astronomers. In line with the philosophy of Chinn (2008), curriculum developers Kawakami and Pai (2007) endeavored to link Western notions of professional development and curriculum research with lived experiences in authentic cultural settings. The project also explored teachers' awareness of learning processes and how teachers' influenced the development of curricula.

In the summer of 2003, the Hawaiian Astronomy Institute was created to pilot the curriculum (Kawakami & Pai, 2005). Nineteen fifth grade students from O'ahu and Hawai'i participated in a 4-week long program that integrated celestial navigation, space science, and culture, with much of the learning taking place aboard the voyaging canoe *Makali'i*. Two key themes of the institute were teaching students proper protocol during visitations (e.g. when entering a new class), and teaching observational skills of Hawaiians. The Hawaiian Astronomy Institute was considered a success. Pre- and post-

tests illustrated that participants' understanding of celestial navigation, space science, and Hawaiian culture improved.

Pacific Basin Information Node. The Pacific Basin Information Node (2005) offered valuable educational resources for science teachers in Hawai'i. The Pacific Basin Information Node was a group committed to helping people to understand and respect the vibrant and unique natural heritage of which they are apart and offered lesson ideas and materials that teachers could use in their biological and ecological sciences curricula. Students explored oceanography and Hawai'i's coral reefs, watersheds, humpback whales, the Bishop Museum, Hawai'i's State Parks, and the birds of Hawai'i's rainforests.

Kūkulu Nā Uapo. *Kūkulu Nā Uapo* (Center on Disability Studies, 2005) offered curriculum ideas for teaching 6th grade science, weaving academic standards with Hawaiian cultural standards and practices for students to gain a greater understanding of themselves, their relationship to others, and the world around them. Of particular importance to the *Kūkulu Nā Uapo* program was instilling in the students a sense of responsibility (*kuleana*) to nurture themselves, others, and their environment. *Kūkulu Nā Uapo's* philosophy is equitable in that it recognizes the need to enhance school success for Native Hawaiian and other local students, where other program developers often do not comment on how their curricula affects non-Hawaiians.

Ecosystems Thrust Area of Hawai'i. The Ecosystems Thrust Area of Hawai'i focused on ecosystem research and monitoring activities that grew out of the *Mālama I Ka 'Āina* sustainability curriculum project. The program focused on the Hawaiian islands' unique mountain-to-sea ecosystems, or *ahupua'a*, extending from upland tropical

forests to the fringing coral reefs, correspond to the roughly wedge-shaped catchments. The program grew from a need to develop the underlying theory and principles of “sustainability science,” based on an understanding of the fundamental interactions between nature and humans (Kaneshiro, Chinn, Kristin, Duin, Hood, Maly, & Wilco, 2003).

Rural Systemic Initiative. Started in 1996, the Rural Systemic Initiative focused on regions of "persistent rural poverty" (Boyer, 2006). Rural Systemic Initiative leaders, while varying in their approaches to reform, all agree that a quality education must reflect the values of tribal peoples and must ultimately serve to strengthen whole tribal communities. The problems many Native American children experience in schools-- high drop-out rates, absenteeism, low academic achievement-- cannot be solved by any one individual. Instead, it requires action by the entire school system and, especially, greater leadership by indigenous peoples themselves.

In one Rural Systemic Initiative project, Boyer (2006) studied the effects of the accidental introduction of the coqui frog into the Hawaiian Islands. Boyer studied 37 schools on 6 islands and found that the inquiry-based science instruction initiative resulted in gains in 5th and 10th grade math scores (the state science assessment was still in development). The project’s goal was to nurture greater environmental awareness through giving students in rural schools a chance to investigate real-world environmental issues. By using the skills and tools of scientists and mathematicians to investigate local ecosystems, Boyer found that the Rural Systemic Initiative both strengthened the

curriculum and reinforced *Malama I ka 'Āina* –an understanding of stewardship within the cultural environmental context of the Hawaiian Islands.

Nā Hana Ma Ke Ahupua‘a, Science in Hawai‘i. The *Nā Hana Ma Ke Ahupua‘a* project (Center on Disability Studies, 2006) was a 3-year study that offered middle and high school teachers in Hawai‘i a culturally responsive curriculum centered on the interdependence of natural resources in Hawai‘i’s watersheds, or *ahupua‘a*. Similar to the Pacific Basin Information Node (2005), this program could be valuable to teachers new to the islands because it specifically aimed at helping teachers to learn more about Hawaiian history, culture and values, and how each relates to the sciences. Like the *Kūkulu Nā Uapo* program, *Nā Hana Ma Ke Ahupua‘a* was inclusive, recognizing the needs of all “at-risk” students, instilling in all children a sense of responsibility (*kuleana*) and encouraging them to learn more about their place in this world.

Evidence-based components such as collaborative learning (Howe & Mercer, 2007) and dialogic inquiry (Wells, 1999) were infused into the curriculum to help all students increase their knowledge and skills in science (Center on Disability Studies, 2006). The differentiated instruction was applicable to general and special education students, engaging them in scientific study with relevant content such as climatology and meteorology, resource management, architecture and engineering, botany and agriculture, astronomy, geology and hydrology.

The *Nā Hana Ma Ke Ahupua‘a* (Center on Disability Studies, 2006) curriculum focused on hands-on activities and concrete learning while conducting experiments (e.g., involving hydrology, solar power, hydrolysis, etc.), completing projects (e.g., exploring local geology, water testing, etc.), and participating in field trips to sewage treatment

plants, watersheds, taro farms, local marine sanctuaries, and to Volcanoes National Park at the end of the school year. In line with Vygotsky's (1978) sociocultural perspective, the locally relevant content focused first on the community, island and state, and then assisted students in making connections between their local environment and the global community. For example, before investigating astrology and the Big Bang Theory, students first were taught the Hawaiian creation chant. This focus was on teaching students that their ancestors devised a viable theory for the origins of the universe perhaps a thousand years before Western scientists, simultaneously rooting the theory in something with which they were familiar and hopefully giving them the tools to take "ownership" of this knowledge.

Role models, elders (*kupūna*) and local scientists were recruited from the community to interact with students in and out of the classroom. *Kupūna* were invited to speak to students about the importance of a connection to the land (or *'aina*) and the value of finding a meaningful career that investigated and alleviated problems faced by the people in Hawai'i, giving back to the local community. Making this connection was another effort to make the curriculum culturally responsive because in Hawaiian culture, mastery of a subject must demonstrate a benefit to the whole community, not just the individual (Dela Cruz et al., 2006). Local scientists were also invited into the classroom to speak with students about what they do, but more importantly, they were encouraged to "tell their story" of how their experience growing up in Hawai'i led them to become scientists.

Perhaps the greatest strength of *Nā Hana Ma Ke Ahupua'a* (Center on Disability Studies, 2006) lay in how the program addressed Gon's (2005) concerns of how the

emotionally divorced stance of typical western science stands in contradiction to the introspective, emotional qualities incorporated in traditional Hawaiian knowledge. An important goal was to reinforce links to the intuitive, emotionally accountable inquiry process which nurtured creative thinking during the renaissance of Polynesian history (Gon, 2005). Another goal was to increase the number of Native Hawaiian adults in science-related postsecondary education and employment fields.

The Present Study

Ka Hana ‘Imi Na‘auao. Data from the *Ka Hana ‘Imi Na‘auao* project were used in this research. The purpose of the study was to evaluate an endeavor to help students bridge the gap between their home and school cultures in an effort to ultimately change the outdated paradigm which separates Hawaiian indigenous and western knowledge systems in public schools in Hawai‘i (Center on Disability Studies, 2007). *Ka Hana ‘Imi Na‘auao* (roughly translated, “the seeking of scientific knowledge”) was a four year project to expand the *Nā Hana Ma Ke Ahupua‘a* project (Center on Disability Studies, 2006) by including an added focus on careers in scientific fields. The program served secondary school teachers across the State and supported Hawaiian public school students to succeed in science-related educational and career pursuits by providing them with culturally responsive science lessons and activities.

From the outset, the project employed a collaboration team process as the foundation of all activities (Center on Disability Studies, 2007). This approach was designed to be *pono* (to do what is right) in regards to Hawaiian thinking and values and built on input from *kūpuna* (respected elders), researchers, cultural and academic experts, employers, Hawaiian role models, and *‘ohana* (family). In particular, curriculum

developers recruited the non-profit organization ALU LIKE, Inc. as a partner to develop the content of the lessons and activities. ALU LIKE staff members were mostly ethnically Hawaiian and members of many groups in which the Hawaiian culture was emphasized. That is, they participated in gatherings in which Hawaiian traditions were engaged, including informal “talk-story” (a culturally based, interactive communication between individuals) meetings, luau, hula, and canoe paddling, as well as more formal family *ho‘oponopono* (problem solving), civic groups, genealogical societies, and Hawaiian Studies programs.

This bi-cultural collaboration between curriculum developers and ALU LIKE, Inc. promoted the development of a curriculum that embedded Hawaiian principles, values, and practices into lessons. *Kūpuna*, role models and others took part in planning and delivery of instruction, and teachers participated in professional development to learn about Hawaiian culture, language, and tradition as well as culturally appropriate methodologies which enable them to weave Hawaiian and western learning into the standards-based science lessons.

The wide variety of curriculum activities included field trips, videos featuring local topics and speakers, guest speakers with Hawaiian and/or science expertise, readings adapted to the interests and literacy levels of students, integration of technology in lesson delivery and student projects, and hands-on lessons. Place-based learning, critical thinking and scientific inquiry were also woven into the curriculum.

While most of these activities and strategies were not designed specifically to address cultural inequities in classrooms, they were considered to be more culturally responsive than a traditional emphasis on seatwork (i.e., reading of texts on continental

US issues, worksheets and written tests). The teaching or sharing of culturally relevant content was infused into lessons, such that content that directly connected cultural ways of knowing or doing with the western knowledge, skills and standards were applied. For example, Hawaiian students were encouraged to explore their connection to the land by investigating the *ahupua'a* their family has historically been connected to and the role their family members typically played in the maintenance of the land. These methods were applied to modern land-management techniques.

This curriculum was designed to encourage participating students to make personal connections with the Hawaiian cultural experts, employers, and role models they met. Program developers also believed that student participants' sense of *ha'aheo* (pride), place, self, and culture would increase through the exposure to Hawaiian language, traditions, values and ways of knowing that was provided in the program. Additionally, as student and teacher input was incorporated into the developing curriculum, both groups benefited from the support each received from project staff to increase their opportunities not only to learn *about* Hawaiian tradition, language and values, but to succeed *through* Hawaiian cultural systems of learning. Teachers also took part in a training course starting in the summer prior to field testing and classes were held bi-monthly throughout the school year.

Hawaiian learning styles include hands-on strategies, placing emphasis on observation and learning by doing (Dela Cruz et al., 2006). Hawaiian educators from ALU LIKE Inc., as well as guest speakers from the local science community worked directly with teachers and students in the classroom doing hands-on activities once a week. Students observed activities being done by Hawaiian educators and scientists and

then were encouraged to do the activities themselves. Also, students were engaged in field trips in order to get outside the classroom, interacting with the environment and with Hawaiian scientists, who were role models and mentors to students.

Another goal of *Ka Hana 'Imi Na' auao* was to promote Hawaiian and ethnically diverse student participants' entrance into postsecondary education science-related, or STEM (science, technology, engineering, and math) fields and careers. This was to address what has been called a "crisis" in science, technology, engineering, and math (STEM) education in the United States (Epstein & Miller, 2011). It was felt that one reason for ethnically diverse students' lack of interest in exploring a science-related career was a lack of confidence to do well in their science work, or lack of *science self-efficacy*. This, and the "STEM crisis" will be explored in the following sections.

The "STEM Crisis"

An important aspect of the STEM crisis that needs attention is the achievement gap that is evident for ethnic/racial minority groups. It is projected that the ethnic/racial minority population of the US will increase from about a third currently to over half by 2060 (US Census Bureau, 2012). Yet, despite several decades of federally supported programs, the rates of science baccalaureate completion for underrepresented minority undergraduates are dismal (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Hurtado, Cabrera, Lin, Arellano & Espinoza, 2009; Hurtado, Han, Sa'enz, Espinosa, Cabrera, & Cerna, 2007; Maton, Kohout, Wicherski, Leary, Vinokurov, 2006). Only 24% of African American, Latino, and Native American students complete a science bachelor's degree in six years, compared to 40% of White students (Center for Institutional Data Exchange Analysis, 2000).

This underrepresentation has an additional negative impact on communities of color, as minority scientists are more likely than non-minorities to study issues specific to minority communities (Nicholas, 1997). Among the three dominant disciplines that comprise the biomedical and behavioral science fields—biological sciences, chemistry, and psychology—underrepresented minority students represented only 18% of bachelor’s and 7% of doctoral degrees in 2004 (National Science Foundation, 2007). This history of underrepresentation has led to the overwhelming majority of practicing professionals in STEM fields being white, middle-class men (Johnson, 2007).

Many minority students lose interest in learning STEM subjects well before reaching high school. In what has been metaphorically referred to in the literature as a “leaky pipeline” (Blickenstaff, 2005; Bordogna, 2003), women and minorities leave STEM preparation at several key points as they progress through educational training toward STEM professions. The American Council on Education reported that full-time attendance, hours worked while enrolled, and rigor of high school curriculum were the major factors contributing to completion of college degrees in STEM fields by minority students (Mento, Sorkin, & Prettyman, 2008). This decline of skilled workers for scientific fields portends a decline in U.S. global competitiveness and the exportation of high-skilled jobs to other countries (Augustine, 2005; Council of Graduate Schools, 2007). Contributing to this decline is the trend that roughly half of those students who display initial interest in majoring in science disciplines change their plans within the first two years of undergraduate study, and very few non-science aspirants become science majors (Center for Institutional Data Exchange Analysis, 2000).

Why is this? Members at the Education Trust interviewed hundreds of students and parents of students attending schools in the U.S to investigate the achievement gap between poor, minority children and their more affluent, white peers (Haycock, 2001). When researchers spoke with adults, no matter where they were in the country, they made similar comments about minority children. “They’re too poor.” “Their parents don’t care.” “They come to school without an adequate breakfast.” “They don’t have enough books in the home.” “Indeed, there aren’t enough parents in the home” (p. 3). In other words, their reasons were always about the children and their families.

In contrast, young people gave different answers (Haycock, 2001). They talked about teachers who often did not know the subjects they were teaching. They talked about principals who dismissed their concerns. They talked about counselors who consistently underestimated their potential and placed them in lower-level courses. And, they talked about a curriculum and a set of expectations that they considered miserably low-level. High school curricula which demands little of high-poverty/minority public school students could be one factor contributing to the low number of ethnically/racially diverse high school students choosing a STEM-related major when entering college. Students may not feel confident in their abilities to face difficult tasks because they had not really been challenged in the past. This lack of science self-efficacy could be one reason why, of those students who enter college in science-related study, roughly half change their plans and pursue non-STEM related fields of study by their junior year (Center for Institutional Data Exchange Analysis 2000). The phenomenon of low science self-efficacy among racially diverse students will be explored in the following section.

Science Self-Efficacy

Science self-efficacy was chosen as one of the main variables of interest in this study in order to gain an understanding of the processes that underlie student decision-making and performance while engaged in a culturally responsive, high school science curriculum. In the next section I provide background on academic self-efficacy.

Central to Bandura's (1986, 1989a, 1989b, 1993, 1995, 1997) social cognitive theory is personal self-efficacy, defined as the belief in one's capability to execute required courses of action, govern one's choices of behaviors and aspirations, and is fundamental in the maintenance and mobilization of effort. Self-efficacy differs from other forms of self-beliefs (e.g., self-concept) as it is concerned primarily with individuals' capabilities to produce results and attain designated types of performances (Pajares, 1997). Bandura contended that students' self-efficacy beliefs are often better predictors of the academic successes compared to objective assessments of abilities. Subsequent research has revealed that these beliefs possibly mediate the effects of prior achievement, knowledge, and skills on subsequent achievement (Bong, 2001; Chemers et al., 2011; Schunk, 1985).

According to Bandura (1997), self-efficacy is established through a dynamic interplay of behaviors, individual perceptions and the external environment. He defined the perception of self-efficacy as "judgments of personal capabilities" (Bandura, 1997, p. 11) and argued that "people will explore, and try to manage situations within their perceived capabilities, but unless they are externally coerced, they avoid transactions with those aspects of their environment that they perceive exceeds their coping abilities"

(p. 14). However, while external expectations can promote development of self-efficacy, they can also hinder it.

Bandura (1997) explained that when a devalued group becomes the target of blame for negative characteristics that others associate with them, group members may eventually believe those degrading qualities about themselves. The influences of environmental structures are significant, but they are only one part of the equation, as Bandura also rejected a socially deterministic view of self-efficacy. Instead, he gave equal attention to the possibility that people within socially disadvantaged circumstances can overcome said obstacles if their perceptions of individual efficacy and behaviors are able to compensate for negative external ascriptions.

Consistent with these theoretical assumptions, Yamauchi and Greene (1997) found that seventh- and tenth-grade students from a rural, predominantly Native Hawaiian community reported lower perceived self-efficacy for achievement in school and in their future careers compared to student reports from the continental US, with particularly troubling consequences for Hawaiian boys. Results of a multiple regression analysis revealed that being Native Hawaiian and male was associated with lower self-efficacy for self-regulated learning. They suggested that the sociocultural context may have provided different information to Native Hawaiian boys and girls regarding their performances in home and school.

The development of self-efficacy related to students' academic pursuits has received much attention in recent literature. Chemers, Hu, and Garcia (2001) found that, above and beyond any effects of previous ability, academic self-efficacy was a strong and

significant predictor of the academic performance, academic goals, personal adjustment, and health of university freshmen. Woolfolk, Hoy and Davis (2006) also pointed to the cyclical nature of academic self-efficacy, motivation and outcomes, where greater self-efficacy in class can lead to greater effort and persistence toward challenging goals, which leads to better performance in school, which in turn leads to even greater academic self-efficacy.

Bong (2001) found that middle school students' self-efficacy was an important factor in predicting their achievement, mediating students' interpretation of their knowledge, skills, or experience of prior attainments, and was judged to be an essential factor in positively predicting learning outcomes. Furthermore, self-efficacy judgments were seen to contain strong subject-specific components. Other studies have also indicated that students' perception of self-efficacy and performance prediction was situation- or discipline-specific (Bong & Skaalvik, 2003; Shell, Colvin, & Bruning, 1995).

Motivation researchers have also established that students' self-efficacy about their academic capabilities is related to academic motivation and performance outcomes in specific domains that include language arts, mathematics and science (Britner & Pajares, 2001; Lent, Brown, & Gore, 1997; Pajares & Valiante, 1999; Shell, Colvin, & Bruning, 1995). In these subject areas, individuals rely predominantly on personal performance accomplishments to form their self-efficacy beliefs. In general, academic performances serve as important sources of information.

Given the importance of science curriculum as a bridge to future STEM careers, more information on the self-efficacy of students learning science may contribute to addressing the nation's pressing concerns about the quality of science education. Consistent with the tenets of self-efficacy theory, Britner and Pajares (2006) found that general self-efficacy correlated with science self-efficacy, and with middle school students' science grades. Students' mastery experiences, self-efficacy for self-regulation, and science self-efficacy were the most consistent predictors of students' grade in science. Furthermore, self-efficacy in science accounted for the largest share of unique variance, lending further confirmation that science self-efficacy is a significant predictor of science achievement. Britner and Pajares pointed to the importance of vicarious experiences, social persuasion and physiological arousal (considered precursors of students' science self-efficacy beliefs); which all correlated with science self-efficacy.

Lau and Roeser (2002) found that during high school, students' science self-efficacy correlated significantly with science achievement and was a better predictor of achievement and engagement in science-related activities both in and out of the classroom, than were gender, ethnicity, or parental background. The inclusion of motivational variables significantly increased the prediction of individual differences in achievement outcomes in science. Specifically, person-level processes, consisting of both cognitive and motivational resources, added unique power to the prediction of students' engagement in the classroom and outside of school. Also, science self-efficacy was found to be a powerful predictor of students' science test scores, classroom grades, and anticipated choices of science-related activities in the future.

Chemers et al. (2011) studied the role of efficacy among underrepresented minority undergraduate and graduate college students and proposed that the effects of science support experiences on commitment to science careers would be mediated by science self-efficacy and identity as a scientist. In their proposed *mediation model* researchers focused on several important science support experiences: research experience, mentor influences, and community involvement. These program and psychological variables were predicted to combine to produce a greater commitment to a scientific career. In the present study, the effects of *Ka Hana 'Imi Na 'auao*, a culturally responsive science curriculum developed for Hawaiian and other students in Hawai'i high schools were analyzed for the influence it had on students' grades (overall GPA), perceptions of *science self-efficacy*, the frequency of *pono behaviors*, and *behaviors conducive to learning*.

The literature review suggests that Native knowledge and Hawaiian ways of knowing in the classroom can help to ameliorate the negative outcomes that many public high school students in Hawai'i face, particularly in science. Next, I will describe the methods of the present study used to evaluate the *Ka Hana 'Imi Na 'auao* curriculum.

CHAPTER 3

METHODS

This chapter discusses the design and conduct of the study, including a discussion of the research questions, setting and subjects, variables, and methods of analysis.

Research Questions and Design

The following research questions were explored: Will students' perceptions of science self-efficacy improve as a result of participation in a culturally responsive curriculum, and in particular for Hawaiian participants? Will being exposed to the curriculum result in significant gains in students' perceptions of pono behaviors, and in particular for Hawaiian participants? Will students' perceptions of behaviors conducive to learning improve as a result of participation in the culturally responsive curriculum, and in particular Hawaiian participants?

The design was a nonequivalent (static group) comparison design (Fraenkel & Wallen, 2006).

O ₁	X	O ₂	O ₃
O ₁		O ₂	O ₃

The strength of this design is the added control group which reduces rival explanations related to history, maturation, testing, and regression effects; however, the primary weakness is the lack of random assignment to treatment and control conditions, which is often not possible in school settings. This results in a possible treatment by selection bias, for example, the students may differ in motivation or interest in known or unknown ways.

Participants

Participants included 332 students enrolled at eight high schools on O‘ahu and Hawai‘i islands in the school years 2006-2007, 2007-2008 and 2008-2009 (see demographic information listed below in Table 3.1). An attempt was made to recruit an equal number of urban (Roosevelt, McKinley, Castle and Kaimuki) and rural schools (Waialua, Nanakuli, Honoka‘a, and Kua O Ka La Public Charter School). The number of students receiving free and reduced lunch differed by location, and, perhaps as a sign of the difficult financial times, increased over the three years of the study. In 2006-2007, 40% of participants received free and reduced lunch came from urban schools, and 45% were from rural schools. By the 2008-2009 school year 43% were in urban schools and in rural areas the levels climbed to 51% of the students receiving free and reduced lunches.

Table 3.1

Demographic Information, Ka Hana 'Imi Na 'auao Sample, 2006-2009 School Years

Mean Age	15.6 (1.17)	Age Range	13 -18
Male	56%	Female	44%
Urban Student Population	47%	Rural Student Population	53%
Treatment Condition	53%	Control Condition	47%
Part Hawaiian	44%	Native Hawaiian	7%
Asian	19%	Caucasian	2%
Pacific Islander	8%	Other (mixed race)	20%

N = 332. *Note.* Number in parenthesis is standard deviation

The participating students were in Grades 9 through 12 (27% ninth grade students, 27% tenth graders, 32% eleventh graders and 14% twelve grade students. The majority of the students were in general education (81%), but special education students were also represented (19%). All students completed surveys before receiving the curriculum (Wave I), roughly half-way through the school year (Wave II) and again just before they were released on summer break (Wave III).

In total, 18 teachers participated (13 female, 5 male) and their cultural backgrounds varied, reflecting the diversity of the islands: Native Hawaiian ($n = 2$), part Hawaiian ($n = 4$), Asian ($n = 4$), Caucasians from the US Continent ($n = 2$), Caucasians who were raised in Hawai'i ($n = 2$), a Pacific Islander ($n = 1$), and a mix of two or more of cultures, or "local" ($n = 2$). Participants taught a variety of science subjects, mainly general or introductory science ($n = 10$), but some taught biology ($n = 4$), marine science ($n = 2$), astronomy ($n = 1$), or food science ($n = 1$). There was one first-year teacher, several who had been teaching for over 20 years, and others whose experience ranged between 3 and 15 years. Two teachers who originally started in the control group in the first year decided to join the treatment group in subsequent years. This was considered problematic, and data for these teachers' students (72 participants) were removed before running the analysis.

This was a quasi-experimental study because teachers could choose to participate in either group. However, in order to ameliorate the effects of subject contamination, once the first teacher at one school was recruited to be in a condition, an effort was made for subsequent teachers at that school to be recruited to the same group.

Instrumentation

The instrument used to measure growth and change over time in this study was the Culturally Responsive Science Perceptions, or CRSP inventory, an instrument created to gauge the self-perceptions of how confident students felt toward doing their science work and how often they behaved in an appropriate manner, both in terms of Western educational expectations and expectations of the Hawaiian culture. In the following section the ways in which its validity and reliability were established will be discussed.

Initial Validation of the Instrument using Exploratory Factor Analysis

Bowditch, Roberts & Galloway (in press), studied the validity of the CRSP inventory. This validation study was conducted with a group of 404 participants from public high schools in Hawai‘i and an Exploratory Factor Analysis was conducted to determine convergent and discriminant validity as well as the stability of the three factors over time. The first step in this process was to identify salient dimensions. Researchers at the Center on Disability Studies (CDS) deemed three psychological dimensions as salient for students learning science in a culturally responsive environment. These included perceptions of *pono* (valued as correct by Hawaiians) *behaviors*; perceptions of *behaviors conducive to learning*; and feelings of *science self-efficacy*, or the perception of confidence in the ability to do science academic work.

Interviews with Hawaiians from the local community and those who worked at CDS and a review of the literature on culturally responsive education programs were conducted to create items to gauge the perceived frequency of students' pono behaviors. The pono behaviors sub-scale items were then reviewed by staff at ALU LIKE Inc. who made final revisions. When developing the CRSP inventory, sets of items conceptually

linked with each salient dimension were included. Originally, Center researchers checked a group of 24 items for accuracy and distinctiveness. The result of the internal-consistency reliability data (Cronbach's alpha) and further EFA, refinement decisions was a three-scale, 22 item instrument; the *Culturally Responsive Science Perception* inventory (CRSP, Center on Disability Studies, 2006).

Procedures and Internal Consistency of the CRSP Inventory

The Exploratory Factor Analysis revealed that a total of ten items loaded sufficiently on the perceived frequency of *behaviors conducive to learning* factor, six items loaded on perceived level of *science self-efficacy* factor, and six items loaded satisfactorily on the perceived frequency of *pono behaviors* factor, indicating sound discriminant validity.

The variance of all three psychological dimensions combined for a total of about 47%, at Waves I and II, and 49% at Wave III, suggesting that the three factors accounted for nearly half of the learning that took place in the classrooms comprising the sample. Furthermore, Eigen values for the three factors at each wave were all greater than 1.0, the typical cut-off in factor analyses utilizing principle components analysis. The Eigen value for *behaviors conducive to learning* was 6.8, *science self-efficacy* was 2.2 and *pono behaviors* was 1.5). A certain amount of overlap existed among all three factors at Wave I, and these correlations remained consistent at Waves II and III.

Total scale internal consistency reliability (Cronbach's coefficient α) estimates were robust with alpha levels of .93 at Wave I, .90 at Wave II and .92 at Wave III. Individual factor reliability values were good to fair for perceived frequency of *behaviors conducive to learning*, and alpha values ranged from .88 at Wave I, .85 at Wave II and

.88 at Wave III. The perceived level of *science self-efficacy* factor alphas were .76 at Wave I, .78 at Wave II and .80 at Wave III. For perceived frequency of *pono behaviors*, factor alphas were .68 at Wave I, .71 at Wave II, and .73 at Wave III. For this study, 332 students completed the CRSP inventory over three school years (2006-2009), and data for the three years were combined.

Further Validation of the Instrument Using Confirmatory Factor Analysis

Structural equation modeling (SEM) facilitates the specification of models that focus on defining a small number of underlying (or latent) constructs through measuring their observed indicators. The measurement model corrects the constructs for errors in their observed measures and is, therefore, important in establishing the reliability and validity of variables used in an organizational analysis. Correcting for measurement error facilitates more accurate estimation of the model's structural parameters. The technique used to define measurement models is referred to in the SEM literature as *confirmatory factor analysis (CFA)*, because of the emphasis on proposing a set of theoretical relationships before actually testing the model against the data to determine whether it confirms the existence of the proposed set of latent factors (Heck, Thomas & Tabata 2010). The goal of the CFA analysis is to reproduce the original observed matrix of covariances by clustering subsets of the observed variables with a smaller number of latent factors.

In contrast to the exploratory factor analytic approach, which is more restrictive in terms of defining the models, CFA provides greater flexibility in defining a specific model. Since items may be restricted to define particular latent factors, covariances may be specified between some or all factors, and covariances between specific error terms

may be permitted. This allows the researcher to examine the reliability and validity of the measurements through the careful specification of constructs and their indicators before testing the proposed model with data. This is often a step that is given little attention in the preliminary stages of investigating theoretical models. It is important to consider how well key variables in a study are measured, because the lack of measurement quality in defining constructs can be an important limitation to the credibility of results stemming from the test of a particular theory (Heck & Thomas, 2009).

In specifying a measurement model, a smaller set of latent factors (η_q) are hypothesized to be responsible for the specific pattern of variation and covariation among a set observed variables (Y_p) contained in a sample covariance matrix. This matrix is decomposed by a model that assumes that unobserved variables (e.g., science self-efficacy) are generating the pattern, or structure, among the observed variables. Each of the observed variables is conceptualized as a linear function of one or more factors. There are two types of factors in defining a model. The common factors that may affect more than one observed variable, and unique or residual factors that may affect only one observed variable. The basic measurement model can be represented as

$$y_i = \mathbf{v} + \lambda\eta_i + \varepsilon_i, \quad (3.1)$$

where for individual i , y is a vector of observed dependent variables, \mathbf{v} is a vector of measurement intercepts for the observed variables, λ is a matrix of factor loadings for the observed variables, η_q refers to the set of latent variables, and ε_i is a vector of measurement errors for observed variables that is uncorrelated with other variables. The

residual terms are contained in a covariance matrix denoted Θ . Equation 3.1 suggests that the observed items are linked to the underlying factors through the factor loadings contained in λ . The covariance structure may then be specified as

$$\Sigma = \Lambda\Psi\Lambda' + \Theta, \quad (3.2)$$

where Λ is a $p \times q$ matrix of observed variable loadings defining the latent factors, Ψ is a $q \times q$ matrix of factor variances and covariances, Λ' is the transpose of Λ , and Θ is a diagonal matrix ($p \times p$) of residual variances and covariances (Heck, Thomas & Tabata 2011).

Several statistical and practical tests (e.g., comparative fit index [CFI], root mean square error of approximation (RMSEA), standardized root mean square residual [RMSR]) can then be examined to determine if the data confirm the set of relationships implied in the hypothesized model. The CFI is scaled between 0 and 1, with values of 0.90 or above typically indicating adequate model fit. SRMR represents the average of the magnitude of the standardized residuals. In most cases an SRMR between .05 and zero indicates a good-fitting model. Related to SRMR, RMSEA provides for a discrepancy of model fit per degree of freedom. Models with RMSEA near .05 are often considered to fit the data adequately. If the model turns out to be consistent with the data (i.e., it reproduces the observed variation present in the data), the researcher has preliminary evidence of its construct validity.

When running the preliminary Exploratory Factor Analysis in SPSS, two items originally thought to be associated with the *science self-efficacy*; “I try to do things correctly;” and “I accept it when people correct me” had better factor loadings on the

behaviors conducive to learning factor. After running the Confirmatory Factor Analysis (CFA, illustrated in Figure 3.1), although loadings were again, rather low (.46 and .55, respectively), they were both found to significantly (at the $p < .001$ level) load on *behaviors conducive to learning*. This test finding was one benefit of using a confirmatory rather than an exploratory approach (using a principle components analysis) for testing a model's fit. Also, the underlying assumption in principle components analysis is that factors should not be correlated; however, Figure 3.1 shows that there was some overlap between all of the factors at each time point.

Also, the two items originally removed from the *pono behaviors* factor in refinement decisions in the EFA due to high loadings on more than one factor, "I care for the environment," and "I try hard to do well in school" were included in the CFA and found to be significant. Therefore, the final CRSP inventory included a total of 24 items, 10 for the perceived frequency of *behaviors conducive to learning*, six for perceived level of *science self-efficacy*, and 8 items for perceived frequency of *pono behaviors* factor. EFA utilized SPSS 18.0, CFA was run using Mplus statistical software, and the multi-level model was analyzed with IBM SPSS 20.0. The preliminary model with no proposed covariances between error terms fit quite well (CFI = 0.85, RMSEA = .07, SRMR = 0.067), but a few changes were made by allowing errors to be correlated in five instances to obtain a slightly higher set of fit indices; however, all of these items were intuitively related. For instance, with the factor *behaviors conducive to learning*, error variance associated with the item "I follow classroom rules" was allowed to correlate with the error variances of the items "I follow written directions," and "I follow instructions." These last two items' error terms were also allowed to correlate, and the error associated

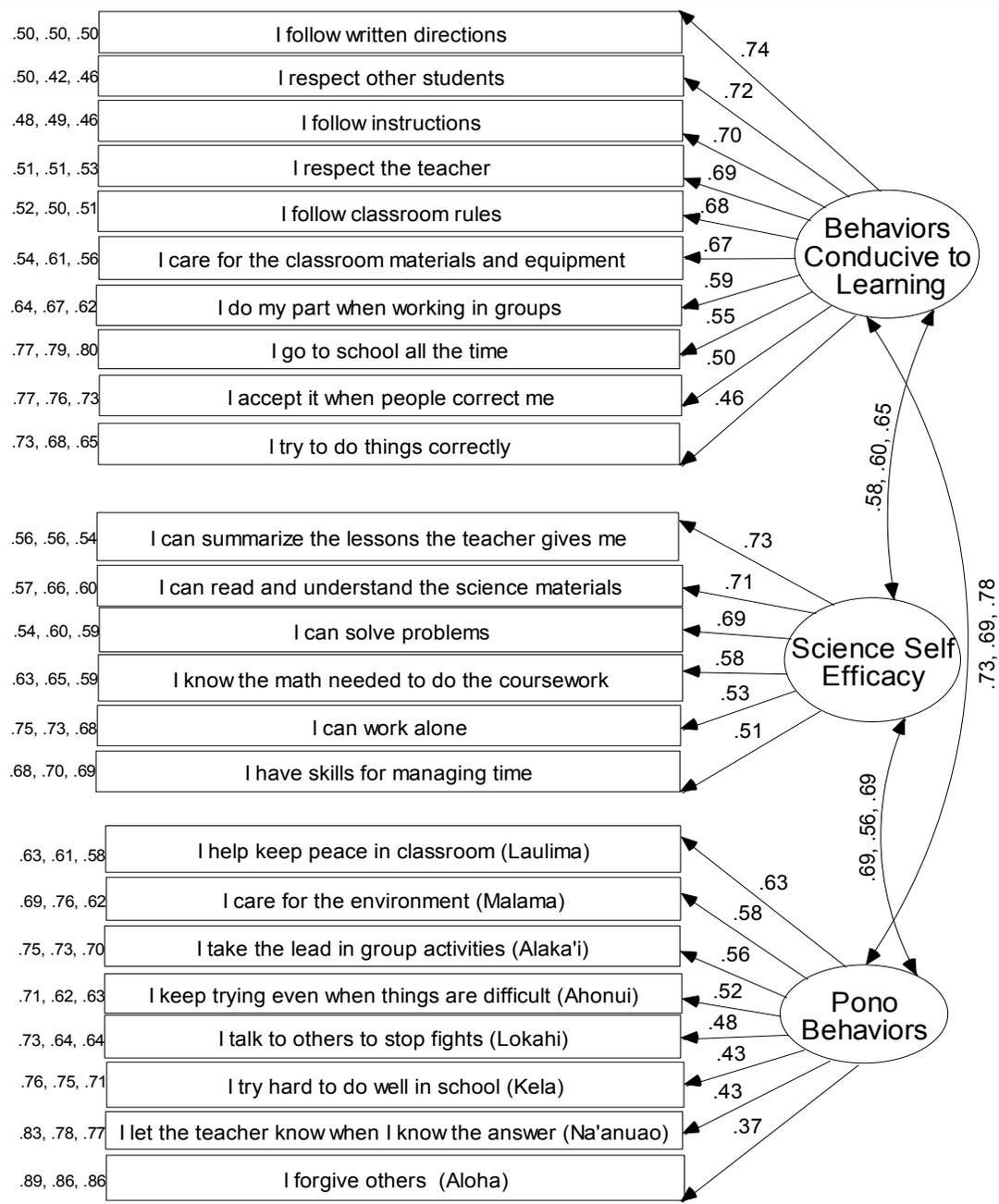


Figure 3.1 Results of Confirmatory Factor Analysis (Maximum Likelihood estimation, standardized solution) illustrating structure matrix of CRSP inventory with factor loadings, inter-factor correlations and item variance. Note: Single-headed arrows represent factor loadings; double-headed arrows represent inter-factor correlations at each time point, values to the left show residual variance by wave of data collection.

with the item “I respect the teacher” was allowed to correlate with the error associated with the item “I respect other students.” For the pono behaviors factor, error associated with the item with the term “I try hard to do well in school” was allowed to correlate with the error associated with “I keep trying even when things are difficult.”

This basic model (with CFI = 0.90, RMSEA = 0.059, SRMR = 0.063) was then proposed to fit across groups at Wave II and Wave III. The literature suggests that values of CFI near 0.90 and above are considered acceptable, and RMSEA near 0.05 are generally considered evidence of good-fitting models to the data (Marcoulides & Hershberger, 1997; Marsh, Balla & Hau, 1996); however, more recent studies suggest CFI values to be closer to .95 (Hu & Bentler, 1999). For RMSEA, a cut-off value close to .06 (Hu & Bentler, 1999) has been considered to indicate a good model fit, or values no higher than 0.07 (Steiger, 2007) and values of SRMR of as high as 0.08 have been cited in the literature as acceptable (Hu & Bentler, 1999). With these three key fit indices all within acceptable limits, this basic model was considered a good fit to the data.

Examining the Factor Means Over Time

Once a model’s preliminary construct validity has been established, researchers often investigate whether the same model fits across other groups or over repeated observations. This process is referred to as testing a model’s invariance or generalizability and represents another way of investigating a proposed model’s construct validity (Heck & Thomas, 2009). Tests of model invariance across groups are conducted by imposing constraints on particular parameters of interest across a number of groups or repeated measurements and determining how well this model fits each of the covariance

matrices of the groups or samples being compared. This facilitates the testing of hypotheses, for example, about the invariance of the factor structure (e.g., same number of factors, same factor variances and covariances), whether the same pattern of factor loadings exists, and whether there are invariant measurement errors across the groups examined.

Table 3.2 illustrates results of the CFA test for significant difference of the three factors over time by setting the first time point to zero and testing for significant change in mean factor scores at times one (Wave II) and two (Wave III). It was found that although no significant change was evident at Wave I, by Wave II there was significant improvement in scores of *pono behaviors* and *science self efficacy* factors. This suggests students were changing over time in their perceptions of pono behaviors and science self efficacy. What remains to investigate is how the treatment and control groupings of students might interact with students' changing perceptions of these constructs.

Table 3.2.

Factor Means, Standard Errors and Level of Significant Change by Time Point

Factor	Factor Means by Time Point		
	0	1	2
1. Pono behaviors	.00	.03 (.30)	.07 (.005)**
2. Science Self-Efficacy	.00	.04 (.36)	.11 (.006)**
3. Behaviors Conducive to Learning	.00	-.04 (.21)	-.05 (.14)

Note: $N = 332$, ** $p < .01$. Note. Number in parenthesis is value of significance.

Examining Treatment Effects Over Time

The primary concern for the analysis of change in students' perceptions is whether the treatment affects students' growth or change in the three constructs over the three measurement occasions comprising the longitudinal design. This is often referred to as a *treatment by time* interaction. The assumption is that the treatment and control groups start out the same before the treatment is introduced. After the introduction of the treatment, it is assumed the growth rates are different over time. In the last section, the CFA provided preliminary evidence that the students' perceptions of their *science self efficacy* and *pono behaviors* changed over time. After confirming the structure of items measuring the three constructs over time, the next step was to develop a multivariate growth model to examine possible treatment effects on changes in the set of constructs over time.

Growth Curve Modeling. Research from this study used Growth Curve Modeling (GCM) in the final analysis, specifically, a Multi-Level Model utilizing Hierarchical Linear Modeling, as the method of analysis. In the following sections, I provide some background on these types of methods that may be useful to the reader. GCM is an approach endorsed for the study of change over time by a number of leading methodologists (e.g., Bryk & Raudenbush, 1987; Francis, Fletcher, Stuebing, Davidson, & Thompson, 1991; Goldstein, 1996, 1986; Rogosa, Brandt, & Zimowski, 1982; Willet & Sayer, 1994). GCM is increasingly utilized in social science research as it allows for rigorous data analysis and individual and group growth analysis and comparisons (Bryke & Raudenbush, 1992). It also allows for measurement error which is not feasible in most other statistical procedures used to measure change (McArdle, 1986).

The process begins with determining the intercept or constant by plotting the first data points from the first measurement, termed the “baseline.” Change is then measured from the intercept. Through the plotting of additional data points (dependent variables) each subject’s or group’s slope is determined and used as the unit of analysis. GCM offers several possible advantages over other statistical approaches to growth over time. In most intervention trials, the interest is not so much in the absolute level of a targeted behavior at a certain time point as it is in the developmental trajectory of targeted variables across multiple time points, e.g., the continuous developmental process before, during, and after an intervention.

GCM allows modeling trends of how groups and individuals change. The parameters describing the normative developmental trajectory identified in the control group are also estimated in the treatment group, and these parameters are then equated across the two groups. This equating allows for the identification of the portion of growth in the treatment group that is attributable to the normative developmental process observed within the control group. In addition to the normative growth factors, a second growth rate factor is added that is unique to the treatment group.

This added factor allows for the identification of differential growth that exists within the treatment group above and beyond the normative developmental trajectory that exists within the control group. In other words, this factor captures the degree to which the normative developmental trajectory observed in the control group may be altered as a function of the intervention applied to the treatment group. This unique treatment group growth factor is what explicitly captures the intervention treatment effect in GCM,

however, the statistical theory, methods and software to analyze such models were not developed until fairly recently.

In research conducted in schools, observations may be made on students, but curriculum interventions typically are administered at the classroom level. Consequently, the data structure is nested, with students representing the lowest level of the hierarchy and classrooms at the second level. The analysis of individual growth represents a special case of this nested structure, as multiple observations are nested within the individual subject on which those observations were made (Bryk & Raudenbush, 1992), in such analyses, time is considered to be nested within the individual.

In multilevel modeling, analysts explore the hierarchical structure of sets of nested data, allowing them to estimate structural and variance/covariance parameters with accuracy and efficiency by focusing on two types of parameters: fixed effects and covariance components (Heck, Thomas & Tabata, 2011). Fixed effects refer to the model's structural parameters, such as the intercept coefficients, or the initial mean score of a group, or slope coefficients (i.e., the relationship between socio-economic status and graduating from high school). Covariance components refer to the complete set of variances and covariances in a model's parameters. Finally, a central component in multilevel modeling is that specific parameters can be designated as randomly varying, meaning that the sizes of the estimates are allowed to vary across groups.

In multilevel modeling, the results are routinely extended to show their variation continuously over time. This elaboration provides useful information, specifically; the nonlinear growth curve includes representations of the following results: the variance of the outcome status over time, variance of the growth rate of the outcome over time, the

correlation of the outcome status and the outcome growth rate over time, the stability of the outcome over time (i.e., the correlation of outcome status at one time with that for a later time), the effect of an individual attribute on the outcome status over time, and the effect of an individual attribute on the growth rate of status over time (Tate, 2000). By investigating these relationships at multiple levels of analysis as well as exploring cross-level interactions that incorporate the dimension of time; exploratory studies are able to paint a more valid and reliable picture than ever before.

Multivariate Growth Formulation

A multilevel formulation can take into consideration the correlation between the multiple outcomes measured on several occasions. The goal is to build a model where the fixed effects are used to control for differences in the means between individual repeated measures and the random effects can be used to model the different variances for the outcomes, as well as the covariances between the outcome measures (Leyland, 2004). Besides providing a thorough test of treatment effects on several outcomes over time, another advantage of this type of multilevel growth model is that one can test the equality of the size of effect of a specific predictor on each of the repeated measures outcomes (Hox, 2010).

In specifying this type of multivariate growth formulation in SPSS Mixed, at Level 1 the Repeated Measures specification was used to collect the repeated measures on the three constructs within individuals. The primary parameters included in a growth formulation are the intercept (often defined as initial status) and the time-related growth slope. In this case, the within-individual covariance structure was specified as compound symmetry, as is common in repeated measures designs where there are a limited number

of repeated measures (Hox, 2010). At Level 2 (between individuals, $N = 332$), fixed predictors including an individual academic variable (GPA) and the treatment variable were also included in the model. At Level 3, the initial status intercepts were allowed to vary across teachers, although because of the small sample size, no teacher characteristics were modeled.

Multivariate linear models are commonly formulated as single-level models specified in matrix notation. To define this type of model in MIXED, I stacked the single-level model with conducive to learning, science self-efficacy, and pono behaviors in a single variable column (Y_{ijk}), where i refers to the particular construct ($i = 1, \dots, 3$) for individual j in the classroom of teacher k . At Level 1, it is convenient to use a categorical indicator (Index1) to identify each construct within individuals (Heck et al., 2010). Specifying the fixed effects portion of the model as having no intercept (NOINT) ensured that separate intercepts were obtained for each of the three constructs at Level 2 (the individual level). At this lowest level, students were nested within teachers (Subject [$id*teacherid$]) on the REPEATED syntax command line. This particular specification had the effect of combining Levels 1 and 2 to create a basic two-level (i.e., student and teacher) multivariate formulation (Leyland, 2004).

By declaring *Index1* as the random variable at the highest level (using *teacherid* as the Subject variable), I specified a random intercept (initial status) parameter for each construct, and by declaring *Wave* as a random variable at that level, a random time slope parameter for construct can be added between teachers. It should be noted that preliminary models suggested the time-related parameter (*Wave*) should be fixed between teachers at the highest level of the model. Since there were multiple constructs being

examined over time, it was possible to examine whether or not the treatment effect was the same for each construct over time. In addition, background variables (e.g., student GPA) were added to examine whether they influenced students' perceptions about the three constructs under consideration. It was also possible to examine whether or not the effects of variables such as student GPA or the time-related effects were the same or different across the constructs. These investigations were conducted by imposing equality constraints on the constructs (Hox, 2010). If the model with equality constraints fits better than the model with freely-estimated parameters for each construct, I could assume there was one effect of the predictor that was the same for all three constructs. In each case, the hypothesis proposed was that the strength of the effect of the predictor on the three constructs was the same.

The fitted two-level growth models were then specified for individual i nested within teacher j at time t for the classroom behavior (CB), self-efficacy (SE) and pono behaviors (P) constructs as follows:

$$\begin{aligned}
 Y_{CBt_{ij}} &= \gamma_{CB00} + \gamma_{CB10} \text{wave}_{t_{ij}} + \gamma_{CB01} \text{GPA}_{ij} + \gamma_{CB02} \text{treat}_{ij} + \gamma_{CB11} \text{wave}_{t_{ij}} * \text{treat}_{ij} + u_{0CBj} + \varepsilon_{CBt_{ij}} \\
 Y_{SEt_{ij}} &= \gamma_{SE00} + \gamma_{SE10} \text{wave}_{t_{ij}} + \gamma_{SE01} \text{GPA}_{ij} + \gamma_{SE02} \text{treat}_{ij} + \gamma_{SE11} \text{wave}_{t_{ij}} * \text{treat}_{ij} + u_{0SEj} + \varepsilon_{SEt_{ij}} \\
 Y_{Pt_{ij}} &= \gamma_{P00} + \gamma_{P10} \text{wave}_{t_{ij}} + \gamma_{P01} \text{GPA}_{ij} + \gamma_{P02} \text{treat}_{ij} + \gamma_{P11} \text{wave}_{t_{ij}} * \text{treat}_{ij} + u_{P0j} + \varepsilon_{Pt_{ij}} , \quad (3.3)
 \end{aligned}$$

where γ_{00} for each construct represents the initial status intercept for each parameter, γ_{10} represents the growth slope for each measurement occasion, γ_{01} represents the effect of student GPA on initial status intercepts for each construct, γ_{02} represents the effect of the treatment on each initial status mean [which was assumed to be the same (i.e.,

$\gamma_{CB02} = \gamma_{SE02} = \gamma_{P02}$], γ_{11} represents the treatment by time interaction effect, u_{0j} represents the randomly varying initial status effect, and ϵ_{ij} represents errors in estimating individual growth trajectories for each construct. As noted previously, for this test of treatment effects over time, the time-related slope coefficients describing the change over time on each construct (γ_{10}) within schools to be fixed (as opposed to randomly varying) between teachers. This was because of the small number of teachers in the sample.

In specifying the model in SPSS Mixed, the *Index1* variable, which was used to define the three constructs, was crossed with the individual-level predictors (*X*) in the combined model (e.g., *Index1*GPA*), to include a separate regression coefficient describing the effect of GPA on each construct. This was important to note, since one goal of the analysis was to examine whether the effects of the treatment, time, and GPA were the same or different on the three constructs. I wanted to impose equality constraints on the predictor, however, that variable (e.g., *GPA*) was added directly into the model instead of as an interaction (Hox, 2010).

The final model examined in Chapter 4 did not include equality constraints for GPA or Wave, but an equality constraint for the treatment effect on the initial status intercepts had 13 parameters to estimate. These included three initial status intercepts, three fixed-effect *Index1*GPA* estimates, one fixed-effect treatment effect on the initial status intercepts (representing an equality constraint that was tested and found to hold), and three fixed-effect estimates for the treatment*time interactions for each construct.

CHAPTER 4

RESULTS

In this chapter the results of the test of treatment effects over time are presented.

These fixed effects are summarized in Table 4.1, which shows each set of effects was statically significant except the treatment effect on the initial status intercepts (which we would expect to be nonsignificant at the start of the study). In addition, there were eight covariance parameters to estimate. These included one variance and one covariance parameter at the lowest level (as specified by compound symmetry), three construct variances and three covariances between teachers at the highest level of the model, for a total of 21 parameters. It should be noted that models with quality constraints imposed for the effects of GPA and Wave on the constructs were also investigated, but they were found to not fit the data as well as the final model presented.

Table 4.1.

Type III Tests of Fixed Effects^a

Source	Numerator df	Denominator df	F	Sig.
Index1	3	111.108	185.430	.000
Index1 * GPA	3	504.334	7.435	.000
Treat	1	17.423	.584	.455
Index1 * Wave	3	414.326	3.161	.025
Index1 * Wave *	3	51.442	3.320	.027
Treat				

a. Dependent Variable: Constructs.

Examining Treatment Effects Over Time

The fixed-estimates are presented in Table 4.2 and Figures 4.1., 4.2 and 4.3. The initial status intercepts suggest that students perceived generally high classroom behavior

scores -5 (*Index1 = 1*), than either self efficacy (*Index1 = 2*) or pono behavior scores (*Index1 = 3*). The table suggests that students' GPA was positively and significantly related to their perceptions of their classroom behavior (*Index1 = 1*) and science self efficacy scores (*Index1 = 2*), by their pono behavior scores (*Index1 = 3*). As noted previously, students in the treatment group did not report significantly different perceptions of the three constructs at the beginning of the study ($\chi^2_{02} = 0.050, p > .05$). Recall that this represents an equality constraint (i.e., a single coefficient that describes the effect on each construct).

Table 4.2.

Estimates of Fixed Effects^a

Parameter	Estimate	Std. Error	df	t	Sig.
[Index1=1]	2.011	.086	97.609	23.481	.000
[Index1=2]	1.458	.081	127.855	18.029	.000
[Index1=3]	1.515	.084	97.450	17.861	.000
[Index1=1] * GPA	.116	.027	482.447	4.287	.000
[Index1=2] * GPA	.070	.027	403.131	2.637	.009
[Index1=3] * GPA	.039	.027	468.230	1.460	.145
Treat	.050	.065	17.423	.764	.455
[Index1=1] * Wave	-.043	.020	517.248	-2.130	.034
[Index1=2] * Wave	.028	.021	616.422	1.358	.175
[Index1=3] * Wave	.029	.021	1037.910	1.431	.153
[Index1=1] * Wave * Treat	.029	.026	88.894	1.153	.252
[Index1=2] * Wave * Treat	.059	.027	125.548	2.165	.032
[Index1=3] * Wave * Treat	.068	.027	261.688	2.519	.012

a. Dependent Variable: Constructs.

Table 4.3.

Estimates of Covariance Parameters^a

Parameter		Estimate	Std. Error	Wald Z	Sig.
Repeated Measures	CS diagonal offset	.151	.004	34.406	.000
	CS covariance	.100	.009	10.293	.000
	UN (1,1)	.014	.009	1.561	.119
	UN (2,1)	.008	.006	1.344	.179
Index1 [subject = Teacher]	UN (2,2)	.006	.005	1.225	.221
	UN (3,1)	.011	.007	1.466	.143
	UN (3,2)	.005	.005	.952	.341
	UN (3,3)	.013	.008	1.484	.138

a. Dependent Variable: Constructs.

Table 4.2 suggests that in the control group (*Index1*Wave effects*), perceptions of students' own behaviors conducive to learning actually declined over time ($\gamma_{CB10} = -0.043, p < .05$). Growth was nonsignificant over time on the other two constructs ($p > .05$). For the treatment group, however, the results suggested that there was no change in terms of students' perceptions of their classroom behavior ($\gamma_{CB11} = 0.030, p > .05$). However, for self efficacy ($\gamma_{SE11} = 0.060, p < .05$) and pono behaviors ($\gamma_{P11} = 0.069, p < .05$), the results were significant.

Table 4.3 presents the covariance parameters for this model. At the individual level, the variance is 0.151 ($p < .001$) and the average covariance between constructs over time was 0.100 ($p < .001$). At level 2, the variances between teachers are relatively smaller (i.e., approximately 0.01).

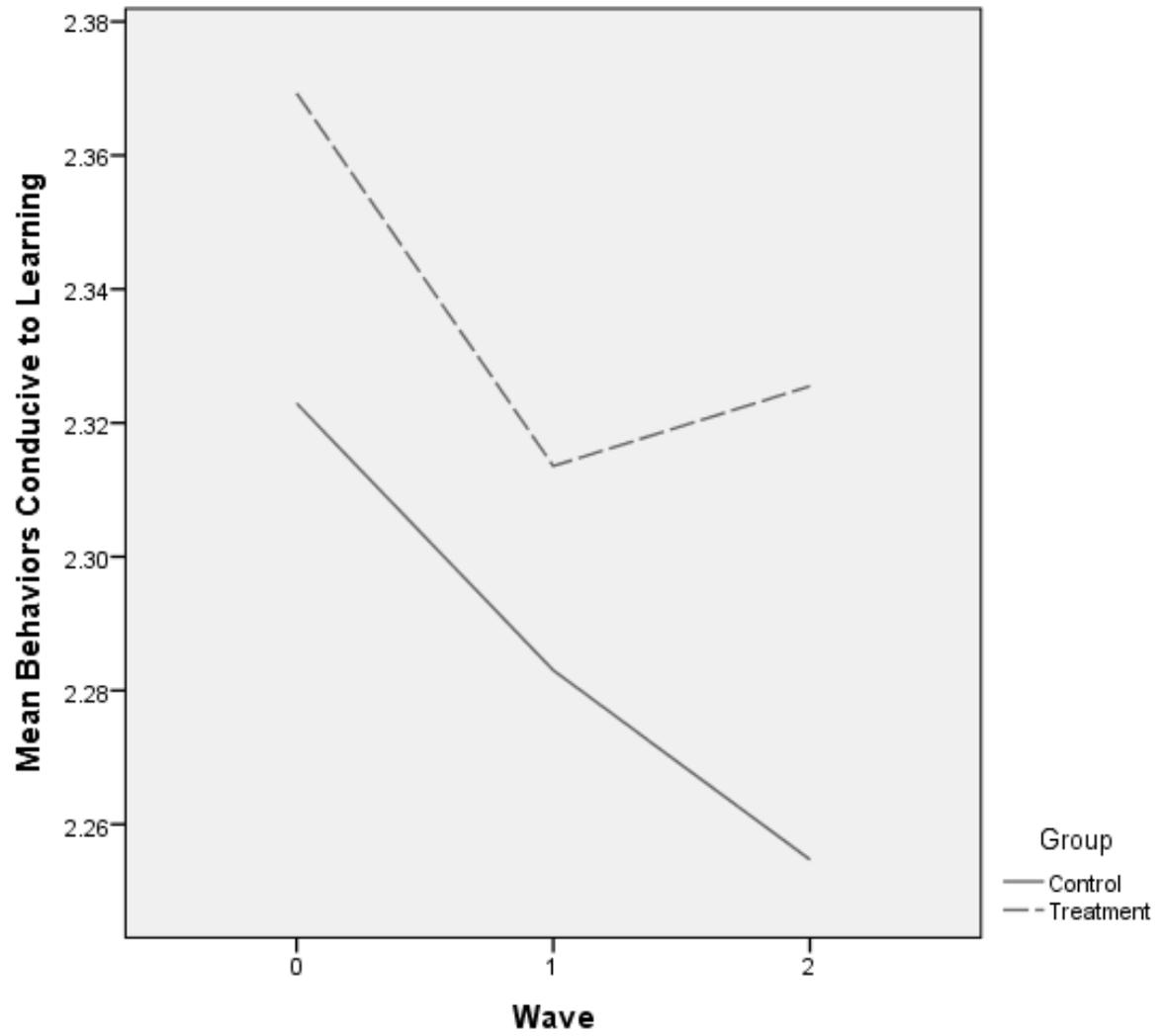


Figure 4.1. Estimated Marginal Means of Behaviors Conducive to Learning

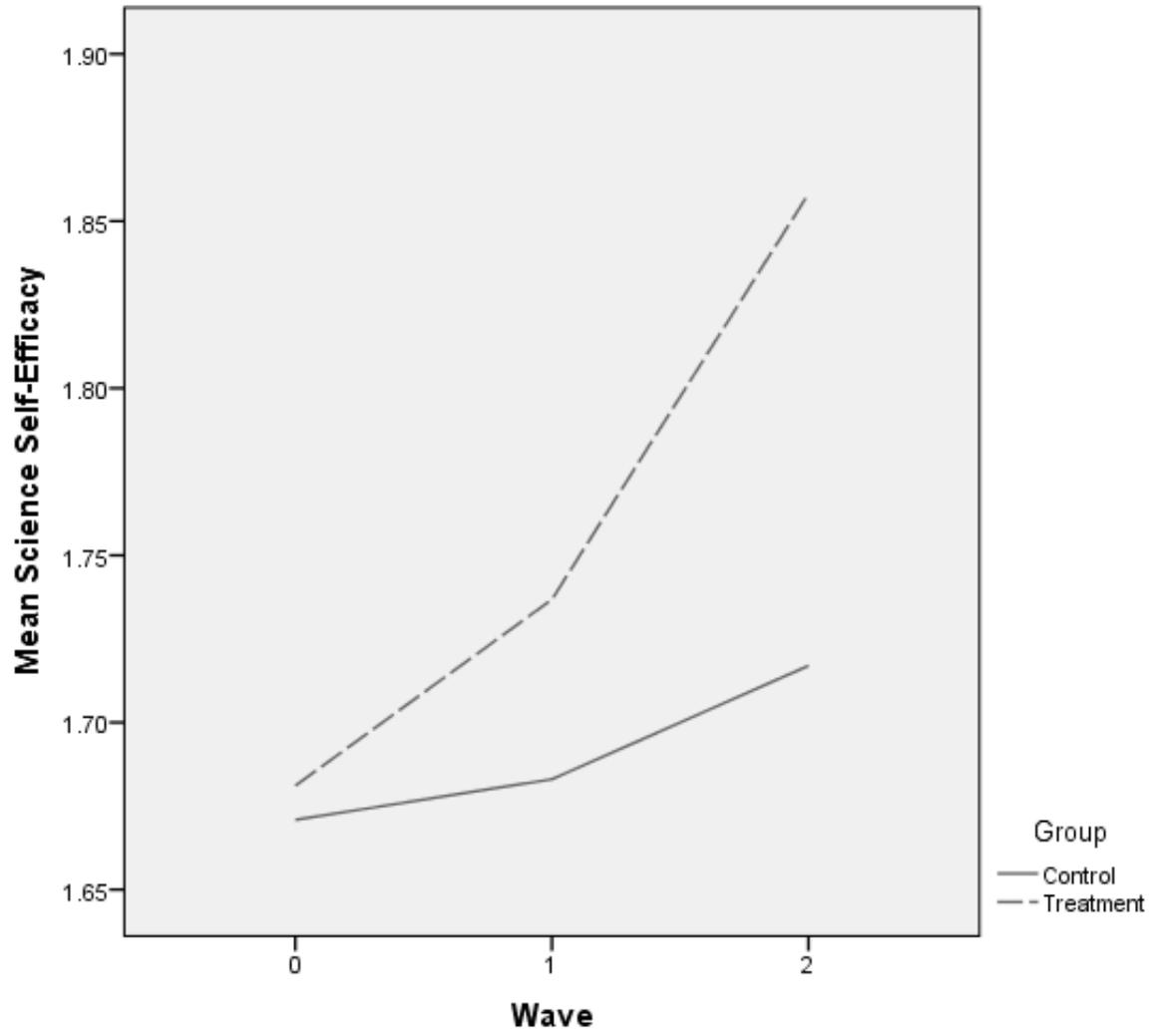


Figure 4.2. Estimated Marginal Means of Science Self-Efficacy

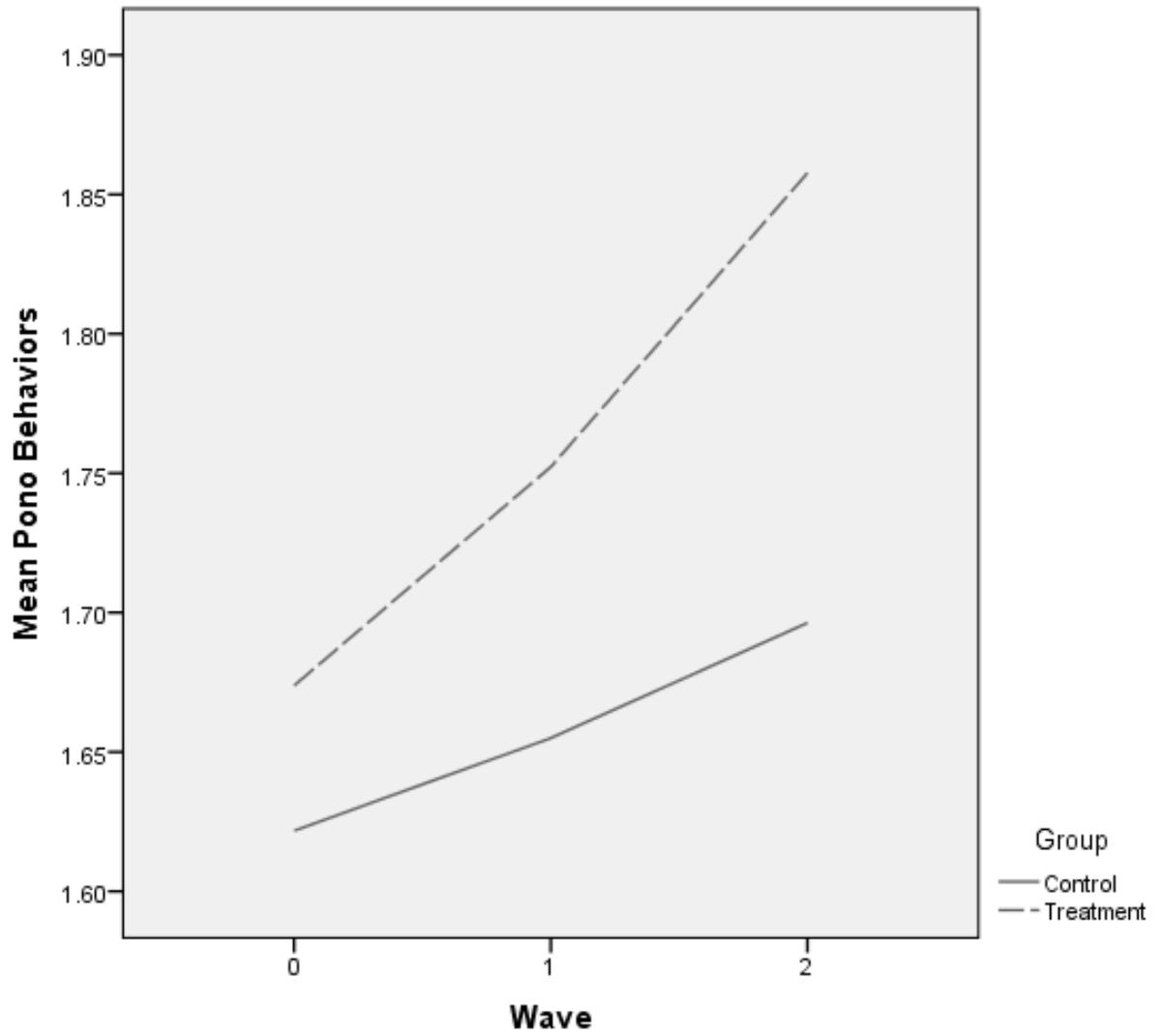


Figure 4.3. Estimated Marginal Means of Pono Behaviors

CHAPTER 5

DISCUSSION

In this chapter I will discuss the results, draw conclusions, discuss the limitations of the study and suggest implications for future research.

Before delving into a discussion of the findings, I would first like to discuss some methodological implications stemming from the choice of models used in the analysis.

For a long time, behavioral scientists have not had adequate measures of individual change or sound techniques for research on change (Bryk & Raudenbush, 1987; Curran & Muthen, 1999; Francis, Schatschneider, & Carlson, 2000). Examples of commonly used analytic techniques include the *t*-test, ANOVA, ANCOVA, MANOVA, MANCOVA, multiple regression, and fixed effects structural equation modeling.

Although these techniques can be useful for evaluating treatment effects under relatively restrictive assumptions, there are several potential limitations that are encountered when these analytic approaches are solely used to study development over time. Examples include the inability to model individual growth over time, decreased statistical power, potentially biased parameter estimates, and unnecessary restriction of inferences that can possibly be obtained from the observed data (Curran & Muthen, 1999; Francis, Schatschneider, & Carlson, 2000; Meredith & Tisak, 1990; Rogosa, 1988; Rogosa & Willet, 1985; Willet, 1994).

The first step in the multi-level or HLM analysis was to partition the variance in the outcome variables into their within- and between-group components (Heck et al., 2011). This was done by arranging the data set to be hierarchically structured by re-formatting the lay-out to be vertically aligned, as opposed to horizontally aligned in the

database. If little or no variation was found in the outcomes between groups, a multi-level analysis may not have been appropriate and the analysis conducted at the individual level would have been sufficient. I found that the slopes did not vary, and hence, were allowed to remain fixed. However, I determined that there was variability in participants' intercepts, and therefore, a multi-level model was examined where intercepts were allowed to vary.

In the following three sections I will discuss the results from the factor analysis and multilevel modeling to answer the following research questions: Did students' perceptions of science self-efficacy improve as a result of participation in a culturally responsive curriculum, and in particular for Hawaiian participants? Did being exposed to the curriculum result in significant gains in students' perceptions of pono behaviors, and in particular for Hawaiian participants? Did student's perception of behaviors conducive to learning improve as a result of participation in a culturally responsive curriculum, and in particular for Hawaiian participants?

Confirmatory Factor Analysis

The results of CFA (Figure 3.1) revealed that some of the factor loadings on the *pono behaviors* variable were under .50, which are considered questionable when running the preliminary EFA (Hurley, Scandura, Schriesheim, Brannick, Seers, Vandenberg, & Williams, 1997). However, the CFA also tested the strength of the relationships, and all were deemed to significantly load on the expected factor. The Principle Components Analysis used in EFA may have been a useful starting point, but in some respects was inappropriate because, first, being *exploratory*, one is not supposed to have a preexisting notion of which items load on what factor (so the items drive the factors). However, I had

a good idea of my factors and the items associated with them beforehand; and therefore, it was more appropriate for the factors to be driving the items. Second, factors should not be correlated in Principle Components Analysis, and by referring to the double-headed arrows in Figure 3.1, it was clear that all of the factors overlapped to some extent.

The correlations located on the double-headed arrows in Figure 3.1 can also be referred to in order to illustrate the stability of the relationship between the variables across the three time points of data collection, lending further evidence to the strength and stability of the factors as they are measured over time. The values located to the left of the items showed the residual variance by wave of data collection, or how students differed from each other when responding to each item. Being very stable, they lent further evidence for the strength of the items associated with each factor, suggesting that the scale had strong validity.

The Multilevel Model²

In regards to the Table of Fixed Effects (Table 4.1), the effect of the index variable (*Index1*), a composite score of all three variables, was significant, so the initial means at the intercepts for the three constructs was not zero. This was also corroborated by information in Table 4.2, where the treatment effect (*Treat*) was only .05 higher in the treatment group initially, and not significant ($p > .05$). The GPA times index effect (*Index1*GPA*) showed that at the initial status for all three variables, the effect of GPA was significantly related ($p < .001$), or in other words, students with higher GPAs had higher initial status. The treatment effect (*Treat*) was tested at initial status and the effect was nonsignificant ($p > .05$), meaning that the groups were similar, in respect to the treatment, which was what I expected at the start of the study.

Table 4.1 shows that the index by time interaction ($Index1 * Wave$) was significant at the $p < .05$ level, which suggests that, over time, there was a change in the means of the three constructs relative to initial status at each point in time. The treatment by time interaction ($Index1 * Wave * Treat$) was also significant ($p < .05$), suggesting that, over time, the means of the three constructs in the treatment group changed. Table 4.2 indicates that GPA was related to all three constructs. Grades significantly increased as means rose for *behaviors conducive to learning* ($p < .001$), and *science self-efficacy* ($p < .01$) but for *pono behaviors* the change was positive, but not significant ($p > .05$). This makes intuitive sense, in that if students became more confident to do their science work and started to behave better in class, they would tend to do better in school.

Behaviors Conducive to Learning. The fixed effects in Table 4.2 separates the three variables and tests the effects of the treatment on each construct, indicating that students' initial intercept for perceptions of *behaviors conducive to learning* ($Index 1=1$) was 2.01. With 2 being the value for "usually," when students were asked if they behave well in class the initial answer was affirmative, and the treatment by time effect ($Index1=1 * Wave * Treat$) indicates that by Wave III scores had not significantly increased ($p > .05$) in the treatment group, finishing at roughly 2.07 by the end of the school year. One must keep in mind that these are self-reported perceptions of the students' behaviors, future research would benefit from an observational tool to verify that *behaviors conducive to learning* do not increase as a result of interacting with culturally responsive curricula.

Table 4.2 indicates that in the control group there was a significant decline ($p < .05$) in *behaviors conducive to learning*, ($Index1=1 * Wave$) and Figure 4.1 clearly

illustrates the interaction effect between treatment and control paths, where, up until Wave 2, both groups were on a parallel negative trajectory, but students' scores in the treatment group lagged at mid-year and started to move in the positive direction over the second half of the year. Perhaps, if there was a fourth time point in the model, the trajectory of the means in the treatment group may have brought levels into significance. The control group scores continued to plummet, which is an important finding. Perhaps this decline in behavior was a direct result of students trying to learn material that was disconnected from the culture where the learning was taking place. It may be that students, when coming into contact with a school system and curricula that was not rooted in their prior knowledge or consistent with their values and norms, decided to "shut down," and their behavior subsequently deteriorated.

An encouraging finding was that there were strong, positive correlations (Figure 3.1) between *behaviors conducive to learning* and *pono behaviors* (.73 Wave I, .63 Wave II, .78 Wave III) as well as between those two constructs and *science self-efficacy* (.69 Wave I, .56 Wave II, .69 Wave III) at each time point in the treatment condition. This implies that, when culture is addressed in school curricula, behaviors deemed as correct by Hawaiians and those behaviors and attitudes that help students succeed in school become related, suggesting that the "cultural mismatch" between home and school cultures (Darvill, 1981, Kawakami, 1999) may not be insurmountable.

The effect of Hawaiian ethnicity was tested and it had little to do with students' initial feelings of *behaviors conducive to learning*. There was very little effect of *Hawaiian ethnicity x time*, suggesting that the answer would be "no" to both parts of the research question; "*Did students' perceptions of behaviors conducive to learning improve*

as a result of participation in the culturally responsive curriculum, and in particular for Hawaiian participants?”

Pono Behaviors. Students' initial *pono behaviors* ($Index1=3$) intercept was 1.51 (Table 4.2), which can be considered the students' true initial status adjusted for GPA and treatment effect. The key parameter in the model is the *treatment* by *wave* effect, ($Index1=3 * Wave * Treat$) where the effect found for the treatment group by time was significant ($p < .05$). Figure 4.3 illustrates that student reports of frequency of *pono behaviors* in the treatment group significantly increased in the expected direction over time, with an increase in value of roughly .07 at each time of data collection, this suggests that students' average scores in the treatment condition went up to 1.65 in perceived frequency of *pono behaviors* by the end of the school year. At the start of the school year students reported values between “sometimes” (=1) and “usually” (=2) and students reported values closer to “usually” by the end of the school year.

These findings suggest that the answer to the first part of the research question; *Did exposure to the curriculum result in significant gains in students' perceptions of pono behaviors, and in particular for Hawaiian participants?* was “yes.” As with other the findings so far, I found that Hawaiian ethnicity had very little to do with students' initial feelings of *pono behaviors*, and there was very little effect of *ethnicity* by *time*. So the answer to the second part of this research question would unfortunately be “no.” Why might this have been? Proponents of culturally responsive education make the point that no matter what culture is the focus, culturally responsive education can be effective for students from all ethnic backgrounds, and can be just as important for middle-class Whites as it is for ethnically diverse students because such curricula fosters the

overarching goals of the commonwealth (Banks, 2004; Gay, 2010). However, with only two percent of the sample being Caucasian, it would be inappropriate to generalize the effects the curriculum had for “White students.” The results did suggest that it was effective for the 48% of the sample reporting that they identified, at least in part, with a culture other than Caucasian or Hawaiian.

That the curriculum was associated with positive outcomes for all students, regardless of ethnicity, is consistent with positive results of culturally based education reported in the literature (Au & Kawakami, 1994; Hollins 1996; Boyer, 2006, Chinn, 2003; Chinn & Silva, 2000; Kana‘iaupuni et al., 2010; Kaneshiro, Chinn, Kristin, Duin, Hood, Maly & Wilco, 2003; Meyer, 2003; Suryanata, & Umemoto, 2002; Yamauchi, Billig, Meyer, & Hofschire, 2006). Furthermore, by addressing and measuring behaviors valued by the Hawaiian community, we are able to illustrate how -and the degree to which- these behaviors are related to behaviors that help students to do well in the classroom as well as feelings of being able to do their science work.

This highlights a valuable contribution to the literature because previously the frequency of Hawaiian cultural behaviors in the classroom has not been addressed in other studies. Previous studies found that culturally responsive curriculum helped students in Hawai‘i to become more connected to their school and community (Kana‘iaupuni et al., 2010; Yamauchi et al., 2006), improved students’ self-efficacy (Kana‘iaupuni et al., 2010), and enhanced social relationships. Culturally responsive curricula was also related to increased Hawaiian cultural affiliation, and school motivation (Kana‘iaupuni et al., 2010). However, this study was one of the first to explore the ways in which culturally responsive curriculum affected behaviors deemed

correct by the Hawaiian community. More importantly, it measured these behaviors in the context of a school setting.

Furthermore, this research validated an instrument (the CRSP inventory) that educators can utilize to measure the degree to which their students are behaving in a *pono* manner, and relates this to *behaviors conducive to learning* and *science self-efficacy*. While the second part of the research question pertaining to the culturally responsive curriculum being more beneficial to Hawaiian students was not found to be supported, this does suggest that curricula grounded in the Hawaiian culture can benefit both Hawaiian and non-Hawaiian students alike, something that most curriculum developers, with the exception of the *Kūkulu Nā Uapo* (CDS, 2005), have failed to address. Although the curriculum is responsive to Hawaiian culture, it is relative to all students' interests and experiences living in Hawai'i, whether Hawaiian or 'local.' This may be because the *Ka Hana 'Imi Na'auao* curriculum, like *Kūkulu Nā Uapo*, encourages all children to learn more about themselves, their world and their sense of place in their world.

Science Self-Efficacy. For the *science self efficacy* variable (Index 1=2), Table 4.2 indicated that students' initial *science self-efficacy* intercept was 1.45, which can be considered students' true initial status adjusted for GPA and treatment effect. When examining the *treatment* by *wave* effect, where there was a significant interaction effect ($p < .05$) found for the treatment group by wave with an increase in value of .06 at each time of data collection after establishing the baseline, significantly increasing students' average scores in the treatment condition to up to 1.57 in *science self- efficacy* by the end of the school year, bringing them to between the value for "sometimes" (=1) and "usually" (=2) at the start of school, getting closer to "usually" by the end of the school

year. This suggests that the answer is “yes” to the first part of the research question; “*Did students’ perceptions of science self-efficacy improve as a result of participation in a culturally responsive curriculum, and in particular for Hawaiian participants?*”

These results are consistent with earlier findings regarding the positive effects of culture-based instruction on self-efficacy beliefs in the classroom (Au & Kawakami, 1994; Hollins 1996; Boyer, 2006, Chinn, 2003; Chinn & Silva, 2000; Kana‘iaupuni et al., 2010; Kaneshiro et al., 2003; Suryanata, & Umemoto, 2002; Kana‘iaupuni, Malone, & Ishibashi, 2005; Yamauchi, Billig, Meyer, & Hofschire, 2006). This longitudinal study adds a valuable contribution to the literature by providing a richer picture that illustrates students’ changing attitudes as they progress throughout the school year, compared to most cross-sectional studies that provide only one “snapshot” in time (Kana‘iaupuni et al., 2010). However, I saw that *Hawaiian ethnicity* was not significantly related to students’ initial feelings of *science self-efficacy*, nor was there an effect of *ethnicity x time*, so the answer to the second part of this research question is “no.”

Consistent with the findings of *pono behaviors*, this study indicates that the effects of the treatment on *science self-efficacy* benefited both Hawaiian and non-Hawaiian students. This can be interpreted in two ways: it was unfortunate that I was wrong in thinking that Hawaiians would benefit the most from the curriculum, but on the other hand, it suggests that, students of all ethnicities can profit from culturally responsive curricula when going to school in Hawai‘i, perhaps because it helps students to know and praise their own culture; as well as their fellow students’ cultural heritages (Gay, 2010).

Although Hawaiian students in the treatment condition did not have higher gains compared to their non-Hawaiian peers, they did make significant gains compared to those students in the control group receiving the more typical curriculum. This suggests that bringing the Hawaiian culture into the classroom may have helped to bridge the gap between student's home and school cultures (Au & Kawakami, 1994; Hollins 1996; Suryanata, & Umemoto, 2002), making students more confident in their ability to do their science work. These study findings also suggests that, as students elicit gains in science self-efficacy; they also see significant gains in their overall GPA. These findings are consistent with the social cognitive theory of Bandura (1986, 1989a, 1989b, 1993, 1995, 1997). Bandura argued that self-efficacy beliefs are often better predictors of academic success compared to objective assessments of ability.

Besides science self-efficacy, students' perceptions of their behaviors conducive to learning were also related to significant gains in overall GPA. This gives further validation to Bandura's (1986, 1989a, 1989b, 1993, 1995, 1997) theory, in that he conceptualized that self-efficacy is established through a dynamic interplay between behaviors, individual perceptions, and the external environment. Perhaps the culturally responsive external classroom environment influenced behavior as well as efficacy beliefs, which in-turn resulted in greater academic success.

It is my hope that these gains persist beyond high school, such that Hawaiian students may be more open to studying STEM pursuits after graduating high school and entering college (Chemers et al., 2011). These findings are another indication that Hawaiian schools, with curricula based on individualist beliefs are not serving the best interests of students in Hawai'i who come from a more collectivist orientation (Trumbull

et al., 2001; Yamauchi, 1998). Indeed, it may be deduced that such a design has the HDOE forcing a “pressure cooker” model of assimilation (Berry, 1990) in Hawaiian schools, placing added stress on students, especially those from ethnically diverse backgrounds.

A growing body of work on “stereotype threat” suggests that negative stereotypes and expectations for one’s social group can engender anxiety, poor performance, and withdrawal from situations that make the threat salient (Steele & Aronson, 1995). This “threat” may be part of the increasing perceptions of obstacles and barriers that face minority students in Hawai‘i. Perhaps the infusion of culture in the classroom engenders a greater sense of efficacy to do their science work, diminishing this perceived threat.

This is not to say that elements of science from the continental US should be left out in favor of Hawaiian epistemology, in keeping with American Indigenous and Native Hawaiian perspectives (Kaiwi & Kahumoku III; 2006; Kanahele, 2009; Renner & Merek, 1998), both indigenous and other viewpoints should be integrated in the classroom, starting with the indigenous perspective and then making connections to the different perspectives of the continental US and the rest of the world. In this way, students are afforded an opportunity to use their prior knowledge when forming new concepts about science, something very important from a sociocultural point of view (Moll, Diaz, Estrada, & Lopes, 1992; Vygotski, 1978) as well as from a context-dependent perspective, because learning is situated, or located in a sense of place (Kawakami, 1999).

From another theoretical standpoint, perhaps this culturally relevant classroom environment help students to adopt an acculturation strategy more akin to Berry's (1990; 1997) integration model, where individuals wish both to maintain their primary culture and to function fully in the dominant culture. In the past, students were asked to leave "Hawaiian-ness" behind to adopt an assimilated coping strategy originally suggested (enforced?) by the US government (e.g. by banning the use of the Hawaiian language in school), perhaps, when students are given the opportunity to "live in both worlds," by learning a curriculum that is responsive to their culture, they are able to thrive academically. But in my thinking, the model is not static. People's attitudes change from place to place and from situation to situation. A student may feel more assimilated in the morning before he or she leaves the house, and then may have a more integrated mindset once they get to school. This line of thought is consistent with Reed's conceptualization (2001), that individuals wear different "hats," or "code switch" when moving to different situations.

However, if the curriculum students are learning is more responsive to the Hawaiian culture, perhaps students living in Hawai'i have less "code-switching" to do. Or rather, when the subject matter is more in line with students' prior knowledge, and as Kaiwi and Kahumoku III (2006), Kanahale (2009), and Renner and Merek (1998) suggest, this knowledge can be utilized as a springboard (*papakū*) for further exploration, moving outwards (*makawalu*) and making connections to other systems of learning. Then the classroom can act as a mediator, where connections can be made between scientific subject matter existing outside of that culture to prior knowledge rooted in the Hawaiian culture. This may help students to "try on different hats." This type of learning

environment may make students less apprehensive and more confident, enabling them to succeed in their science work.

The positive findings of the study suggest that, when science is being learned in Native communities, the culture and land where the learning takes place should be respected and utilized as a starting point for acquiring new concepts. Like Gon (2005), I believe that Western science and Hawaiian culture are compatible, and that this method of teaching children in Hawai'i can be the most effective way to help students do better in school because it offers an effective strategy to help close the gap that may exist between students' home and school cultures. However, I would like to caution educators new to the Hawaiian Islands not to read too much into the bridging cultures theoretical framework by taking it to mean that the "gap" is too far to "bridge," and they may not be able to reach their Hawaiian students -and therefore stop trying. This would be a great injustice. Rather, new teachers to the State should embrace Hawaiian history, values and beliefs, and then utilize that knowledge in the classroom to better teach and reach all their students.

Limitations of the Study

One limitation to this study is that an observational tool was not utilized in order to validate how students behaved in class. Future researchers may benefit from combining the student survey information with observational data in order to validate that the behaviors these students are reporting are an indication of their true behaviors in the classroom. Historically, systematic direct observation has been considered an essential component of behavioral assessment, (Alessi, 1998; Hintze, Volpe, & Shapiro, 2002). This is consistent with best practices of measuring student behavior mentioned in the

literature (Assor & Connell, 1992; O'Malley et al., 2003). Researchers have long questioned the validity of data derived solely from students' self-reports because students' abilities to accurately assess their own behaviors vary; and therefore, direct observation, or a combination of self-reports and observations is preferable when assessing students (Assor & Connell, 1992; O'Malley et al., 2003).

Other limitations included a rather high degree of error variance in *the pono behaviors* variable. Also, I had to make certain assumptions in order for the multi-level model to run. For instance, I had to assume that participants were randomly assigned to treatment and control groups. Also, the assessments were assumed to be made at equal intervals in all conditions -neither of which were the case. Future longitudinal studies would benefit from a more rigorous, randomized design. However, this brings up ethical concerns because although internal validity would be better addressed, researchers would have to possibly turn away students who may benefit from the curriculum.

I had hoped that the correlations between *pono behaviors*, *science self-efficacy* and the *behaviors conducive to learning* variables would become stronger over time as students became more familiar with the culturally responsive curriculum and the Hawaiian culture. In other words, as students started to behave in a more culturally appropriate manner, it was hoped that this would lead to better behavior in class, which might lead to becoming more confident in their abilities to do their classwork in science. In this way I hoped to provide evidence that the curriculum could help bridge the gap between home and school cultures. This was not the case. The two correlations decreased at Wave II before coming back to the same level between *pono behaviors* and *science self-efficacy*. However, there was a slight increase in the relationship between *pono*

behaviors and *behaviors conducive to learning*, from an alpha of .73 to .78, lending some evidence for this notion. In future research, an item should be included in the survey itself, asking students the degree to which they agree that participation in a culturally responsive curriculum does indeed bridge that gap.

Implications for Future Research

One over-arching conclusion can be drawn from the data. When curriculum developers in Hawai‘i are more culturally conscious, centering material and activities on children learning more about themselves, their world and their sense of place in their world, it may benefit all learners, not just those for whom the curriculum was targeting. This provides implications for future research. First, the issues surrounding students’ self-efficacy to pursue their academic work, especially for Hawaiian students learning science is a concern that warrants further attention. Second, this study provides valuable information regarding the relationship between behaviors valued as correct by the Hawaiian community and the behaviors and attitudes that spell success in school.

These positive results are indicative of the need for the HDOE, especially in these days of high-stakes assessments, to provide more student-centered, culturally responsive curricula to public schools in order to better meet the demands placed on schools endeavoring to raise test scores. Educators would also benefit from additional observational instruments to be created that directly relate to how students behave and learn in Hawai‘i public schools. Further research on the effects of these recommendations would be pertinent, especially the implementation of more longitudinal research that examines how students in Hawai‘i respond to curricula that is more relevant to them.

References

- Alessi, G. (1998). Direct observation methods for emotional/behavior problems. In E.S. Shapiro & T.R. Kratochwill (Eds.), *Behavioral assessment in schools: Conceptual foundations and practical applications* (pp. 14–75). New York: Guilford.
- Assor, A., & Connell, J.P. (1992). The validity of students' self-reports as measures of performance-affecting self-appraisals. In D. H. Schunk & J. Meece (Eds.), *Student perceptions in the classroom* (pp. 25-46). Hillsdale, NJ: Lawrence Erlbaum.
- Au, K. H., & Kawakami, A.J. (1994). Cultural congruence in instruction. In E. R. Hollins, J. E. King, & W. C. Haymen (Eds.), *Teaching diverse populations: Formulating a knowledge base* (pp. 5-24). Albany: State University of New York Press.
- Augustine, N. R. (2005). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Retrieved from: <http://www.commerce.senate.gov/pdf/augustine-031506.pdf>
- Ballenger, C. (1997). Social identities, moral narratives, scientific argumentation: Science talk in a bilingual classroom. *Language and Education, 11*, 1-14.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman and Company.
- Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In Bandura (Ed.), *Self-efficacy in changing societies* (pp. 1-45). Cambridge: Cambridge University Press.
- Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychology, 28*, 117–48.

- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.
- Bandura, A. (1989a). Regulation of cognitive processes through perceived self-efficacy. *Developmental Psychology*, 25, 729-735.
- Bandura, A. (1989b). *Multidimensional scales of perceived self-efficacy*. Unpublished test, Stanford University, Stanford, CA.
- Banks, J.A. (2004). Multicultural education: Historical development, dimensions, and practice. In J. A. Banks & C. A. M. Banks (Eds.) *Handbook of research on multicultural education* (2nd ed., pp. 3-29). San Francisco, Jossey-Bass.
- Berry, J.W. (1997). Immigration, acculturation, and adaptation [Electronic version]. *Applied Psychology: An International Review*, 46 (1), 5-34.
- Berry, J.W. (1990). Psychology of acculturation: Understanding individuals moving between cultures. In R. W. Brislin (Ed.), *Applied cross-cultural psychology*, (pp. 232-253). Newberry Park, CA: Sage.
- Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, 17(4), 369 – 386.
- Bong, M. (2001). Between- and within-domain relations of academic motivation among middle and high school students: self-efficacy, task value, and achievement goals. *Journal of Educational Psychology*, 93, 23-34.
- Bong, M., & Skaalvik, E.M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review*, 15, 1–40.
- Bordogna, J. (2003). *Next -Generation engineering: innovation through integration*. NSF technical report, 98-92.

- Bowditch, S., Roberts, K. D., & Galloway, L. (2012). Bridging the gap between home and school cultures in Hawai‘i. Unpublished manuscript. Honolulu: University of Hawai‘i .
- Boyer, P. (2006). It takes a Native community: Educators reform schools in an era of standards. *Tribal College Journal of American Indian Higher Education*, 17(4), 14-19.
- Britner, S.L., & Pajares, F. (2006). Sources of Science Self-Efficacy Beliefs of Middle School Students. *Journal of Research in Science Teaching*, 43(5), 485-499.
- Britner, S.L., & Pajares, F. (2001). Self-efficacy beliefs, motivation, race, and gender in middle school science. *Journal of Women and Minorities in Science and Engineering*, 7, 271–285.
- Bryk, A.S., & Raudenbush, S.W. (1992). *Hierarchical linear models*. Newbury Park, CA: Sage.
- Bryk, A.S., & Raudenbush, S.W. (1987). Application of hierarchical linear models to assess change. *Psychological Bulletin*, 101, 147-158.
- Center for Institutional Data Exchange Analysis. (2000). *1999–2000 SMET retention report*. Norman, OK, University of Oklahoma.
- Center on Disability Studies. (2005). “*Kukulu Na Uapo–Building Bridges a 6th grade Physical Science Curriculum*. Honolulu, HI: University of Hawai‘i.
- Center on Disability Studies. (2006). *Science in Hawai‘i: Nā Hana Ma Ke Ahupua‘a – A Culturally Responsive Curriculum*. Honolulu, HI: University of Hawai‘i.
- Center on Disability Studies. (2007). *Science in Hawai‘i: Ka Hana ‘Imi Na ‘auao – A Culturally Responsive Curriculum*. Honolulu, HI: University of Hawai‘i.

- Center on Disability Studies. (2007). *Science Career Interest (SCI) inventory*. Honolulu, HI: University of Hawai'i.
- Chapman, A., Davidson, A., & Panet, C. (2002). *Cultural crisis in education*. St. Paul, MN: Edchange. Retrieved from www.edchange.org/multicultural/papers/culturalcrisis.html
- Chambers, D. W. (1999). Seeing a world in a grain of sand: Science teaching in multicultural context. *Science and Education*, 8, 633-644.
- Chemers, M.M., Hu, L., & Garcia, B.F. (2001). Academic self-efficacy and first-year college student performance and adjustment. *Journal of Educational Psychology* 2001, 93(1), 55 – 64.
- Chemers, M.M., Zurbriggen, E.L., Syed, M., Goza, B.K, & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues*, 67(3), 469-491.
- Chinn, P.W.U. (2008). Connecting traditional ecological knowledge and Western science. The role of Native Hawaiian teachers in sustainability science. In Rodriquez A. J. (Ed.) *The multiple fasces of agency, Innovative strategies for effecting change in urban school contexts* (pp. 1-27). Rotterdam, Netherlands: Sense Publishers.
- Chinn, P.W.U. (2003). Preparing science teachers for culturally diverse Students: Developing cultural literacy through cultural immersion, cultural translators and to communities of practice. *Cultural Studies of Science Education*, 1(2), 367-402.
- Chinn, P.W.U., & Silva, T. (2002). *Pikoi ke kaula kualena, Focus on the essential core: Developing culturally relevant, standards-based science curricula for teachers of*

- Hawaiian and part Hawaiian students*. US Department of Education, Office of K-12 Education Programs under Native Hawaiian Education Act.
- Council of Graduate Schools. (2007). Graduate education: The backbone of American competitiveness and innovation. *A report from the council of graduate schools advisory committee on graduate education and American competitiveness*. Washington, DC: Council of Graduate Schools.
- Curran, P. J., & Muthen, B.O. (1999). The application of latent curve analysis to testing developmental theories in intervention research. *American Journal of Community Psychology, 27*(4), 567-594.
- D'Amato, J.D. (1988). "Acting": Hawaiian children's resistance to teachers. *The Elementary School Journal, 88*(5), 529-544.
- Darvill, J. (1981). KEEP Kamehameha early education program: How did it happen? Educational Perspectives: *The Journal of the College of Education at the University of Hawai'i, Mānoa, 20*, 3-4.
- Dela Cruz, K.C.K., Salzman, M.B., Brislin, R., & Losch, N. (2006) Hawaiian attributional perspectives on intercultural interactions in higher education: Development of an intercultural sensitizer. *International Journal of Intercultural Relations, 30*, 119-140.
- Epstein, D., & Miller, R. (2011). *Slow off the mark: Elementary school teachers and the crisis in science, technology, engineering, and math education*. Washington, DC: Center for American Progress.
- Francis, D.J., Fletcher, J.M., Stuebing, K.K., Davidson, K.C., & Thompson, N.M. (1991). Analysis of change: Modeling individual growth. *Journal of Consulting and Clinical Psychology, 59*, 27-37.

- Francis, D.J., Schatschneider, C., & Carlson, C.D. (2000). Introduction to growth curve analysis. In Drotar's (Ed.) *Handbook of Research in Pediatric and Clinical Psychology*, (pp. 51-73). New York: Kluwer Academic/Plenum Publishers.
- Friary, N., & Bendure, G. (2003). Facts about Oahu. In *Oahu* (pp. 11-33). Victoria, Australia: Lonely Planet Publications.
- Gallas, K. (1994). *The languages of learning: How children talk, write, dance, draw, and sing their way into understanding the world*. New York: Teachers College Press.
- Gay, G. (2010). Pedagogical potential of cultural responsiveness. In Banks, J. A. (Ed), *Culturally Responsive Teaching: Theory, Practice and Practice* (2nd edition, pp 24-47). New York: Teachers College Press.
- Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education*, 53, 106-116.
- Gilbert, G.S. (2011). Developing culturally based science curriculum for Native American classrooms. In Reyhner, J., Sakiestewa, G., & Lockard, L. (Eds.). *Culturally appropriate approaches for teaching indigenous students* (pp. 43-55). Flagstaff AZ: Northern Arizona University Press.
- Greenfield, P.M. (1994). Independence and interdependence as developmental scripts: Theory, research, and practice. In P. M. Greenfield & R. R. Cocking (Eds.), *Cross-cultural roots of minority child development* (pp. 1-37). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Goldstein, H. (1996). Consistent estimators for multilevel generalised linear models using an iterated bootstrap. *Multilevel Modelling Newsletter*; 8(1), 3–6.
- Goldstein, H. (1986). Multilevel mixed linear model analysis using iterative generalized least squares. *Biometrika*, 73, 43–56.

- Gon, S.O. (2005) *Hawaiian Science: Are science and culture compatible?* Retrieved from <http://www.fukubonsai.com/M-L9d.html>
- Gordon, M.M. (1964). *Assimilation in American life: The role of race, religion, and national origins*. New York: Oxford University Press.
- Hawai'i Department of Education. (2005). *Marcopolo, Hawai'i resources for students and teachers*. Retrieved, from <http://www.k12.hi.us/~tlct/marcopolo/curriculum/hawaiiresources.htm>
- Hawai'i Department of Education. (2003). *Raising our expectations, no child left behind, public schools of Hawai'i*. Retrieved from http://netserver.net/doe/website/livefiles/science_rollout1_training_25.4.ppt
- Haycock, K. (2001). Closing the achievement gap. *Educational Leadership*, 58(6) 6-12. Retrieved April 11, 2012, from <http://www.ascd.org/readingroom/edlead/0103/haycock.html>
- Heck, R. H., Thomas, S. L., & Tabata, L. (2011). *Multilevel modeling of categorical outcomes with IBM SPSS*. New York: Routledge/Taylor & Francis Group.
- Hewitt, K. (2003). "I Neva Pass": Stories of Native Hawaiian students as they prepare to become teachers. *Pacific Educational Research Journal*, 12, 21-42.
- Hintze, J.M., Volpe, R.J., & Shapiro, E.S. (2002). Best practices in the systematic direct observation of student behavior. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology IV* (pp. 993–1006). Bethesda, MD: National Association of School Psychologists.

- Hollins, E.R. (1996). *Culture in school learning*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Howe, C., & Mercer, N. (2007). *Children's social development, peer interaction and classroom learning* (Primary Review Research Survey 2/1b). Cambridge, UK: University of Cambridge Faculty of Education.
- Hox, J. J. (2010). *Multilevel analysis: Techniques and applications* (2nd Edition). New York: Routledge.
- Hu, L.T., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.
- Hurley, A.E., Scandura, T.A., Schriesheim, C.A., Brannick, M.T., Seers, A., Vandenberg, R.J., & Williams, L.J. (1997). Exploratory and confirmatory factor analysis: guidelines, issues, and alternatives. *Journal of Organizational Behavior, 18*, 667-683.
- Hurtado S., Cabrera N.L., Lin M.H., & Espinosa, L.L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Research in Higher Education, 50*(2), 189–214.
- Hurtado, S., Han, J.C., Sa'enz, V. B., Espinosa, L.L., Cabrera, N.L., & Cerna, O.S. (2007). Predicting transition and adjustment to college: Minority biomedical and behavioral science students' first year of college. *Research in Higher Education, 48*(7), 841–887.
- Irwin, E.P. (1924, December). Ed Irwin more than suggests that we should not try to "Americanize" Orientals in Hawaii, even if we can. *Paradise of the Pacific*,

- pp. 54-56. Article obtained from J. Friedson (Ed.), *The shaping of modern Hawaiian history, towards greater equality* (pp. 7-10). Honolulu, HI: Curriculum Research and Development Group, University of Hawai'i.
- Johnson, A.C. (2007). Unintended consequences: How science professors discourage women of color. *Science Education*, 91(5), 805-821.
- Kaestle, C.F. (1990). *Pillars of the republic: Common schools and American society, 1780-1860*. New York: Hill & Wang, Inc.
- Kaiwi, M.A.K., & Kahumoku III, W. (2006). Makawalu: Standards, curriculum, and assessment for literature through an indigenous perspective. *Hulili, Kamehameha Schools Journal of Multidisciplinary Research on Hawaiian Well-Being*, 3, 183-206.
- Kanahele, P. (2009) *Papakū Makawalu, an ancient system of Hawaiian knowledge*. Taped lecture retrieved from <http://vimeo.com/4621142>.
- Kana'iaupuni, S.M., & Ishibashi, K. (2003). *Left behind: The status of Hawaiian students in Hawai'i public schools*. Honolulu, HI: Kamehameha Schools, PASE.
- Kana'iaupuni, S.M., & Kawai'ae'a, K. (2008). E Lauhoe Mai Na Wa'a: Toward a Hawaiian indigenous education teaching framework. *Hulili: Kamehameha Schools Journal of Multidisciplinary Research on Hawaiian Well-Being*, 5, 67-90.
- Kana'iaupuni, S., Ledward, B., & Jensen, U. (2010). *Culture-based education and its relationship to student outcomes*. Honolulu, HI: Kamehameha Schools, Research & Evaluation.
- Kana'iaupuni, S., Malone, N., & Ishibashi, K. (2005). *Findings from the 2005 Native Hawaiian assessment, March 2005*. Retrieved from http://www.ksbe.edu/pase/pdf/Reports/Demograph_Well-Being/04_05_29.pdf
- Kaneshiro, K.Y., Chinn, P., Kristin N., Duin, K.P., Hood, A.P., Maly, K., & Wilco, B.A. (2003). Hawai'i's mountain-to-sea ecosystems: Social-ecological microcosms for

- sustainability science and practice. *Earth and Environmental Science EcoHealth*, 2(4), 349-360.
- Kawakami, A. J. (1999). Sense of place, community, and identity, bridging the gap between home and school for Hawaiian students. *Education and Urban Society*, 32, 18-40.
- Kawakami, A. J., & Au, K.H. (1998). Culture, control, and community in the education of Hawaiian children. In P. Smagorinski (Chair), *Ethical dilemmas of "culturing the children."* Exploring the consequences of designing social features through education. Symposium conducted at the annual meeting of the American Educational Research Association, San Diego, CA.
- Kawakami, A. J., & Pai, N. (2005). The Mo'olelo (Story) of Teachers Learning and Teaching Hawaiian Culture and Space Science: New Opportunities Through Minority Initiatives in Space Science (NOMISS) *Hūlili: Multidisciplinary Research on Hawaiian Well-Being*, 2(1), 47-72.
- Kubli, F. (2005). Science teaching as a dialogue -Bakhtin, Vygotsky and some Applications in the classroom. *Science and Education*, 14, 501-534.
- Laosa, L. (1999). Intercultural transitions in human development and education. *Journal of Applied Developmental Psychology*, 20(3), 355-406.
- Lau, S., & Roeser, R.W. (2002). Cognitive abilities and motivational processes in high school students' situational engagement and achievement in science. *Educational Assessment*, 8, 139-162.
- Leach, J., & Scott, P. (2003). Individual and sociocultural views of learning in science education. *Science and Education*, 12, 91-113.

- Ledward, B.C. (2007). On Being Hawaiian Enough: contesting American Racialization with Native Hybridity. *Hūlili: Multidisciplinary Research on Hawaiian Well-Being*, 4, 107-146.
- Lee, O. (2002). Science inquiry for elementary students from diverse backgrounds. In W. G. Secada (Ed.), *Review of Research in Education*, 69, 83-115.
- Lee, O., Deaktor, R.A., Hart, J.E., Cuevas, P., & Enders, C. (2005). An instructional intervention's impact on the science and literacy achievement of culturally and linguistically diverse elementary students. *Journal of Research in Science Teaching*, 42(8), 857-887.
- Lent, R.W., Brown, S.D., & Gore, P.A. Jr. (1997). Discriminant and predictive validity of academic self-concept, academic self-efficacy, and mathematics-specific self-efficacy. *Journal of Counseling Psychology*, 44(3), 307-315.
- Leyland, A.H. (2004). A review of multilevel modelling in SPSS. Retrieved on November 13, 2005 from <http://stat.gamma.rug.nl/reviewsspss.pdf>
- Loving, C.C. (1998). Cortes' multicultural empowerment model and generative teaching and learning in science. *Science and Education*, 7, 533-552.
- Maton, K.I., Kohout, J.L., Wicherski, M., Leary, G.E., & Vinokurov, A. (2006). Minority students of color and the psychology graduate pipeline: Disquieting and encouraging trends, 1989-2003. *American Psychologist*, 61(2), 117-131.
- Marcoulides, G.A. & Hershberger, S. (1997). *Multivariate Statistical Methods: A First Course*. Mahwah, NJ: Lawrence Erlbaum.
- Marsh, H.W., Balla, J.R., Hau, K.T. (1996). An evaluation of incremental fit indices: A clarification of mathematical and empirical properties. In G. A. Marcoulides and

- R. E. Schumacker (Eds.) *Advanced Structural Equation Modeling: Issues and Techniques* (pp. 315-353), Mahwah, NJ: Lawrence Erlbaum.
- McArdle, J. J. (1986). Latent variable growth within behavior genetic models. *Behavior Genetics*, *16*, 163-200.
- Mento, B., Sorkin, S., & Prettyman, T. (2008). Encouraging Women and Minorities to Attain Degrees in Computing and Related Fields. *Information Systems Education Journal*, *6* (13). Retrieved from <http://www.isedj.org/6/13/ISEDJ.6%2813%29.Mento.pdf>
- Meredith, W., & Tisak, J. (1990). Latent curve analysis, *Psychometrika*, *55*, 107-122.
- Meyer, R.E. (2003). *Learning and instruction*. Upper Saddle River, NJ: Merrill.
- Meyer, M. (2012). *Moving to Hawai'i: A step-by-step guide*. Broomfield, CO, Boise, ID, Clickbook.
- Minerbi, L., McGregor, D., & Matsuoka, J. (Eds), (1993). *Native Hawaiian and local cultural assessment project (phase I problems? assets identification)*. Honolulu: University of Hawaii at Manoa.
- Moll, L.C., Diaz, S., Estrada, E., & Lopes, L. M. (1992). Making contexts: The social construction of lessons in two languages. In M. Sarvia-Shore & S. F. Arvizu (Eds.), *Cross-cultural literacy: Ethnographies of communication in multicultural classrooms* (pp. 339-366). New York: Garland.
- National Center for Education Statistics. (2010). *National Assessment of Educational Progress*. Retrieved from <http://nces.ed.gov/nationsreportcard/>
- National Science Foundation, Division of Science Resources Statistics. (2007). *Women, minorities, and persons with disabilities in science and engineering*. Washington, DC: National Science Foundation.

- Native Hawaiian Education Council. (2006). *Nā Honua Mauli Ola, Hawai‘i guidelines for culturally healthy and responsive learning environments* (1st ed.). Hilo HI: University of Hawai‘i at Hilo.
- Native Hawaiian Education Council. (2002). *Nā Honua Mauli Ola, Hawai‘i guidelines for culturally healthy and responsive learning environments* (2nd ed.). Hilo, HI: University of Hawai‘i at Hilo.
- Nicholas, D. (1997). Making more minority scientists. *Environmental Health Perspectives, 105*(2), 174–177.
- Oakes, J., & Lipton, M. (1999). Contemporary learning theories: Problem solving and understanding. In J. E. Vaicuras (Ed.) *Teaching to change the world* (pp. 66-94). Boston, MA: McGraw-Hill College.
- Ogbu, J. U. (1994). Cultural frame of reference. In P. M. Greenfield & R. R. Cocking (Eds.), *Cross-cultural roots of minority child development* (pp. 354-389). Hillsdale, NJ: Lawrence Erlbaum Associates.
- O'Malley, K.J., Moran, B.J., Haidet, P., Seidel, C.L., Schneider, V., Morgan, R.O., Kelly P.A., & Richards, B. (2003). Validation of an observation instrument for measuring student engagement in health professional settings. *Evaluation & Health Professions, 26*(1), 86-103.
- The Pacific Basin Information Node. (2005). *Linking you to the learning opportunities in the Pacific basin*. Retrieved from <http://pbin.nbii.gov/educaion/indexasp>
- Pajares, F. (1997). Current directions in self-efficacy research. In M. Maehr & P. Pintrich (Eds.), *Advances in motivation and achievement, 10*, (pp. 1–49). Greenwich, CT: JAI Press.

- Pajares, F., & Valiante, G. (1997). Influence of self-efficacy on elementary students' writing. *The Journal of Educational Research, 90*, 353–360.
- Piaget, J.C., Margaret (Trans), (1952). *The origins of intelligence in children*. New York, NY: W. W. Norton & Co.
- Reed, G. G. (2001). Fastening and unfastening identities: negotiating identity in Hawai'i. *Discourse: Studies in the Cultural Politics of Education, 22*(3) 327-339.
- Renner, J.W., & Merck, E.A. (1988). *The learning cycle and elementary school science teaching*. Portsmouth, NH: Heinemann.
- Rogosa, D.R. (1988). Myths about longitudinal research. In K. W. Schaie, R. T. Campbell, W. Merideth, & S. C. Rawlings (Eds.), *Methodological issues in aging research*. New York: Springer.
- Rogosa, D.R., Brandt, D., & Zimowski, M. (1982). A growth curve approach to the measurement of change. *Psychological Bulletin, 92*(3), 726-748.
- Rogosa, D.R., & Willett, J.B. (1985). Understanding correlates of change by modeling individual differences in growth. *Psychometrika, 50*, 203-228.
- Rosebery, A., McIntyre, E., & Gonzalez, N. (2001). Connecting students' cultures to instruction. In E. McIntyre, A. Rosebery, & N. Gonzales, (Eds.), *Classroom diversity: Connecting curriculum to students' lives* (pp. 1-13) Portsmouth, NH: Heinemann.
- Roth, W.M., & Lucas, K.B. (1997). From "truth" to "invented reality": A discourse analysis of high school physics students' talk about scientific knowledge. *Journal of Research in Science Teaching, 34*, 145- 179.
- Roth, W.M. (1996). Teacher questioning in an open-inquiry learning environment: Interactions of context, content, and student responses. *Journal of Research in*

- Science Teaching*, 33, 709-736.
- Roth, W.M., & Bowen, G.M. (1995). Knowing and interacting: A case of culture, practices, and resources in a Grade 8 open-inquiry science classroom guided by a cognitive apprenticeship metaphor. *Cognition and Instruction*, 13, 73-128.
- Roychoudhury, A., & Roth, W.M. (1996). Interactional processes in a constructivist physics lab. *International Journal of Science Education*, 18, 423-445.
- RMC Research Corporation. (2004). *Evaluation of the Wai'anae High School Hawaiian Studies Program*. Unpublished manuscript. Denver, CO: Author
- Sato, C. (1991). Sociolinguistic variation and language attitudes in Hawai'i. In J. Cheshire (Ed.), *English around the world: Sociolinguistic perspective* (pp.647-663). Cambridge: Cambridge University Press.
- Sato, C. (1989). A nonstandard approach to Standard English. *TESOL Quarterly*, 23(2), 259-280.
- Schunk, D.H. (1985). Self-efficacy and classroom learning. *Psychology in the Schools*, 22, 208-223.
- Shell, D.F., Colvin, C., & Brunning, R.H. (1995). Self-efficacy, attributions, and outcome expectancy mechanisms in reading and writing achievement: grade-level and achievement level differences. *Journal of Educational Psychology*, 87, 386-398.
- Shrag, J., & Johnson, J. (2002). *Suspension study*. Honolulu, HI: Center on Disability Studies Media Center.
- Sing, D.K., Hunter, A., & Meyer, M.A. (1999). Native Hawaiian education: Talking story with three Hawaiian educators. *Journal of American Indian Education*, 39(1), 4-13.

- Steiger, J.H. (2007). Understanding the limitations of global fit assessment in structural equation modeling. *Personality and Individual Differences*, 42(5), 893-98.
- Suryanata, K., & Umemoto, K.N. (2002) Tension at the nexus of the global and local: culture, property, and marine aquaculture in Hawai`i. *Environment and Planning* (35), 199-213.
- Skyllton-Sylvester, E. (2002). Literate at home but not in school. In G. Hull & K. Schultz (Eds.), *School's Out! Bridging out-of-school literacies with classroom practice* (pp. 61-95). New York: Teachers College Press.
- Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, 69, 797 -811.
- Suina, J., & Smolkin, L.B. (1994). From natal culture to school culture to dominant society culture: Supporting transitions for Pueblo Indian students. In P. Greenfield & R. Cocking (Eds), *Cross-cultural roots of minority child development* (pp. 115-130). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Takenaka, C. (1995). A perspective on Hawaiians. *Hawai`i Community Foundation Diversity Project*. Honolulu: Hawai`i Community Foundation.
- Tate, R.L. (2000). Elaboration of HLM growth modeling results. *Florida Journal of Educational Research*, 40, 53-75.
- Tharp, R.G., Jordan, C., Speidel, G.E., & Hu-Pei Au, K. (2007). Education and Native Hawaiian Children: Revisiting KEEP. *Hūlili: Multidisciplinary Research on Hawaiian Well-Being*, 4, 269-318.

- Tharp, R., & Gallimore, R. (1988). *Rousing minds to life: Teaching, learning, learning and schooling in social context*. Cambridge: Cambridge University Press.
- Triandis, H.C. (1989). Cross-cultural studies of individualism and collectivism. In P. M. Greenfield & R. R. Cocking (Eds.), *Cross-cultural roots of minority child development* (pp. 6-15) Hillsdale, NJ: Lawrence Erlbaum Associates.
- Trumbull, E., Rothstein-Fisch, C., Greenfield, P.M. & Quiroz, B. (2001). The bridging cultures framework. In *Bridging cultures between home and school: A guide for teachers* (pp. 1-27). Mahwah, NJ: Earlbaum Publishers.
- U.S. Census Bureau. (2012). *Projections of the Population by Sex, Race, and Hispanic Origin for the United States: 2015 to 2060*. Washington (D. C.): US Census Bureau. Retrieved from <http://www.census.gov/population/projections/data/national/2012/summarytables.html>
- Vosniadou, S., Ioannides, C., Dimitrakopoulou, A., & Papademetriou, E. (2001). Designing learning environments to promote conceptual change in science. *Learning and Instruction, 11*, 381-419.
- Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wells, G. (1999). *Dialogic inquiry: Towards a sociocultural practice and theory of education*. Cambridge: Cambridge University Press.
- Willett, J.B. (1994). Measuring change more effectively by modeling individual growth over time. In T. Husem & T. N. Postlethwaite (Eds.), *The international encyclopedia of education* (2nd ed.) (pp. 213-225). Oxford, England: Pergamon Press.

- Willett, J.B., & Sayer, A.G. (1994). Using covariance structural analysis to detect correlates and predictors of individual change over time. *Psychological Bulletin*, *116*, 363-381.
- Woolfolk Hoy, A.E., & Davis, H.A. (2006). Teacher self-efficacy and its influence on the achievement of adolescents. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (pp. 1–45). Greenwich, CT: Information Age.
- Yamauchi, L.A. (1998) Individualism, collectivism, and cultural compatibility: Implications for counselors and teachers. *Journal of Humanistic Education & Development*, *36*(4), 189 -199.
- Yamauchi, L.A. (2003). Making school relevant for at-risk students: The Wai'anae High School Hawaiian Studies Program. *Journal of Education for Students Placed at Risk*, *8*(4), 379-390.
- Yamauchi, L.A., Billig, S.H., Meyer, S., & Hofschire, L. (2006). Student Outcomes Associated with Service-Learning in a Culturally Relevant High School Program. *Journal of Prevention & Intervention in the Community*, *32*(1/2), 149-164.
- Yamauchi, L.A., & Greene, W.L. (1997). *Culture, gender and the development of perceived academic self-efficacy among Hawaiian adolescents*. Paper presented at the 1997 annual meeting of the American Educational Research Association, Chicago, IL.

Footnotes

¹All students who reported being Native Hawaiian or part Hawaiian were included in the Hawaiian sample.

²Hawaiian ethnicity was included in the first analysis but found to have no significant effect on any of the variables and therefore was omitted from the final model.

Appendix A

The Culturally Responsive Science Perception (CRSP) Inventory

Student Background Information

Student Number _____

Student's Initials ___ Age ___ School _____ Teacher _____ Period ___ Date _____

Gender: Male Female Current grade level: 8th 9th 10th 11th 12th

Course Level: Special Education General Education Honors/Advanced Placement

Ethnicity (Nationality): *Please check all that apply.*

- African/African American
- American Indian/Alaskan Native
- Filipino/Filipino American
- Hispanic/Latino (Mexican, Spanish, Cuban, etc.)
- Native Hawaiian
- Micronesian/Micronesia American
- White (not of Hispanic origin)
- Samoan/Samoan American
- Japanese/Japanese American
- Chinese/Chinese American
- Korean/Korean American
- Part Hawaiian
- Vietnamese/Vietnamese American
- Other: _____

Primary Disability (if any): Physical Developmental Social/Emotional/Behavioral

Other (please specify) _____

Student Rating Form

Researchers at the University of Hawai'i would like you to be in our study. We are asking students about their skills, interests, and how they live day to day. Your opinions are important to us, so we would like you to be honest when filling out this questionnaire. Please mark *one* of the boxes in each row below to show how often you do what is described in the statement on the left.

Your answers will not be shared with your teachers and will not affect your grade

1. I forgive others.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
2. I talk to others to stop	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never

3. I help keep peace in the classroom.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
4. I help keep peace in the classroom.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
5. I try hard to do well in school.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
6. I keep trying, even when things are difficult.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
7. I take the lead in group activities.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
8. I take care of the environment.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
9. I let the teacher know when I know the answer.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
10. I can read and understand the science materials.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
11. I can summarize the lessons the teacher gives me.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
11. I know the math needed to do the class work.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
12. I can solve science problems.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
13. I try to do things correctly.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never

14. I accept it well when people correct me.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
15. I have good skills for managing my time.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
16. I can work by myself.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
17. I do my part when working in a group.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
18. I respect other students.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
19. I respect the teacher.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
20. I go to school all the time.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
21. I take care of the classroom materials and equipment.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
22. I follow classroom rules.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
23. I follow instructions.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never
24. I follow written directions.	<input type="checkbox"/> All the time	<input type="checkbox"/> Usually	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Never

Appendix B

SPSS Syntax Used in the Multi-level Mode

```
MIXED Constructs BY Index1 WITH Wave Treat gpa Hawaiian  
/CRITERIA=CIN(95) MXITER(100) MXSTEP(10) SCORING(1)  
SINGULAR(0.000000000001) HCONVERGE(0,  
ABSOLUTE) LCONVERGE(0, ABSOLUTE) PCONVERGE(0.000001,  
ABSOLUTE)  
/FIXED= Index1 GPA*Index1 treat wave*Index1 treat*index1*wave | NOINT  
SSTYPE(3)  
/METHOD=ML  
/PRINT=G SOLUTION TESTCOV  
/Random = Index1 |Subject(teacher) Covtype (UN)  
/REPEATED=code | SUBJECT(id*Teacher) COVTYPE(CS).
```