INTERSECTION OF OPPOSING PEDAGOGICAL FRAMEWORKS: NATIVE HAWAIIAN ANCESTRAL STORIES AND SCIENTIFIC INQUIRY IN A HIGH SCHOOL SCIENCE CLASS

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ABSTRACT
Inquiry is defined as “an examination into facts and principles.” In science education science inquiry is a process through which important discoveries are made by students through scientific methodology. The most important step in this process is forming the right question. The questions formed by students are usually the wrong questions which deem the remainder of the inquiry process impotent. This research will look at the pedagogy of ancestral stories for a solution. For the researcher, ancestral stories were a source of wonderment and learning not only from the lessons the stories revealed but mainly from the questions that still remained after the stories were told. Questions such as “why does the eel only swim near that part?”, or “why does the story only talk about the uhu?” are examples of questions that remained after experiencing an ancestral narrative. The research questions were composed for the purpose of finding compatibility between the two pedagogies. The first research question which reads how can Native Hawaiian Ancestral stories encourage an increased level of student driven interactions at all levels of feedback from Native Hawaiian students in science classrooms focuses the research on the level of student feedback that initiate questions. Question two which reads “how can teachers of Native Hawaiian students facilitate
the construction of science inquiry projects from ancestral stories addresses the skill of the teacher and imbeds the concept of pedagogical knowledge into the literature. The last research question “how do analysis and discussion of the stories connect Native Hawaiian students to their ancestral intelligence” examines the role of identity and identity to ancestral intelligence. The method intended for this research was Grounded theory which allows the researcher to develop principles, concepts and theories based on the data presented. Another method utilized in this research is an undocumented but culturally imbedded method identified as the Native Hawaiian Research method for lack of a better title. The result of the data analysis was the development of the intersection of story and science that occurs when the story line is stripped away to reveal an interconnection of natural phenomena.
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CHAPTER 1

Introduction

Pelehonuamea was the daughter of Kahinali‘i and Kānehoalani; her sister closest to her in age was named Pelekumulani. Pelehonuamea grew to be quite beautiful and married Wahieloa, a chief of their land. They had two children: Laka, a girl, and a menehune, a small sprite-like creature. Wahieloa later became infatuated with Pelekumulani, Pele’s younger sister. This infatuation caused them to search for a new homeland. For this reason, lava flows outside of Hawai‘i. Pelehonuamea insisted on going to look for her first love. She took her brothers and sisters with her. Pele’s mother provided her and her canoe mates a huge tidal wave in order to move them rapidly from island to island. She landed on a land called Hapakuela, a land not known to us today. When she asked the natives if they had come across any visitors recently, especially a man and a woman, they replied that they had received no visitors for some time. Pele left that land, and a great wave flooded that land and killed every living thing on the land. This action was repeated on the rest of the islands Pele traveled to until she arrived at Mokupapa on Nihoa. Pele took her stick and dug for a suitable home, and every time she dug on every island, she would reach water. This happened time and again until she reached Kīlauea on the island of Hawai‘i. There she made her home in Halema‘uma‘u (Poepoe, 1908/1999).
The Principal Investigator

My ancestral connections begin on Hawai‘i and Maui Island. I am a descendent of the Moku of Ka‘ū and Kohala. I am a keeper of the altar dedicated to Laka. The English translation of my name is Pleiades, a constellation that signifies an important time of the year for Hawaiians. I grew up on the homestead in Keaukaha, a small community on the ocean on the northeast side of the island. I lived in Keaukaha for most of my childhood; I was surrounded by only Hawaiians for the first 13 years of my life. I am one of the fortunate Hawaiians whose parents and grandparents were insistent upon a strong cultural foundation. Due to my education in the traditional practice of Hula, a family practice passed down for five generations, I have been immersed in the language and the stories of my ancestors. My family and my practice supported and encouraged my western educational pursuits. My name is a big reason for my interest in science. At the time, I knew nothing of the prospect of other worldviews of science; therefore, I became a student of a subject in western science called astronomy. Before I could go into the industry, I visited a local school to give a “career day” talk. I was shocked by the lack of positive changes in the school’s science curriculum. I was also astounded by the lack of Hawaiians in the class. I decided that science education was the direction to take. In my years as a physics teacher, I have seen the trends, the mandates, the
initiatives that have been aimed towards promoting Hawaiians in science, including the ‘Ōhi’a Project, Nā Pua No‘eau Gifted and Talented programs, STEM (science, technology, engineering, and math) programs, and a number of DOE federal grants for the recruitment and training of Hawaiian teachers in math and science. These are all great initiatives with a great direction; however, there is work still be done. As an indigenous educator in western science, I am responsible for exposing Hawaiian students to the depth of the scientific intelligence of their ancestors. Our Kupuna (ancestors) needed to be competent observers and record keepers in order to survive, and survive they did for hundreds of years before the white man came. They not only survived; they flourished. The records and documentation of these observations were recorded in stories, poetry, and chants. In my practice of Hula, I realized this at an early age due to the fact that Hula communicates these observations. However, I never connected this concept with western science. In Hula, we become the natural element we are portraying. This is the concept on which this study is built.

*The Intersection of Pedagogies*

This study will investigate two cultural frames of learning and the effect one has on the other through a common discovery strategy of inquiry.
First, this study will explore the indigenous pedagogical phenomenon of ancestral stories. Why study stories? Why use this form of text as a narrative connection to science? Stories are a common link through all indigenous cultures past and present. Stories put events and activities that otherwise would appear as separated and inconsequential in a specific context. Storytelling is one way to organize meaning. Stories develop a context in which the imagination finds content for what is learned (Cajete, 2000). The lessons that I have learned through these transmissions have stayed with me and will be part of my learning forever. Narrative tradition is a distinct intellectual way of knowing and possesses several strengths as a data source such as persistence, duration of observation, time and space perspective, and quantitative data (Snively & Corsiglia, 2000). Indigenous stories envelop effective mental strategies to fix patterns of meaning in memory. In her study of Navajo storytellers, Eder (2007) found that stories carry a change of emotion that greatly enhances the likelihood of retaining the meanings conveyed because memorable events tend to be associated with strong emotion. Narratives of nature that I was told as a child reflect Eder’s study of the Navajo storytellers. Snively and Corsiglia (2000) confirmed the usefulness of indigenous stories by stating, “large numbers of indigenous peoples observe, interpret, and orally report nature exhaustively. Rather than writing about their findings, they may use metaphoric stories to
compress and organize important information so that it can be readily stored and accessed” (p. 17). A growing number of scientists have begun to decode and transcribe interpreted indigenous science knowledge. This knowledge has become a part of the data-gathering process for scientific inquiry employed by modern scientists.

Inquiry is an expected learning objective, according to the Hawai‘i State Content and Performance Standards, from Grade 1. In a review of our state’s science standards, “science inquiry, and the scientific process” are first and foremost on the list of content requirements. Therefore, the expectation for students in Hawai‘i is to master the skills of scientific inquiry. For example, in the second grade, a student is expected to make predictions about the world around him or her based on observation (Department of Education Hawaii, 2008). According to the National Science Education Standards website for Grades 7–12, scientific inquiry will be the focus in America’s science classes. In a successful science classroom, students quite often initiate new activities related to an inquiry, formulate questions and devise ways to answer them, collect data and decide how to represent this information, organize data to generate knowledge, and test the reliability of the knowledge they have generated. Teachers are expected to facilitate inquiry. They provide guidance throughout every step in the inquiry process. In the science classroom envisioned by the
Standards, effective teachers continually create opportunities that challenge students and promote inquiry (National Science Education Standards, 2004). The direction of the culture of “school science” is inquiry and the process of establishing theory through the process of inquiry.

This study will establish that deep analysis of ancestral stories will result in the deliberate and intentional act of formulating investigative scientific inquiry.

Pilot Study
A field study research project was conducted. The pilot project served several purposes.

First, the assumptions were built into the methods. There were three assumptions that prefaced this pilot study. The first stated that high school or secondary school is a more appropriate setting for a scientific inquiry research, than elementary school. The second assumption made was that interactions are indicators of motivation and engagement. The last assumption was that stories stimulate interaction.

The second purpose of the pilot project was to observe any reactions students might have to ancestral stories within the science curriculum.
Last, it was necessary to observe the effectiveness of a separate storyteller, or a person other than the teacher delivering the story. This information was necessary for further research endeavors.

The research questions that guided this field study research project were as follows:

1. Will ancestral stories motivate higher order thinking questions than a traditional science lesson for elementary-aged Native Hawaiian children?

2. What will interactions between students and teachers look like after exposure to an ancestral story versus exposure to a traditional classroom science lesson?

Through observations via video and audio in four different classroom settings, these questions were points of continuity. However, other questions and results arose through the data and field notes. This brief synopsis of the study will explain these “other” questions, the data, and the proposal questions driven by the study.

This project involved two settings. The first setting was a summer school classroom of second and third graders. The session in this setting was done in June and will from this point on be known as the June session. There were two consecutive days of study during the June session. The students were part of a 4-
week summer school session. The theme of summer school that year was Native Hawaiian plant dyes. All but four students could speak Hawaiian, and all but those four were from the same school. On the first day, the lesson was on plant chromatography. The teacher gave the students a short lecture, a paragraph with new vocabulary words to copy, and instructions on the lab on chromatography. The students then went outside to the school garden to gather plants, returned, and conducted the lab. The teacher then asked the students questions on the lab and the new vocabulary. This lesson was approximately 35 minutes long. The ancestral story followed the lesson. The story was from the Pele and Hi‘iaka saga. The story was indirectly related to the science lesson, which involved the dye colors of Hi‘iaka’s skirt. The story was done by a storyteller and not the teacher. The second day involved a new teacher, a new science lesson, a new story, and a new lesson and story format. The only similarities to the first day were the setting, the students, and the fact that the session involved a science lesson and a story.

The next session was in July; therefore, it will be known as the July session. The July session involved students from a Hula Hālau. Their ages ranged from 5 to 11. This session also consisted of two consecutive days of science lessons followed by storytelling. The first day of the session was taught by a veteran science teacher in the DOE. Her lesson was on rain and its aspects. The story on
this day was also on rain and was told by a very knowledgeable storyteller well versed in culture, language, and the Hawaiian myths. She told a story about a great deluge of rain in Pana‘ewa. The second day, the teacher gave a lesson on volcanoes. This was also a veteran science teacher who gave the students a presentation floor to present their version of how volcanoes work. The story that followed was on Ke Kaiakahinali‘i, or the ocean that brought the volcano. It was told by a young storyteller who was well versed in the language but had no teaching or research experience.

The obvious fact is that this field research project had many variables that were difficult to overcome in the data-gathering and analysis steps of the process. There were different teachers and storytellers throughout the project. Additionally, none of the lessons or stories was the same. The completed report on the education field study class 740 reflects this hurdle in the flow of the project.

The data were based on the one consistent aspect of the project, which was that every session consisted of a traditional science lesson followed by a story. The first data analysis was based on the second inquiry that drove this field project. The question of interaction was investigated in this data analysis. Through observation and transcripts, the researcher looked for interactions between the students and the teacher. Each interaction was counted and coded.
There were two categories: teacher-initiated interactions and student-initiated interactions. Teacher-initiated interactions were interactions initiated by the teacher for the purpose of obtaining feedback from the students to either check for understanding or clarify instruction. Student-initiated interactions were student driven and student initiated. These included statements, yes/no questions, directions, opinions, and expandable questions. The researcher looked for responses such as questions of wonderment, statements of related daily activities, or opinions that expanded upon the lesson. All interactions were coded and then counted.

The second data analysis was based on the outcome of the observations and the first data analysis. It was discovered through review of the first set of data and the video that the teacher’s cultural, content, and pedagogical knowledge played a major role in the number of student-driven interactions. Therefore, the second data analysis looked at the frequency of opportunities the teacher took in obtaining student responses during the science lesson and the story. In addition, the quality of responses was coded and counted. This portion of the study answered questions such as the following: Were teachers and storytellers open to questions and comments? Did teachers and storytellers provide wait time for questions? Did storytellers and teachers address comments and opinions, or were they skipped over? Did teachers and
storytellers use strategies that were open-ended and encouraged student inquiry? Did teachers provide opportunities for students to connect the stories or lessons to home or family? (Center for Research on Education, Diversity, and Excellence, 2004)

At the end of the study, the data were analyzed. The interesting conclusion from the first portion of the study yielded positive data toward the utilization of ancestral stories in the classroom (Table 1.1). The data described observations of student reactions and interactions in the immersion classroom. The student participants gave their opinions within the context of the story, reacted to the familiarity of the names and places mentioned in the story, and related their activities in school to the story. For example, when the story of Pana'ewa and Hi'iaka was shared, students explained that they remembered these names from the dance they did for May Day. They then proceeded to sing the song they performed.

In the analysis of the quantitative data pertaining to the science lesson portion, the numbers supported a similar student behavior toward the lesson. There was an increase in student interaction during the science lesson portion as well. This contradiction was studied in the second phase of data analysis.

In the second portion of the research, data analysis focus changed from the story and lesson to the storyteller and teacher. It was important to observe
the strategies each instructor utilized to draw in student response. Again, a transcript of the sessions was recorded, and codes were used. The codes represented different types of communication between the teacher and the students in order to describe in detail how the teacher’s actions—mostly verbal actions along with some nonverbal actions—affected the traffic and flow of the interactions. This perspective of data collection allowed the researcher to take a closer look at teaching strategies that prompted more responses from students. It was interesting to find that teacher experience in content area and pedagogy is an important factor in student engagement and inquiry inducement. The same pedagogical notion goes for the storyteller. Teaching strategies such as providing wait time for student questions and answers, asking open-ended questions, and asking follow-up questions were factors in the quality and quantity of student interactions. However, in addition to those teaching strategies, genuine indigenous knowledge of stories, place names, character descriptions, and cultural norms and activities are equal in value and influence to native Hawaiian students.
### Table 1.1
*Teacher Initiated Interactions - Story vs Lesson*

<table>
<thead>
<tr>
<th></th>
<th>Instructional</th>
<th>Explanations</th>
<th>Questions&amp;Answers</th>
<th>Demonstration</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson</td>
<td>28%</td>
<td>5%</td>
<td>59%</td>
<td>7%</td>
<td>59%</td>
</tr>
<tr>
<td>Story</td>
<td>24%</td>
<td>2%</td>
<td>73%</td>
<td>0</td>
<td>41%</td>
</tr>
</tbody>
</table>

### Table 1.2
*Student Initiated Interactions – Story vs Lesson*

<table>
<thead>
<tr>
<th></th>
<th>Question&amp;Answer</th>
<th>Reactionary</th>
<th>Self motivation</th>
<th>Opinion</th>
<th>Inquiry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson</td>
<td>22%</td>
<td>32%</td>
<td>6%</td>
<td>38%</td>
<td>0</td>
<td>33%</td>
</tr>
<tr>
<td>Story</td>
<td>41%</td>
<td>13%</td>
<td>36%</td>
<td>1%</td>
<td>8%</td>
<td>66%</td>
</tr>
</tbody>
</table>
Table 2.1
*Frequency and types of teacher activities that DISCOURAGED student feedback*

<table>
<thead>
<tr>
<th></th>
<th>CQ</th>
<th>INS</th>
<th>GO</th>
<th>YN(S)</th>
<th>From the total number of Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storyteller</td>
<td>31%</td>
<td>34%</td>
<td>0</td>
<td>34%</td>
<td>53%</td>
</tr>
<tr>
<td>Lesson/teacher</td>
<td>34%</td>
<td>0</td>
<td>2.5%</td>
<td>50%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Table 2.2
*Frequency and types of teacher activities that ENCOURAGED student feedback and student interactions with teachers.*

<table>
<thead>
<tr>
<th></th>
<th>Inq</th>
<th>OPEN</th>
<th>OPEN(T)</th>
<th>FAM</th>
<th>From the total number of interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storyteller</td>
<td>7%</td>
<td>13%</td>
<td>26%</td>
<td>48%</td>
<td>59%</td>
</tr>
<tr>
<td>Lesson/teacher</td>
<td>13%</td>
<td>0</td>
<td>68%</td>
<td>0</td>
<td>41%</td>
</tr>
</tbody>
</table>

Explanation of Tables

Table 1 shows the number of teacher-initiated interactions or situations in which it was necessary for the teacher to initiate feedback from students. The column headings are the strategies used by the teacher to initiate interactions, and the row headings indicate whether or not the strategy and interaction were part of the lesson or story. Fifty-nine percent of the total teacher-initiated interactions observed occurred during the lesson portion, while a slightly lower amount (41%) of the teacher-initiated interactions observed occurred during the story portion of the class. Closer scrutiny of the data analysis reveals that
teacher-directed strategies such as instruction and question-and-answer sessions made up the greater part of the total number of interactions. The following sample of a transcript from the pilot study is an example of question-and-answer dialogue:

T: Okay, so what are you going to all get the same kind of plants?
S: No.
T: So if this group gets kukui, what will this group get?
S: Kukui, no lai or something.
T: Okay, make sure who’s going to get pua.
S: no pua just leaves (raise their hand)
T: Remember, not all of you.

This was a continuous exchange of questions and answers within 2 minutes of data gathering. This type of interaction made up 60% of the teacher interactions.

Student-initiated interactions or situations in which it was the student initiating the line of communication were coded, counted, and analyzed in Table 2. As in Table 1, the column headings of Table 2 represent the type of interactions observed, and the row headings indicate the portion of the class in which the observations occurred (i.e., the story portion or the science lesson portion). The data show that the student-initiated interactions were 2 times greater during the story portion of the class than during the lesson portion of the class. Moreover, the self-motivated student interactions, or the interactions in
which the students exclaimed their knowledge of the story, accounted for 36% of the interactions in comparison with 6% in the lesson portion.

Tables 2.1 and 2.2 answers to the assumptions made prior to the pilot study. The analysis of the video and field notes revealed the distinctive ability of the teacher to pull out the teachable moments of the lesson and the importance of teacher facilitation in all portions of the class. The column headings in Table 2.1 represent the types of interactions observed that discourage student feedback. CQ stands for closed questioning or questions looking for a one-word answer. INS stands for instructional strategies such as lecturing and direct instruction. The letters GO stand for Guiding Observations, and YN stands for Yes or No answers by students or teachers. The last column indicates the total number of teacher activities that discouraged student feedback on behalf of the personnel indicated (i.e., the storyteller or the teacher). The row headings designate the personnel. A quick glance at the last column reveals that although the medium of instruction was a story and not a lesson, the personnel did not push the interaction to encourage extended feedback or did not have the skill to do so. Closer analysis reveals that activities such as closed questioning and instruction were the driving strategies used by the storyteller in the storytelling portion of the class. It was unexpected to see that the lesson portion of the class or the portion taught by the teacher produced the smaller number of occurrences of
activities that discouraged feedback; this result was unexpected due to the fact that the medium of instruction was a science lesson.

Table 2.2 represents the frequency and types of teacher activities that encouraged student feedback and student interactions. As in Table 3, the column headings represent the type of activities that were observed that encouraged student feedback, and the row headings indicate the personnel who encouraged the feedback. A predictable fact produced by this data analysis concerned the number of activities that encouraged student feedback. The numbers relating to the storyteller was slightly higher than that of the science lesson. However, upon closer analysis, one can conclude that the specific activity or strategy used most frequently in the story portion was that of FAM or familiarity of the names, places, and characters of the story and not necessarily an instructional strategy used by the storyteller. On the other hand, throughout the lesson portion, the teacher was able to draw out open ended questions from the students, even if overall, the result was a lower number of occurrences that encouraged student feedback.

The first research question of this dissertation study was written in regards to the pilot study, specifically the different levels of feedback. Student feedback being an indication of engagement is the assumption, and the connection Native Hawaiian students have with the ancestral stories playing the
role as anticipatory set is the catalyst of engagement. This pilot study set the foundation for the dissertation study by serving the intentions or purposes of the initial study. One purpose was to determine the use of a storyteller. Data have proven that this process would be much more effective without a storyteller. The other purpose was to prove that stories initiate interaction and hence engagement. This purpose was also served, as a glance at Table 2 will confirm.

Last, the first research question for the dissertation study reads, “How can Native Hawaiian ancestral stories encourage an increased level of student-driven interactions at all levels of feedback from Native Hawaiian students in science classrooms?” This research question is directly related to this pilot study. Again, looking into a 5-E classroom or a classroom that involves the five levels of science education engagement is just the first step (Lacy, 2005). The next step involves exploration or a need to satisfy curiosity; this is the beginning of inquiry. In order to begin to answer the first research question of the dissertation research, this foundation had to be laid.

*Research Statement and Questions*

The purpose of this research was to stimulate scientific inquiry through the utilization of Native Hawaiian ancestral stories in connection with the following research questions:
1. How can Native Hawaiian ancestral stories encourage an increased level of student-driven interaction at all levels of feedback from Native Hawaiian students in science classrooms?

2. How can teachers of Native Hawaiian students facilitate the construction of science inquiry projects from ancestral stories?

3. How do analysis and discussion of the stories connect Native Hawaiian students to their ancestral intelligence?

The definitions listed here are derived from a review of literature, comments, thoughts, and expressions of knowledge on the subjects of school science, indigenous science, and scientific inquiry.

**Definitions**

*Scientific Inquiry*

The *National Science Education Standards* (National Science Education Standards, 1994) defined *scientific inquiry* as

The diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.
The standards further stated that scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. The National Science Teachers Association (NSTA, 2004) recommended that teachers help students and learn how to identify and ask appropriate questions that can be answered through scientific investigations. Regarding students’ understanding about scientific inquiry, NSTA recommended that teachers help students understand the following:

- That science involves asking questions about the world and then developing scientific investigations to answer these questions.
- That there is no fixed sequence of steps that all scientific investigations follow. Different kinds of questions suggest different kinds of scientific investigations. (NSTA, 2004)

The National Science Foundation, the organization that makes decisions on the nation’s scientific structures and the validity of these structures, has dedicated an entire volume of its monograph *Foundations* to scientific inquiry in kindergarten through fifth-grade classrooms. In this publication, inquiry is the focus of science learning. The authors emphasize that inquiry is an approach to learning that involves a process of exploring the natural or material world and leads to
questions, making discoveries, and rigorously testing those discoveries in search of new understanding (National Science Foundation, 2000).

Science

More definitions are clarified in Aikenhead and Ogawa’s writings. In their article “Indigenous Knowledge and Science Revisited,” they gave a brief history of the word science. This word was substituted for the ideology of natural philosophy, phrasing used by the religious views of man’s dominion and power over nature. A new organization in the late 1800s had to professionalize the phrase natural philosophy and decided to use the word science, which in Latin means “knowledge.” This organization, the British Association for the Advancement of Science, was the model for today’s American Association for the Advancement of Science (AAAS), which authored Project 2061—Science for All Americans. For this reason, science or professional science is synonymous with western science. Ogawa reaffirmed that science, in its diversity of applications, defines perceptions of reality, or rational perceptions of reality—in this case, the reality of a culture’s place in nature.

Where, then, does “school science” fit into nature’s reality? Science classrooms are struggling with the nature of the school environment (i.e., diverse population of students, school–state mandates, test scores, etc.). Therefore, teachers will find it difficult to rise above the basic scientific method, which
presently scarcely follows a positivistic and realistic model. These models
describe a science that is free from any worldview, a science that is inductive and
deductive, a science in which data reveal objective, value free, universal, secure
knowledge or nature (Aikenhead & Ogawa, 2007). This point is also confirmed
in the Hawai‘i State Content Standards for science, which state that a student
needs to describe how a study must be consistent with experimental and
observational evidence about nature and abide by the rules of evidence (Hawai‘i
Department of Education, n.d.).

*Hawaiian Science*

As one would suspect, there is no formal definition or equal translation
for the word or even the idea of “science” in the Hawaiian language. There have
been attempts to create Hawaiian words for the word *science* such as *akeakamai* or
ākea (*broaden*), akamai (*5, 6*) (*smart*), or a Hawaiian-ized English word, ʻepêkema. At
the start of this study, I knew of the unfamiliarity of Eurocentric science, as
Ogawa and Aikenhead described it, to Hawaiian knowledge. Therefore, as any
researcher would do, I threw out the question to those in the know—the
practitioners and academia of the Hawaiian culture. The question put to this
party of cultural intelligence was “What is your definition of Hawaiian science?”
The following is an example of their responses.
As Hawaiians, Kanaka Maoli, kanaka Hawai‘i for almost two centuries we have been trying to live as a group, think as a group and function as a group but we are really individuals who come from a family system and we own that family system. That family system is inclusive of sky, ocean, earth creatures and human. Our systemized way of knowing comes from this family connection. The family has a dominant elemental form which makes us who we are; the elemental characteristic dictates our societal interaction, our level of tolerance, and our approach to situations. Within the family, a less dominant elemental form may surface from the natural course of life. (Dr. Pualani Kanakaole, personal communication, February 2, 2008)

Therefore, as it stands now in the language of academic definitions, “science” is not as definitive as it is in the western sense of the word. It is unfamiliar; it rides the borders of definitive science and reflects the Native Hawaiian understanding of the natural world. Snively and Corsiglia (2009) assisted in bridging this unfamiliarity with their definition of traditional ecological knowledge in “Discovering Indigenous Science: Implications for Science Education”:

A branch of biological and ecological science (TEK), which can be thought of as either the knowledge itself, or as documented ethno-science enriched
with analysis and explication provided by natural science specialists.

(Snively & Corsiglia, p. 9)

This definition could be the bridge from the familiar to the unfamiliar, still understanding that the parallel is hazy. We could categorize and pull out themes embedded in the responses we received from our cultural practitioner; however, this study will not attempt that and would rather preserve the integrity that dwells within the words of ancestors. Therefore, this study will incorporate responses into the narrative as it corresponds to individual phenomena pulled from the students’ reactions.

**Indigenous Stories**

In Donna J. Eder’s study on Navajo storytelling in schools, Navajo stories are described as “the means by which many Navajos have constructed the meaning of life, of human beings, and of the universe: They are the means by which this knowledge is passed on. Ceremonies are structured by stories and given meaning through stories” (Eder, 2007).

Similar to this definition of native stories is that of myths as a primal way of presenting realities and truths. Cajete (2000) stated the following in his writing on indigenous science education:
Myths give focus to and clarify those things which are deemed important. They relate the learner to paradigms of proper relationship to plants, animals and all of nature. It is the development of representational thinking. (p. 7)

In congruence with that statement, Oscar Kawagely (2006), in his writing on Yupiaq science entitled *A Yupiaq Worldview: A Pathway to Ecology and Spirit*, relayed a story on the parallel and equal relationship of man and animals. He affirmed that myths are a way for man to make sense of nature’s instructions. Stories and myths are serendipitous discoveries and the blending of the pragmatic inductive and spiritual realms. Myths are the Alaska Native’s tool for teaching.

Indigenous stories are texts that explain natural phenomena. They equate our existence to the existence of all other organisms on this Earth and sometimes even make our existence inferior to that of other organisms on Earth. Kawagely (2006) illustrated this idea in his text on the role of the Raven as the creator of land. In Maori texts, the whale has deified status. In our creation chant of the Kumulipo, all organisms that exist come before and are the older siblings of humans (Beckwith, 1986). These are the lessons that are passed down from generation to generation through some medium—oral tradition, writing, or images—with only the change being the source of the oration. Therefore, this
explanation of natural phenomena was used by the ancestors to predict nature, establish laws and principles, and communicate a common thought.
Chapter 2
Literature Review

The purpose of this doctoral research is to find that well-worn trail of ancestral scientific intelligence that is now unfamiliar and overgrown with generations of educational misconnections. This researcher hopes that this study will beacon young native Hawaiian students to this trail. Two pointers to this trail will be discussed in this literature review. One pointer is ancestral stories. The quoted thoughts and comments in this section verbalized by very well-respected elders, indigenous educators, and science teachers will indicate the course to take to find the trail of ancestral intelligence. This review will also assert this research’s unique position in the use of indigenous pedagogy in the science classroom. There are several other meaningful directions on the integration and/or related cultural curriculum in western science education. This portion of the literature review will these varied indigenous approaches to science curriculum.

Another pointer is the western term scientific inquiry. Discussions in this section will develop the idea that scientific inquiry is much more than a specific sequence of steps listed in the scientific method. The facilitation offormulating the right questions is the first step in inquiry. Literature on questions and questioning is reviewed. This section also includes the importance of teacher training and pedagogical content as well as cultural knowledge for this type of
curriculum in inquiry education. The pedagogical knowledge possessed by a science teacher plays a crucial role in this study and in inquiry education.

Ancestral Stories

In the introduction of this study, the term indigenous stories are defined. (There may be a distinct similarity between the terms indigenous stories and ancestral stories, in that the purpose of their composition is to explain natural phenomena; therefore, the terms ancestral stories and indigenous stories may be used interchangeably throughout this writing). Ancestral stories are texts that link us back to the beginning. They describe our source (Beckwith, 1981), explain our progression (Poepoe, 1908), and foretell the future (Kamakau, 1956). This portion of the literature review will illustrate the necessity of indigenous stories to native people as a form of instruction. It will then focus on Native Hawaiian ancestral stories and the foundation that they provide onto which we can structure a framework of scientific inquiry.

Indigenous Scholars on Ancestral Stories

It has been a privilege to be able to build upon the knowledge base of great indigenous scholars in science education. These scholars share gratitude with this researcher to their ancestors for the stories, verses, and oratories they have graciously handed down.
As mentioned above, myths (stories) are the native’s tool for teaching (Kawagley, 2006). Stories display the magnitude of ancestral knowledge. In a story written in Kawagley’s book *A Yupiaq Worldview: A Pathway to Ecology and Spirit*, the human characters change into animals, which Kawagley explained is a reflection of the the ancestors limitless knowledge of the animals behavior and needs. He went on to describe the practitioners deriving knowledge through observation of their natural environment, he confirms that the ancestors knew the animals and their learned behaviors, their likes and dislikes, and how they were to be treated there was communication a relationship between humans and animals, (Kawagely, 2006). The ancestors’ experiences with their environment were so unified that their stories relayed the characteristics of animals and plants and humanized these characteristics in order to place them in a story context. Stories are necessary for the transmission of appropriate attitudes and values (Kawagely, 2006).

Native stories relate the interdependence of plants and animals to human behaviors of survival (Cajete, 2000). The survival of many of the indigenous people today is due in part to ancestral observations related in stories and verse. Cajete (2000) stated in his book *Native Science: Natural Laws of Interdependence* that “discoveries like the use of fire, coming to know ecological relationships and responsibilities to the natural world, a sense of how things began, understanding
orders and cycles of nature are among the first elements of science” (p. 13). These discoveries or “first elements of science” are described in stories composed by the ancestors of this land as illustrated in the stories displayed in the introduction of this proposal. All basic components of scientific thought and application are metaphorically represented in most Native stories of creation and origin (Cajete, 2000).

The phrase cultural history (Salmon, 2002) is a term that evolved from ancestral stories. A writing by Enrique Salmon entitled “Sharing Breath: Some Links Between Land, Plants, and People” defined this term. Salmon affirmed that cultural history is a way of perceiving the natural surroundings and the cultural history of through creation stories, ones that, expresses how the world began. It also provides metaphors and cultural models through which interpretations regarding people and plants can be made.

Native Hawaiian stories provide readers with a pathway into resources such as the forest, ocean reefs, deep-sea caves, volcanoes, and the human body. Dennis Kawaharada (2003) confirmed that we learn about the features of nature through the naming of characters. He gives the example of Lāʻieikawai and a group of 5 sisters who become her protectors of sorts. These sisters all have plant names for example Kahalaomapuana, the fragrant hala, is the youngest sister.
According to Kawaharada (2003) this name describes the long, thick-growing leaves of the hala that provide shelter from rain and sun. The strong leaves also symbolize her power of protection through the thorns along the edges. Kawaharada stressed the importance of stories when he maintained that “this kind of fundamental vision planted and nurtured in our minds from childhood through story and experience makes a difference in our adult behavior and actions” (p. 68).

Ancestral Stories, Science, Western Science — A Comparison

This portion of Chapter 2 will focus upon the native skill of observation and analysis of the natural world. The purpose of the addition of this section is to establish the uniqueness of ancestral stories and why ancestral literature is considered a conduit to the natural world. The discussion of the differences between western academic scientific processes and ancestral scientific processes is necessary and will occur on four different fronts. The first will address the means used by ancestral stories to develop ideas about the physical and biological world. Then a process of science practicum will be described that will address the question of the successful assimilation of western scientific processes, procedures, and theories into the world of native science through ancestral stories. The distinguishing factors of native science through ancestral stories could be described through concepts such as static science versus fluid native
science, inanimate versus native animated objects, and detached observing versus being a part of the system observed. The next section of this writing will integrate this discussion in the assimilation of western research methods into native Hawaiian observational records of nature communicated in ancestral stories.

*Development of Ideas of Physical and Biological World*

The best direction to take on this question is to reference the stories directly. When one draws directly from the stories with simple interpretations, ideas about the physical and biological worlds come into focus.

In a section of the story of Kamiki, there is a battle between the hero Kamiki and the evil guardian of Mahiki and Pokahi forest. This evil guardian is known as Luanuuanuupoelekapo. In this battle, Kamiki captures the ‘awa gourd named Kapapaiaoa that was said to have the eyes of the 40,000 and 4,000 gods of Luanuuanuupoelekapo. This enraged the evil guardian, and she set out to capture Kamiki with a net named Nananananuihoomakua. After awakening the 40,000 and 4,000 gods to block the exits out of Mahiki forest, Luanuuanuu sent a runner, Muki, to block Kamiki at the pass. To watch for this runner, Kamiki climbed the branchless Kawau tree. Kamiki’s grandmother covered the tree and forest with mist to hide Kamiki. He caught up with Muki and smeared him with overripe breadfruit, resulting in a slippery, slightly blackened, stench-covered
runner. Muki was very perturbed to say the least and was sent back to his master in this state. Kamiki’s grandmother assisted in his escape by covering the forest with a heavy dew-laden mist. He escaped and went to Kauluhenuihihikoloiuka and Lanimamao, his grandparents’ doorway. His grandmother saw him and called out, in a chant. This is the verse she spoke.

1. Nanaikekihiokamalama
2. E Nana, ho‘onanana ka lā Nana, the sun flutters
3. E Nana, ho‘onanana ka ua Nana, the rain flutters
4. E Nana, ho‘onanana ka makani Nana, the wind flutters
5. E Nana, ho‘onanana ka ‘ino Nana, the storm flutters
6. E Nana, ho‘onanana ke kai Nana, the sea flutters
7. E Nana, ho‘onanana ka mālie Nana, the calm flutters
8. E Nana, ho‘onanana ka manu e lele Nana, the bird flutters

We will return to the story within the remainder of this scientific inquiry response because there are many important details that were left out that will be used to demonstrate the biological and physical science research in ancestral stories.

The purpose of the recitation of this section of this particular story is to expound upon the development of ideas of the physical and biological world of ancestral stories. There are several academics that use this story to explain the basic “storytelling” methods of native Hawaiians from certain areas (Maly, 2003). Their historical, archeological, and anthropological takes on this story of Kamiki explore literary devices such as place names, plot, antagonists, settings, and so
forth. My take on this story as a native Hawaiian scholar is that of a tool. This tool provides me with several pieces of information on particular aspects of nature. A metaphoric comparison can be found in the purpose of the microscope and its parts. Further adjustment of focal lengths allows magnification of certain parts of one object that lie on the stage of the instrument (The Parts of a Microscope, 2007).

On the lowest setting of magnification with the coarse adjustment, we can analyze and record our observations of this section of the story. At this focus point, we can see that this battle and the natural activity of the forest occurred during a certain time of year: Nana, or March and April (Nuuhiwa, 2009). The chant tells us this:

1. Nanaikekihiokamalama
2. E Nana, ho'onanana ka lā Nana, the sun flutters
3. E Nana, ho'onanana ka ua Nana, the rain flutters
4. E Nana, ho'onanana ka makani Nana, the wind flutters
5. E Nana, ho'onanana ka ‘ino Nana, the storm flutters
6. E Nana, ho'onanana ke kai Nana, the sea flutters
7. E Nana, ho'onanana ka mālie Nana, the calm flutters
8. E Nana, ho'onanana ka manu e lele Nana, the bird flutters

The forests of Mahiki and Pokahi located above Waipiʻo valley into Waimea (place names) are noted at the beginning of this section. We can also infer the type of forest and the characteristic canopy that occur in this forest.
If we increase the magnification on our microscope to observe our object, then we will see botanical and biological specificities. The story describes the forest above Waipiʻo in detail. In Kamikiʻs attempts to escape with Kapapaiaoa, he hears the din of the 40,000 gods (ka pihe of ke akua) and the 400,000 rustling (nehe mau) and the 4,000 gods behind him (o ke kini akua, o ka lehu o ke akua; Beckwith, 1970).

These “gods” actually relate to organisms and elements that make that forest home. We can infer the type of organisms being discussed here by the sound they are making. Forty thousand gods provide a din, 400,000 gods because a rustling sound, and 4,000 elements or organisms provide a whistling that can either be birds or branches.

Another observation at this magnification is the verse that reads,

1. Kauā make loa ʻoe iaʻu e nä
2. Mü kānaka  a human germ
3. Mü hauna  a stink germ
4. Mü honoā  a germ of excrement
5. Mü naʻanaʻa  a leaning germ
6. Mü hoʻokīkiʻI  a protruding germ
7. Mü ʻaihue i ka ʻōnohi o kuʻu haku ē.  Germ that steals the eye of my god

The translation refers to the action of Muki, the runner of Luanuuuanuupoelekapo, chasing Kamiki and insulting him. This chant refers to the forest decomposers, specifically earthworms, larvae, caterpillars, borer
weevils, and so forth. This verse describes the different types of decomposers found in this forest (Pukui, 1986).

Again, the AAAS (1990) stated that the means used to develop ideas about the physical and biological world are particular ways of observing, thinking, experimenting, and validating. Kamiki and the plethora of ancestral stories also develop ideas in particular ways. As we have seen in this short section of a longer dynamic text, these ways include observation, validation, thinking, and documentation.

If we fine-focus our microscope to a higher magnification, we can see new details of the observed object. With this higher resolution, a whole other world of information is revealed. This closer look concerns the names given to the characters and objects in the story. The guardian of this forest is Luanuuanuupoelekapo. When deconstructed, this name describes the method of cultivation of forestry plants. Luanuuanuunupoelekapo or “the scattering of darkness due to reverberation” is the primal form of this forest of Mahiki.

Another name to investigate is that of the giant spider sent to cast a giant web-like net over the forest. This spider is named Nananananuihoomakua or the “spider web that causes maturation” or the next step after the gathering of seeds. The construction and deconstruction of character names hold a wealth of observable information that may answer questions or provoke more questions.
The means of the story of Kamiki to develop ideas about the physical and biological world are observation, interpretation, validation, identification, thinking, and documentation. Notice that the concept of experimentation is not included in this list, as it is in the opinion recorded by the AAAS (1990). However, an experiment in the true definition of the word (“Experiment,” 2009) is a test, especially a scientific one, carried out in order to discover the results of a particular course of action—to see what will happen. Experimentation in this case would be a part of the observation process in Hawaiian stories. For example, in a conversation, a renowned Native Hawaiian artist and lei maker described the experimentation process as done with kapa making. “Well we just started, we found some wauke, and we had to find out the hard way and try new things.” She also stated that in terms of the planting,

the artist is responsible for growing the plant, for taking care of it, training it, then he’s responsible for harvesting and he learns like we had to learn that in some cases you can only harvest at certain times of the year and you can’t do it all year long. (Macdonald, 2009)

Through trials and recordation of weather and plant expectations, she became knowledgeable of the harvest season of wauke. In the popular story of Maui and the Alai, Maui tried several ways to start a fire. Of course, in the story, his failure was due to bad information, but his efforts were a form of experimentation. He
attempted this activity several times until he found the correct fire-starting material. Experimentation is an important task in the recording of environmental transformation.

*How can ancestral stories be utilized to successfully assimilate western scientific processes, procedures, and theories?*

The purpose of ancestral stories and chants is timeless. There is the purpose of survival, perpetuation, and continuity. Therefore, Native Hawaiian scientists conduct a fact-finding mission toward a specific truth about the natural phenomena surrounding them. As purpose is utility, this purpose must be known. The Kumulipo documents the following as an example of this statement (Beckwith, 1951).

614. Hānau Kāne he akua The god named Kāne is born
615. Hānau ‘o Kanaloa,’ Kanaloa is born in the form of a squid
   o ka he’e haunawela ia Kanaloa
616. Hānau ka pahu The pahu were born
617. O Moanaliha Of Moanaliha
618. Kawaoma‘aukele and Kawaoma‘aukele
   ko lāua hope mai is younger than them
   kona muli is the younger sibling
620. ‘O ke kanaka ola loa o lau a lau ali‘i The healthy man amongst the numerous chiefs

In order to survive and thrive, the means of survival needed to be observed and recorded in a language that those in that field of study could understand. The first line describes the water, which is Kāne or the surface
running water, and Kanaloa, or the sub-surface water. The names Kāne and Kanaloa also tell us the times of year that this water can either be plentiful or scarce. The time of Kanaloa is the last half of our year from the months of August to December. Kāne could be either the nights of Kāne or the first half of the year from January to July. Then it tells us the sources of the water, which are Moanaliha or the ground water such as aquifers, water tables, caves, and Kawaomaʻaukele, or the water gathered by the forest from mist, rain, afternoon clouds, and so forth. Notice that it mentions that Kawaomaʻaukele is younger than them, which tells us that this water has not been around, or cycles through quicker than ground water or Moanaliha.

In order to survive and thrive as a people, we need to conduct fact-finding missions that reveal the reality of our natural phenomena. We are blessed with ancestral data. Hawaiians today benefit from ancestral research, and our purpose is to establish and sometimes re-establish our proposals for research. For example, if a student of mine needed to find the springs active and non-active of his ʻIli for the purpose of taro patch restoration and water resources, I would advise him to first research the hydrology maps of his area located in the Department of Water Supply. Within this task, instruments used to take accurate measurements and analysis could be employed. This information is data along with descriptions recorded in ancestral stories. Then we would look for chants,
stories, and family names written and recorded for his place. From these data, we would physically search for these water-sources, whether they are springs or streams. Again, technology resulting from western scientific study should be integrated into this step of research. Then, family kupuna would be consulted to confirm the information already gathered. Next, we would look back into the chants and ancestral stories to validate our observations and resources and rejuvenate the names of the different springs or streams. The final step, besides building the taro patch, is to record the research through story.

Within this process, western science and scientific research can serve as tools. Technology progresses due to discoveries. Instruments are invented to measure these discoveries (Kuhn, 1970). The purpose of western science will exist within the foundation of ancestral stories, that being observation, methods, and processes of observation.

Static Versus Fluid Native Science
At first glance, the historical perspective of ancestral stories is most likely to be described as archaic. These stories were authored over a hundred years ago; they originate from chants that were applicable generations before early technological advances, and many of the religious beliefs they express are obsolete. Suffice it to say that ancestral stories would be thought of as static unchanging mythology used to animate an idea. However, ancestral stories are
artifacts of native science and observation documentation and serve as guides for
observations. In that view, ancestral texts such as stories and sayings are fluid
and changing as times, locations, and composers change. They were never
meant to be hard, cemented scientific laws that, if broken, would cause one to be
jeered and slighted by one’s peers.

An example of this fluidity is the multiple versions of a single story epic.
There exist at least four known versions of the story of Pele and Hi’iaka
(Emerson, 1997; Poepoe, 1999). The reason for this lends to the many
observations documented and also to the life of the language. Therefore, native
Hawaiians are not bound to one theory of Ka Huaka’i o Hi’iaka, which tells us of
the re-vegetation and reforestation of our islands.

Another example of this concept of fluid science is the structure or lack
thereof of the language. The beauty of the native language is in the access of
interpretation. For example, the word kea translates into “wide or vast,” as it is
used in the name of the originating deity Wākea. Another translation of kea is
“white or white’ish, as in one kea or “white sand” (Pukui, 1986).

The chants, ‘ōlelo noe'au, and stories that describe the observable
phenomena and inform us of our natural surroundings are fluid and
transformable. This concept is repeated again and again, namely in the many
versions of one story and in the living language, and within this concept of
fluidity we find truth. Cajete (2000) stated that “truth is not a fixed point, but rather an ever evolving point of balance, perpetually created and perpetually new” (p. 19).

In Kuhn’s book *The Structure of Scientific Revolutions*, the dynamics of western science and experimentation are called *paradigms*. These paradigms are “accepted examples of actual scientific practice” (Kuhn, 1970, p. 44). These examples include law, theory, and application, which stem from coherent traditions of scientific research. Western science involves conducting experiments and tests based on established scientific traditions associated with such names as Newton, Lavoisier, Copernicus, and Einstein (Kuhn, 1970). Rather than being a thought, theory, or concept from an individual, our ancestral stories are actually a collection of observations from different traditions from a place over a long period of time. Certainly, Newton, Lavoisier, Coulomb, and even Einstein spent a great deal of time in observation and data analysis, which led them to the lasting theories we pull from today. Ancestral stories such as Pele and Hiiaka and the story of Maui, however, are collections of observations. This knowledge was pulled together as time went on and melded into one continuous story—hence the different versions. The premise is the same, but the ingredients of the text may be different and certain aspects of the story may be more crucial in one version than in another (Nuuhiwa, 2009).
Due to skills lost such as language, poetry writing, observations, and survival, this art of story composition in order to perpetuate data has discontinued (Kanahele, 2010). However, Kanahele stated that “this is important to continue, it speaks of the journey, and if this art dies then the journey stops moving forward” (personal communication, 2010).

*Inanimate Versus Animated Objects*

Cajete (2000) stated that “everything in nature has something to teach humans” (p. 9). This statement is the basis for ancestral stories. Composers use characters and storylines as voices for non-human organisms and elements. For example, in the story of Kamiki, the forest of Mahiki is a living entity named Luanuuanuupoelekapo. The forest lies at the top of Waimanu and Waipi‘o valley on the island of Hawai‘i. This is a large ‘Ōhi‘a dominant forest that houses both abundant and rare native vegetation. The extraordinary characteristic of this forest is the relationship it has with the wind. Due to its location and contents, this forest and the wind work together to create interesting sounds and shapes. The story’s composer uses this characteristic to teach the readers about the wind, the canopy, the calendar, and the forest floor. For example, mentioned in a prior section of this writing is the call of the 4,000 and 40,000 gods that cause a din and a rustling sound. Depending on the direction and strength of the
wind, the canopy will cause a forest explorer to hear a din. Also, if a wind blowing up the wall of the valley exists, then the covering of the forest floor will start swirling, causing a rustling noise. The chant recited by Kamiki’s grandmother gives us the time of year, which is Nana or mid-March into April.

There are many more examples of the animation of natural elements and the lessons each organism and element has to teach us. Therefore, in ancestral stories, the aspects of nature and the elemental activities “speak” and reveal their secrets via the observations made by the ancestors. “Listen to what the forest has to say” (Kanahele, 2010). The inheritance of these stories would not be possible if the authors and those that inspired these stories were not skilled observers. For the purpose of turning a ‘Ōhi’a forest into a large dragon-like lizard in the story of Hi’iaka, one had to sit and observe and “listen” to the forest.

In contrast, Kawagely (2006) reflected upon his own science education experience and remembered textbooks, the scientific method, and science experiments. My own undergraduate science education consisted of textbooks, lab manuals, study guides, and the scientific method. I am sure that this description is a very familiar one to Native science students. Science and nature are far from animated in this setting. Natural phenomena are discussed, measured, tested, observed, and noted but not animated. “You have to regard
the forest, talk to them, then listen this is ceremony” (J. Konanui, personal communication, September 2009).

Detached Observing Versus Being a Part of the System

“Science manipulates things and gives up living in them” (Merleau-Ponty, 1964. p.1). This statement describes the status of western academic scientific research as it exists beyond classical science. There was no excuse for our ancestors to live detached from nature. This behavior was the difference between life and death. Becoming a part of the forest, the reef, or the river was the way of life and means of survival. The stories are a record of this life. The stories are a documentation of ancestral life “living” in nature.

Beckwith (1970) stated that “much that seems to us wildest fancy in Hawaiian story is to him a sober statement of fact as he interprets it through the interrelations of gods with nature and man.” (p.3-6) Therefore man had to “accommodate” (Beckwith, 1970) himself as another individual in the physical world. This places him amongst and within nature rather than outside it. Hence, observations of one’s surroundings are done as “one-of” rather than above-all.

In the story of Kamapua’a, the base form of this hero is a pig. He could transform into a man if need be, but the environment described in the story is more suitable for a pig. The pig can also transform into a kukui, a triggerfish,
and a type of fern (Kameelehiwa, 1996). This text displays the placement of man as one of the many natural forms rather than the supreme-being. Furthermore, there exist families who bear the name Pua’a and Kama (McKinzie, 1997), a flag of recognition that these are descendants of this hero and his kin. This also leads to the fact that generations of humans have a familial relationship to nature. In this light, observations documented by ancestors are likened to western-type diaries. Animism of trees, ferns, mountains, and fish is a result of this belief.

Kawagley (2006) explained that “western science tends to emphasize compartmentalized knowledge (by disciplines), which is often de-contextualized and taught in the detachment of a laboratory setting” (p. 75). In comparison, he continued, “Native people...have traditionally acquired their knowledge of the world around them through direct experience in the natural environment” (p. 75). Kawagley displayed the noticeable difference between ancestral stories and western science. In ancestral stories and Native science, laws and theories change in the context of everyday survival, in the context of environmental changes, and in the context of land transference.

There is a kinship when a tree, a bird, or a form of lightning is named and claimed. This activity allows the researcher access to the natural phenomena as a part of the family rather than the dominant organism.
The purpose of this section of this dissertation is to demonstrate the disparity between indigenous observational science as seen through ancestral stories and western science. More importantly, they, the Native Hawaiian students need to take the offerings of ancestral stories and science together with the tools and equipment of western science and have a beneficial collaboration toward a more thorough and complete picture of nature and land kinship.

*The “Way” of Inquiry*

Many of today’s science education researchers confirm that inquiry points to a positive direction in epistemological methods. Welch, Klopfer, Aikenhead, and Robinson (1981) stated that inquiry is a general process by which human beings seek information or understanding. Inquiry is a way of thought. This statement was written in a 1980 report that analyzed the role of inquiry in Science education. Although the report concluded that students perceived science as something to be done only by somebody other than themselves, Welch et.al agree that knowledge and skill development in scientific inquiry processes is important for many students (Welch et al., 1981).

Scientific inquiry as a “way of being in the world” is described by Ann Rosebery in 1996 for the Exploratorium Institute for Inquiry; the document that lists this source is the report of the Northwest Education Regional Laboratory (NWERL) on scientific inquiry (Henrichsen & Jarrett, 1999). The quote continues
to read that “it [inquiry] is a stance about one’s relationship to the world, to people, to one’s work to knowledge” (Henrichsen et al., 1999). Inquiry is also a “way students learn and understand science” (NSTA, 2004). The NSTA’s position statement on inquiry published in 2004 confirmed its full support for using this method in the science curriculum. The NSTA board recommends that all K–16 teachers embrace scientific inquiry and are committed to helping educators make it the centerpiece of the science classroom. The use of scientific inquiry will help ensure that students develop a deep understanding of science and scientific inquiry. (NSTA, 2004)

The National Science Education Standards (NSES) were completed in 1996 to answer the call for science literacy for all Americans. The NSES committee emphasized inquiry as a new way of teaching and learning that reflects how science itself is done and stressed that this method is a way of achieving knowledge and understanding the world (National Science Education Standards, 1994). The standards were written with the notion that inquiry is central to science learning. The NSES document defined inquiry as “the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (p. 23). Inquiry “also refers to the activities of students in which they develop knowledge and understanding of scientific ideas” (National Science Education Standards, p. 23). The AAAS described
inquiry in much the same fashion as the NSES. The AAAS stated that inquiry relies on evidence and hypotheses across the disciplines and that there is no fixed set of steps for scientists to follow. *Project 2061* is a project begun in 1985 by the AAAS that outlines what students should know and be able to do before graduation. For America’s students, inquiry and the process that is assumed by this word is an essential skill to know before graduation. Scientific inquiry should be understood as ways of thinking and doing, as well as bodies of knowledge. Teachers need to know the methods that foster this (AAAS, 1990).

It is agreed that scientific inquiry is a process of discovery and learning. It is also agreed that communication between scientists, science groups, lab teams, teachers, and so forth is essential to this process. The exchange of ideas and techniques is common among scientists as to what validates a scientific investigation (AAAS, 1990). However, the utility definition of scientific inquiry will depend on the participants involved in this process.

The definitions of inquiry lend to the activity and hence the product of scientific inquiry. In *The School and Society*, Dewey (1938/1990) described the activity of sewing and weaving, stating,

> every material used in every occupation, and of the processes employed. The occupation supplies the child with a genuine motive; it gives him
experience at first hand; it brings him into contact with realities. It does all this but in addition it is liberalized throughout by translation into its historic and social values and scientific equivalences. With the growth of the child’s mind in power and knowledge it ceases to be a pleasant occupation merely and becomes more and more a medium, an instrument, an organ of understanding and is thereby transformed. (p. xx)

Dewey emphasized inquiry as central to students’ education. The significance of student’s firsthand experience with familiar objects (i.e., weaving of wool) is reflected in students’ current participation in software design, environmental issues, and transportation. Inquiry is based upon these experiences and transforms merely interesting questions into familiar “organs of understanding” (Dewey, 1938/1990). Scientific inquiry, therefore, brings not only product in the form of new information and outcomes, but also process in the form of investigative skills and proficiency in the object of study. Wells (2000) added to this thought in saying that “inquiry is as much about being open to wondering and puzzlement, and trying to construct and test explanations of the phenomena that evoked those feelings, as it is about mastering any particular body of information” (Wells, p. 63).
Inquiry, as defined above, is the closest process in western education to the Native Hawaiian pedagogical model. There is no word in the Hawaiian language that translates into *inquiry*. There is a saying, *Ma ka hana ka ‘ike*, that translates into “in work there is knowledge,” that perhaps comes close but is still far enough to barely bridge the large gap between western literacy and the success of Hawaiian students in the present structure of education. If it can be said that there was some relating factor, it was Dewey (1938/1990) who touched upon it in *School and Society* when he stated that “method, purpose, understanding shall exist in the consciousness of the one who does the work, that his activity shall have meaning to himself” (p. 23). In scientific inquiry, as defined in this section, there is, at the least, a bridge of understanding, a mutual agreement among Native Hawaiian science (as described in the introduction), Native Hawaiian education, and a Western educational methodology movement.

*The Intersection of Pedagogies; The Questions*

When a student formulates the right question, boom, it just goes right from there. We start to organize their study, we get right on the ball, but the problem is the question… if they don’t structure the question correctly, then we struggle, that’s where I lose a lot of them when project time comes.
This quote is taken from an interview conducted with a science teacher at a Hawaiian-based charter school.

The National Institute of Health (NIH, 2007) published a section on scientific inquiry. This publication gives some background on the type of questions that can be answered through the scientific inquiry process. According to this document, “not all questions can be answered using scientific investigations. Testable questions are answered through observations or experiments that provide evidence. Students need guidance and practice to be able to distinguish questions that are testable from those that are not” (p. 30).

The NIH listed the following criteria for testable questions:

The question centers on objects, organisms, and events in the natural world.

The question connects to scientific concepts rather than to opinions, feelings, or beliefs.

The question can be investigated through experiments or observations.

The question leads to gathering evidence and using data to explain how the natural world works. (p. 30)

*Foundations*, a publication dedicated to scientific inquiry, made the statement that questioning is at the heart of the inquiry process (National Science Foundation, 2000). A questioning environment is a classroom environment that
allows learners to explore new territory. Any questions regarding the science content being taught in the classroom are welcomed comfortably and attended to by the teacher. In this writing on the process skills of inquiry in the National Science Foundation publication, the author stated that “asking questions leads to an action which in turn leads to more questions” (National Science Foundation, 2000). This cycle is crucial in finding personal, meaningful connections.

So where do these questions come from? On the quest for meaningful connections, Wells (1997) recited this quote by A. Bettencourt (1991) in an unpublished paper on understanding science:

Understanding starts with a question; not any question, but a real question. Said another way, a real question expresses a desire to understand. This desire is what moves the questioner to pursue the question until an answer has been made.

Wells then related this statement to students’ connections and attitudes toward the question by explaining that the question only motivates inquiry when it is taken over and “owned” by the student (p. 65).

In order to make meaningful connections through questions, one must experience these connections. Each student brings a set of experiences to the
science classroom that informs his or her body of scientific knowledge
(Henrichsen & Jarrett, 1999). Questions that arise from a gap in experience
deepen the quest for the answer and thereby the quality of the investigation.
This study looks to ancestral stories for this experience.

Pedagogical Content Knowledge

Schulman (1986) defined pedagogical content knowledge (PCK) as

the ways of representing and formulating the subject that make it
comprehensible to others…, which includes an understanding of what
makes the learning of specific topics easy or difficult: the conceptions and
preconceptions that students of different ages and backgrounds bring
with them. (p. 143)

Teachers need to know not only the “what” but also the “how,” “who,” and
“when,” and they must possess the skill to reorganize that knowledge in order to
be successful. Learners are unlikely to come before teachers as “clean slates”
(Schulman, 1986). Therefore, a teacher must be able to reorganize the curriculum
in order to reach each student. This research illustrates a direct relationship
between the theory of PCK and its implications for science inquiry based
classrooms. Research conducted by Van Driel, Verloop, and deVos (1996)
indicated that “teachers when teaching unfamiliar topics, have little knowledge
of student problems and specific preconceptions and have difficulty selecting appropriate representations of subject matter” (p. xx).

Cochran, DeRuiter, and King (1993) examined Schulman’s explanation of PCK. They argued that equating content knowledge and the concepts of PCK does not justify constructivism; therefore, they expanded this theory to be more consistent with constructivism. The term pedagogical content knowing is defined as “a teacher’s integrated understanding of three components of pedagogy, subject matter content, student characteristics, and the environmental context of learning” (p. 266). This alternative model of PCK relates directly to this research.

Cochran et al. added two components to Schulman’s view of PCK: student characteristics and the environmental context. The application of both pedagogies of scientific inquiry and ancestral stories require that both be met by the teacher. In a school with a high Native Hawaiian population, or a charter school based on Hawaiian cultural values, a teacher will already be at a disadvantage if his or her curriculum and preparations are based on a traditional school science curriculum. Additionally, both pedagogies form complex structures that require a specific knowledge base. This type of border crossing (Aikenhead, 1996) can only happen if teachers possess confidence in both the nature of science (NOS) and PCK. This requires teachers to be confident in ancestral stories and scientific inquiry facilitation (Waiti & Hipkins, 2002).
Teacher Experience in Science Inquiry

If students learn science through their own experience and building upon what they already know, how important is teacher pedagogical knowledge in this process? Although scientific inquiry may seem instinctive, a process humankind implements on a daily basis, the complexity of the method is far from instinctive. The teacher is crucial in this process, and teacher knowledge of this method drives the process. The National Science Education Standards (1994) stated that “inquiry into authentic questions generated from student experiences is the central strategy for teaching science. Teachers focus inquiry predominantly on real phenomena, in classrooms, outdoors, or in laboratory settings.” The standards also require that science teachers guide and facilitate learning through focusing and supporting inquiries, orchestrate discourse among students about scientific ideas, and model skills of inquiry though open curiosity (National Science Education Standards, 1994). The NSTA recommended that teachers help students to identify and ask appropriate questions that can be answered through scientific investigations. Additionally, a teacher should help students design and conduct investigations, use equipment, and communicate their results (NSTA, 2004). Welch et al. (1981) suggested that the desired state of a scientific inquiry environment is the responsibility of the teacher “the teacher is the critical factor in achieving a desired state consistent with inquiry teaching.”
The science teacher who promotes inquiry in class values inquiry, encourages inquiry, and enables others to understand the process (Welch et al., 1981). Wells (2000) stated that a teacher must promote an inquiry-safe environment for students. The teacher should be “able honestly to say, in response to students’ questions, I don’t know, how can we find out?” (Wells, 2000). Wells confirmed that this action will create an “ethos of collaborative inquiry in the classrooms” (p. 23).

Scientific inquiry in K–12 schools is an instructional strategy, just as direct instruction, lecture, mentoring, and demonstration are used by teachers to relay information that will add to students’ experience and knowledge base. Hence, teachers who utilize this instructional strategy must be skilled in navigating students through this process fluidly and without bias. Additionally, teachers must be skilled in facilitating students’ focused reflection on the process in order to ensure that a layer, or layers, of a knowledge base have been laid so that structures of knowledge and experience can be supported and added. Therefore, if scientific inquiry is a school’s instructional strategy of choice, the opportunity for attainment of pedagogical knowledge of this strategy must be provided. Dewey (1938) stated that “any education experience is mis-educative that has the effect of arresting or distorting the growth of further experiences” (p. 25).
Once in a while, there are initiatives and spikes in the learning environment that force the education experts, teachers, professors, and curriculum writers to question their approaches. Introducing a strategy such as scientific inquiry into science education was one of those “shake-ups.” Although appearing in the late 1970s as a replication of professional practice (National Research Council, 1994), today it is still being “introduced” into the schools. Prior beliefs still come into conflict with developing conceptions of project-based science. Keys and Bryan (2001) described these beliefs as “myths” and categorized these myths. Four types of myths that pertain to this concept are the transmission myth, the efficiency myth, the myth of rigor, and the myth of preparing students for examination (Keys & Bryan, 2001). An article puts practice to these myths by providing an in-depth examination of one middle school science teacher’s attempt to understand and implement project-based and scientific-inquiry instruction. Ladewski, Krajcik, and Harvey (1994) exposed challenges teachers experience when faced with unfamiliar scientific inquiry-based instruction.

One challenge is not being able to cover the mandated curriculum because of student investigation and collaboration. This issue is especially crucial in this time of accountability and testing. Teachers and administrators must look at time limitations of the year and ask important questions. “Should the teacher use
her limited instructional time to encourage students to ask their own questions, pursue their own investigations, and share ideas or use the time to help students pass the test by covering all the curriculum standards?” (Ladewski et al., 1994, p. 500).

Among many other challenges teachers face when enacting project-based instruction is whether to encourage students to take responsibility for their own progress and their own learning or whether to let the teacher direct the flow of information and activities in order to control student behavior and classroom management. It is harder to facilitate than to control. To control means having the correct answer and eventually giving it. If inquiry is the strategy in the classroom, teachers will have to ask the important questions through investigations rather than obtaining the correct answer. A teacher must be open to the possibility that conclusions to students’ investigations may not agree with textbook conclusions. Teachers must also be open to the possibility that students may even question traditional definitions and descriptions of scientific concepts.

In observations made with the research participants, student interest and student engagement were essential student characteristics. The National Science Educational Standards referred to inquiry as a learning process in which students are engaged. If this opportunity for student involvement is absent from a classroom, the result may be directed controlled science instruction. In an
article by Ronald Anderson (2002), the question of research regarding inquiry in the classroom was asked. Anderson mentioned several positive learning attributes that would be impacted in the absence of inquiry such as “emphasis of reasoning, reading and writing for meaning, solving problems, building from existing cognitive structures, and explaining complex problems” (p. 5).

Additionally, Anderson addressed the differences between traditional science classroom pedagogy and a scientific inquiry pedagogy, which, in turn, highlighted the negative impacts the absence of science inquiry would have. In the stifling of scientific inquiry, Anderson sees the teacher as transmitting information rather than helping students process information and as directing student actions and explaining concepts rather than coaching students and facilitating student thinking. Students’ roles in this context are mainly those of information receivers who record information and memorize facts rather than self-directed learners who process information and take responsibility and authority for answers (Anderson, 2002).

Keys and Bryan (2001) confirmed that teachers are active curriculum creators and that curricula are strongly influenced by their beliefs, their epistemology, and their knowledge of what a science education program should include (p. 635). What a story is, its place in the curriculum, and its basic meanings are part of these beliefs. In order to include ancestral stories in a
science classroom, teachers must be willing to take on the following challenges as part of their teaching beliefs.

Understanding, analyzing, and internalizing ancestral stories are major concerns that must be addressed in training teachers in the utilization of this pedagogy. This concept deals with the difference between Native Hawaiian ancestral stories and western traditional stories. In order to explore this concept, I will post a definition and purpose of a traditional story. This comes from a website dedicated to story retelling.

A *Story* is an arrangement of words and images that re-create life-like characters and events. By how a storyteller describes and arranges a description of a story’s events, issues and ideas, the storyteller gains the attention of an audience. To sustain that interest, the action of a story is often presented as revolving around resolving some human need: to feel loved, to be in control of one’s life and fate, to be able to avenge wrongs, overcome obstacles, discover and understand the meaning and purpose of life. To reward the interest of an audience, the storyteller arranges the elements of their story to fulfill the issues it raises. (Johnson, 2008)

In comparison, the following is the continuation of a question that was posted in an earlier writing. In this statement, the meaning or purpose of an ancestral story actually brings up a new question:
Do our stories and chants clearly provide instructional directives of ancestral knowledge? How do we interpret our stories, chants, imagery and dance? How many of our practices are applicable to modernity? Is it our responsibility as parents, grandparents to interpret our cultural literature and practices to our children, grandchildren and others? Our chants and stories connect us to our immediate and distant past and reveal some pedestrian information which can also be veiled in cultural metaphor. (Hookui ka mana, Personal Notes, Conference, 2009)

Beckwith (1970) stated,

Much that seems to us wildest fancy in Hawaiian story is to him a sober statement of fact as he interprets it through the interrelations of gods with nature and with man. Many a so-called moolelo which a foreigner would reject as fantastic nevertheless corresponds with the Hawaiian view of the relation between nature and man. (p 3)

The most significant distinction between the two definitions here is the fact that one concentrates on the feats, actions, emotions, and discoveries of man, whereas the definitions and statements regarding Native Hawaiian ancestral stories confirm that nature and natural phenomena are the characters and focus of stories. The importance of instruction through ancestral stories lies in these definitions and the willingness of teachers to internalize this value. In the classroom, this is where the discussion begins.
What Does Data Look Like?

In a recent observation session with prospective research participants, a portion of the Pele and Hiiaka story was broken down by the students and the teacher. At the conclusion of this activity, the teacher broke the students into groups and instructed them to read through their notes, review the notes on the board and the story, and come up with three science concepts from the story. After 15 minutes of discussion, the groups were asked to present their science concepts. There were three science concepts that were presented out of the whole class. Is there no science in the story? That afternoon, I discussed the class activities with the teacher. An interesting observation was revealed when we discussed the fact that the students read the *story*, not the *text*. During the next class session, the teacher communicated a basic truth about Hawaiian ancestral stories. She explained to the class that the ancestors documented their observations of their surroundings (i.e., the sky, weather, ocean, plants, volcanoes, etc.) in the form of chants and poetry. These chants and poetry were developed into stories. Therefore, the students need to think of these stories and the characters in terms of natural phenomena, thinking of the characters not as people but as plants, clouds, winds, waves, and so on. Beckwith (1975) stated, “The Hawaiian worshiped nature gods and these gods entered into a greater or
lesser extent into all the affairs of daily life, played a dominant part in legendary history” (p. 2-6).

This is the second challenge that teachers will face when utilizing ancestral stories in their science inquiry curriculum. Teachers must understand and accept certain truths about Hawaiian ancestral stories, the most important being that the story is text relaying data taken from observations of natural phenomena.

Hiiaka and Lohiau had many companions racing alongside them, like sharks, dolphins and other deadly fish of the sea. They swam out until the top of Wai’ale’ale was covered by the sea. That was where they floated and Hiiaka said to her man, Lohi’au: “here we are in Hawaii sea called Moanawaikeoo. This sea travels to Oahu and further on to the horizons of Kahikiku where it crashes against Kahikimoe. This is where the surf swells. Get ready, the waves are coming, Ka’onohiokala is rising.” As soon as the rays of the Sun spread across the surface of the water, Hiiaka called out for the waves to come. A huge gust of wind blew in, bringing a large current inshore. When the surf comber rolled in, it towered. Hiiaka encouraged Lohiau to soar like an akihikeehi ale bird and ride on the highest point of the waves. Hiiaka swam after and surfed the wave. At that time, all of the signs that Hiiaka mentioned to Wahine omao were seen in the heavens (Poepoe, 1999)
This portion of a very old, very significant story in Hawaiian culture is an example of informative text written by ancestral observers. All of the references to nature in the above text are descriptions of natural phenomena and are presented in a story-like fashion. In the following passage of the above text—

Get ready, the waves are coming, Kaʻonohiokala is rising.” As soon as the rays of the Sun spread across the surface of the water, Hiiaka called out for the waves to come. A huge gust of wind blew in, bringing a large current inshore. When the surf comber rolled in, it towered. Hiiaka encouraged Lohiau to soar like an akihikeehi ale bird and ride on the highest point of the waves—

—one can pull out important data on ocean characteristics, the time of day and/or year a specific swell occurred or a current brought wind, and indicators of this phenomenon such as bird sightings (akihikeehi) or sightings of fish such as moano, dolphins, and bigger pelagic fishes.

An ancestral story could be read to simply support a scientific inquiry due to the fact that the story itself describes aspects of western scientific concepts. If one were to read this passage as a story only, it is doubtful that observable data would be the outcome. However, this study regards the ancestral story as the data, as the natural occurrence. If teachers and students do not regard the text of
the story as such, then the occurrence described above with the participant students in the classroom observation will become a common scene.

*Other Cultural Science Education Models: A Comparison*

There are several resources that promote indigenous science in the science classroom curriculum. The teacher’s dilemma involves choosing the most appropriate cultural view of science to utilize in conjunction with western science education if the goal is learning the nature of science (Waiti & Hipkins, 2002). In a paper presented at New Zealand’s Science Education Symposium, Waiti and Hipkins discussed this problem. They pointed to three models: the traditional ecological knowledge (TEK) and cross-cultural perspective, Stanley and Brickhouse’s multicultural perspective, and Cobern’s and Loving’s pluralist perspective. Waiti and Hipkins concluded that the TEK perspective, although holistic, does not draw clear lines between NOS and cultural systems, whereas the multicultural perspective emphasizes science as a distinct cultural system. They agreed that the perspective most appropriate in alignment with western science is the pluralist perspective described by Cobern and Loving (2001). The appropriateness lies in the fact that this perspective keeps other worldviews separate from science, “taught and valued on their own knowledge building terms” (Waiti & Hipkins, p. 8).
The science curricular method described in this study intersects pedagogies rather than serve as a support program. Therefore, this study is not particularly about ancestral knowledge and experience that are illustrated in oral narratives and stories, although this is a very important characteristic of this proposed method. This study will focus on the epistemological method displayed by the ancestral stories. This concept will be rolled out throughout the course of the research.

*Our Place in the Realm of Hawaiian Intelligence—Ancestral Identity*

It is important that within the constructs of border crossing, world view vs. western science, and indigenous ways of knowing, that we know who we are and who we strive to become within the daily course of science learning. Gee (2003) stated that “learning—active learning—is inextricably caught up with identity” (p. 59). In order to actively and critically learn within a semiotic domain (Gee, 2003), students must make a commitment to see themselves in terms of the identity of a person who can learn in and value that domain. Gee defined *semiotic domain* as “any set of practices that recruits one or more modalities (oral, written, language, images, equations, gestures, graphs) to communicate distinctive types of meanings” (p. 17). Gee confirmed that learning in a semiotic domain requires identity work. It requires taking on a new identity and forming bridges from one’s old identities to the new ones. For example, a
student engaged in real science inquiry and not just passive learning must be willing to take on the identity of a science investigator and problem solver.

Therefore, the problem lies in the situation where a student is unwilling to take on a new identity. According to Gee’s theory, these students must successfully make connections between the old identities and this new one; they must form bridges from their semiotic domain to a new semiotic domain. There have been many instances in my tenure as a high school science teacher that I have observed Native Hawaiian and other local students appear resistant to and threatened by this science thinker identity.

This frame of fear is problematic for learning in a deep way. Gee stated that people cannot learn within a semiotic domain if they are not willing to commit to seeing themselves in terms of a new identity, an identity that immerses them in the values and beliefs of this new domain. If this commitment overcomes the few, then others committed to this new domain will value, accept, and recognize these students as part of their affinity group.

How do Native Hawaiian students communicate this identity within the social context of science inquirers? Gee explained two different concepts that can answer this question. The first concept is that of Discourse with a big “D” (Gee, 2005). There is a way in which we recognize a scientific-inquiry world of Discourse even if there is no mention of it being science. Science learners look a
certain way; they have certain characteristics; and they display certain kinds of values and attitudes. Gee described this configuration of words and things as the “Science Learner Discourse.” We can describe ancestral stories’ Discourse in the same fashion; they have certain characteristics, and they display certain kinds of values and attitudes. Therefore, the question is this: Can these be integrated into one Discourse?

The next concept that Gee described is intertextuality. Gee (2005) defined intertextuality as “the way in which a piece of spoken or written language uses or reuses works from elsewhere by either quoting them or alluding to them in some fashion” (p. 176). As we read a story written hundreds of years ago in a world totally separate from a science inquiry-based classroom, we see a very situated Discourse. However, this concept of intertextuality allows students and the teacher to reuse works from the stories in the science inquiry process or vice versa. For example, after experiencing the story and pulling out the natural phenomena that occur in the story, a teacher may ask the class to list evidence from the story that supports this statement. This border-crossing-type process is a link to pedagogical intersection.

The prediction for the students and teacher who participate in this research is that they develop the ability, confidence, and wherewithal, either consciously or unconsciously, to form their own identities. The teacher is also
expected to be able to foster that identity through her knowledge of the stories. The assertion of this prediction is based on these facts: (a) ancestral stories provide students a “study” of a specific natural phenomenon, (b) ancestral stories are well documented either in the original text or through many translations, and (c) ancestral stories are ancestral and belong to the students.

The research hypothesizes that the structure of scientific inquiry through ancestral stories builds what Gee (2003) called the “regime of competence” (p. 71). This principle bears a strong resemblance to Vygotsky’s Zone of Proximal Development (Vygotsky, 1978) in the statement that the learner gets “ample opportunity to operate within, but at the outer edge of, his resources, so that at those points things are felt as challenging but not undoable” (Gee, p. 71). The following are ways in which ancestral stories accomplish this.

- They form a foundation of deep thinking necessary for commitment to new identities.
- They provide opportunities for practice that in turn sharpen the inquiry skills of the teacher.
- The teacher will be able to form new Discourse identities for her students in discussing their achievements and strategies with other teachers, administrators, and parents.
They form a “community of practice” (Lave & Wenger, 1991) with students that involve situated discourse that deepens inquiry regarding nature and science.

Phinney (2004) defined ethnic identity in terms of development:

Ethnic Identity Development is an aspect of becoming an adult. Becoming an adult involves figuring out who you are, finding a sense of direction and purpose. . . . finding a niche, or a comfort zone; in short, developing a secure identity. (p. 1)

It is a self-conceptualization that includes a sense of membership in an ethnic group and the attitudes and feelings associated with that membership. For those individuals who claim an ethnic identity, membership in this group provides salience and centrality (Phinney, 1996).

Phinney established a definition in order to construct measurement tools for ethnic identity development among adolescents. Within this writing regarding the ethnic identity development, Phinney supported my understanding of ethnic identity through a description of the Multigroup Ethnic Identity Measure. This is a survey designed to assess ethnic identity. Phinney (2004) found that positive results of this measurement are associated with psychological well being, lower rates of substance abuse, and absence of depression. Using principles from other identity theorists such as Marcia and
Erikson, Phinney found that commitment, or the strength of one’s ties with a particular ethnic group, derive from one of two sources. One source is commitment without exploration or foreclosure. Such commitments are unexamined, as in the case of the adoption of one’s parents’ views without questioning their meaning. Another source of commitment is achievement or commitment with exploration. This refers to one who has developed a personal understanding of his or her ethnicity. The term used in this paragraph is exploration. This refers to the process of examining the implications of one’s ethnic group membership (Phinney, 2004). Although these concepts of ethnic identity are presented as short, hard, and fast in these last two paragraphs, the four descriptions of ethnic identity does build a foundation on which to pull in, compare, contrast, and examine concepts in the context of the students in this study.

A recommendation from Phinney’s identity measurement is that exploration and commitment is a strong combination in identity discovery. “More questions lead to better understanding and increased understanding leads to more questions,” stated Phinney (2004, p. 9).

Identification with one’s group involves more than group membership. Phinney (1996) stated that “components such as self labeling, sense of belonging, positive evaluation, preference of the group, ethnic interest and knowledge, and
involvement in activities associated with the group” (p. 923) contribute to self-esteem development. Relating therefore to the previous paragraph, ethnic identity is a process where one progresses from taking one’s ethnic identity for granted solely on the basis of opinions from others to an achieved identity that reflects confidence and enthusiasm regarding one’s membership group.

Being a member of a group demands a sense of responsibility to the growth of the group. This process may include “learning about the history and traditions of their group and confronting issues of discrimination and prejudice” (Phinney, Romero, Nava, & Huang, 2001, p. 136,137). Examples of these traditions and history are artifacts such as ethnic language proficiency, cultural maintenance, and social interaction with peers. “Social interaction can provide a means by which ethnicity is experienced and expressed” (Phinney et al., p. 139). However, an important issue of ethnic identity that is related to cultural ethnicity (Phinney, 1996, p. 921) is that of heterogeneity. For example, an individual of a certain Native Hawaiian blood quantum can say that he or she is a member of the same group as me; however, I may disagree due the degree of involvement that characterizes my membership. Therefore, defining specifically an individual ethnic identity, I feel, must depend on the individual and the progress through their commitment and exploration of their ethnic group.
Phinney utilized poignant categories in evaluating the extent and benefit of ethnic identity. As mentioned previously, high *commitment* and *exploration* are strong indicators of achieved ethnic identity. In adolescence, *exploration* questions begin to arise, and *commitment* to the group of membership is being achieved (Chavez & Guido–DiBrito, 1999). Phinney (1996) stated that “ethnicity is a meaningful psychological variable to the extent that it has salience and centrality of the individuals involved”—the stronger one’s ethnic identity, the greater the contribution that identity makes to one’s self concept (p. 922). One starts to look at aspects of oneself (i.e., self-concept, sense of belonging, physical characteristics, familial characteristics, and natural interests) in terms of one’s ethnic identity. For some, ethnic identity is a process that begins with exploration and moratorium to an achieved identity committed to group membership. Herein lies the strength of Phinney’s theory to the frame of this research.

The hope for this research is that students will begin to observe nature, school, and other academic pursuits through the window of their ethnic identity. This group membership will become a salient and central part of their learning and experiences. Ancestral stories are impactful artifacts that can achieve this commitment because they belong to the students and no one else. These texts, which have been studied, documented, discussed, translated, and documented
again by different groups of academics, commercialists, and authors, fundamentally belong to Native Hawaiian students. Ownership of this resource is one of the “perks” of group membership.

“In some ways, Hawaiian Identity has been conceived, manufactured, and fabricated by external forces that do not share the interests of the indigenous peoples that they mold and shape to fit their own reality” (Halualani, 2002). Although Phinney’s research does not focus on Hawaiian identity or any “named” ethnic group and generalizes the theory to include all ethnic groups, the above quote does describe the weakness of this theory (and perhaps others) in terms of deeply rooted convictions of these people. Kanaiaupuni and Malone (2006) wrote about the Hawaiian identity’s connection to land. This definitive description of the Hawaiian ethnic identity is missing here and in other cases of research regarding cultural and ethnic identity. This is, of course, due to no fault of the author, but it is a weakness in regard to the application of these theories to Native Hawaiians.

Ancestral stories and Native Hawaiian students’ utilization of this tool to excel in science inquiry are specific to one ethnic group, Native Hawaiians. Perhaps the possibilities for this curriculum expand to other Polynesian people, perhaps to other indigenous groups, but this research and researcher are well versed in Native Hawaiian literature and students and regard the claim to their identity as a priority. Kanaiaupuni and Malone (2006) argued that “Place is a key force in the interplay of internal and external influences on contemporary Hawaiian identity processes” (p. 284). The same could be said about ancestral
stories; the two go hand in hand, as one explains the other and the other provides the source.

Predictions for the students and teacher who participate in this research are that they develop a stronger commitment through exploration of a cultural context, that of ancestral stories. Phinney (1996) stated that a progression occurs “through a period of exploration into the meaning and implication of one’s group membership; to an achieved ethnic identity that reflects a secure, confident sense of oneself as a member of a group” (p. 923).

Research has shown that group identity is an important predictor for global self-esteem (Phinney, Cantu, & Kurtz, 1997). This research also includes an increased sense of belonging, positive attitudes, commitment, and involvement with one’s group as significant predictors of self-esteem. Broadly speaking, this is a positive prediction for the students and teacher participants in this research, but Hawaiians have no words for self-esteem. However, for the sake of global application, this is a strong indication of the direction of this research. More importantly, the intellectual level of interpretation and inference that exists in the stories is reason for esteem building, not necessarily in the self but in the individual’s source.
Chapter 3
Method

Frameworks of Methodology

This study utilized methodologies that served as both theories and methods, and therefore there was a direct connection between the method of study and the structure of research support. The literature review discussed two culturally reflective influences, Discourse Analysis and an indigenously unique Native Hawaiian approach to research.

This study was based on an ancestral epistemological process that has stood time tests and, when unpacked by this study, will be available to all students and teachers. Stories are functions rooted in culturally defined scenes and events and are fundamental units of description and analysis (Mishler, 1999). Within this vision of not only storied learning but also ancestrally identified pedagogy, process inquiry was an appropriate framework for this research.

Discourse Analysis

Discovering what is said and what is really said in a conversation is done through discourse analysis. The literature review stated that stories are deep conversations that were recorded in a storied format. Gee (2005) confirmed that a conversation is composed of a myriad of interactional events taking place among specific people at specific times and places. Specifically, we were studying discovered learning processes of Native Hawaiian students through
their experience with ancestral stories and scientific methods. More definitively, the participants were Native Hawaiian students in a charter school science class with a science teacher who was knowledgeable about Hawaiian culture but was more skilled in scientific inquiry methods. Therefore, the temporal and social characteristics of this research justified the use of discourse analysis. However, this is not the most important reason for discourse analysis utility. Conversation and language are used to give things meaning and value (Gee, 2007). In the conversations that took place after the story was read and analyzed, students would attempt to make sense of the story and apply meaning and value to activities, ideas, and morals relayed in the story. This effort to signify ideas and morals is one purpose of discourse analysis. Another reason for the application of this methodology is the expectation of changed identities or transferred identities. Gee (2007) stated that “we use language to recognize taking on a certain identity or role that is to build an identity here-and-now” (p. 11). When observing the students’ conversations, as well as conversations with their teacher, the language used depicted transference of identity in the direction of deeper interpretation of science methods through their ancestral stories. Discourse analysis entered into this research as a “framework” rather than a theory within the text of the literature review. Gee (2007) wrote of discourse analysis as if it were a method to be used in order to construct contextualized meaning out of discussions and conversations among participants of varied backgrounds. Although the languages being heard from these participants were diverse and might have a diverse history, they are connected. Gee stated, “in
any situation things are connected or disconnected, relevant to or irrelevant to each other, in certain ways” (p. 102). In the data, students struggled to connect their articulation of science to the ancestral stories that they read. The conversations and discussions facilitated by the teacher mitigated the connection.

Linda Tuhiwai Smith (1999) confirmed that the position of an indigenous insider is one of great responsibility and fortitude. As recipients of ancestral knowledge, we have different reasons for empirical and academic studies than non-indigenous researchers do. This writing will discuss these positions and responsibilities through the knowledge of indigenous authors such as Dr. Manu Meyer and Kawena Pukui. The methodology for data collection, analysis, and interpretation will be acknowledged.

Native Hawaiian Research Method

Meyer explained that Hawaiian understanding is our own understanding. In her gallant undertaking to experience Hawaiian understanding, she framed Hawaiian epistemology within seven distinct moku of knowing (Meyer, 2001). The method of data gathering that Meyer utilized is one common to many Native Hawaiian researchers. For the composition entitled Polynesian Family Systems in Kau, Mary Kawena Pukui spent endless days interviewing the kamaʻaina of Kaʻū. More recently, Larry Kimura recorded valuable interviews he conducted with many well-respected, much-loved Kupuna. My grandfather, a Hawaiian educator, knew that his conversations with the kamaʻaina of Lāʻie and Kahuku must be recorded. His tapes are kept at the BYU Hawaii Library. These
recorded interviews have been data-gathering tools of Native Hawaiian researchers to explore and experience our ancestral stories.

In the same respect, an older and much more basic data-gathering tool of Native Hawaiian research is an ancestral pedagogical process. The form of teaching children a practice was simply to observe and listen with no interruptions. Any questions or interruptions would be thought of as niele [intrusive] (Pukui, 1998). This was done for several basic reasons; first, it was dangerous for the Kumu to take his attention even momentarily off her work. Another reason is that it demonstrated respect toward their kumu, as it did toward the practice itself (Pukui, 1998). In Manu Meyer’s research, a kupuna participant confirmed that the elders learned more by observations and learned nearly nothing by asking questions (Meyer, 2001). “Be very observant, and when you are to listen, listen very carefully, that’s not for you to open your mouth” (Meyer, p. 133). This is the only teaching method I experienced in my Hula tradition. From basic steps to lyrical compositions, my only training was through observation, listening, doing, and being corrected as needed. Therefore, whenever something was being presented, such as a new dance, a new step, or a new skill, you did not start doing it right away. You watched, imitated on the second instruction, and then tried. In congruence with other indigenous cultures, the method of observation and reflection was a common form of data collection. Oscar Kawagely (2006) described this by stating, “culturally appropriate knowledge was gained through activity as well as contemplation
and observation” (p. 21). My data-gathering methods were patterned after this genealogical teaching strategy.

Along the same lines as the pursuit of ancestral knowledge, data are analyzed according to familiar and inherent science. There are several sources that agree with this pursuit. Smith (2000) wrote on the uniqueness of Kaupapa research: “Kaupapa Maori is derived from a very different epistemological and metaphysical foundation that gives Kaupapa Maori its distinctiveness” (p. 261). The distinctiveness of Native Hawaiian research is not only in its epistemological foundation, but also in its significant purpose. In the aforementioned paragraphs, it was stated that the purpose of Native Hawaiian research was to delve into the deep pool of ancestral knowledge and to apply that knowledge to Native Hawaiians’ existence today. In this context, the analysis of gathered data is the bridge between what is observed and how it is interpreted. Therefore, the question to ask is this: What does Native Hawaiian data interpretation look like?

There are two major types of data interpretation that I utilized in my research that mimic ancestral interpretation and analysis. The first is a stratified sequence exemplified in the creation chant of living things entitled the *Kumulipo* (Beckwith, 1981):

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Hanau ka i’a, hanau ka naia, i ke kai la holo
Hanau ka mano, hanau ka moano i ke kai la holo,
Hanau ka nana, hanau ka mana i ke kai la holo,
Hanau ka nake, hanau ka make i ke kai la holo,
Hanau ka napa, hanau ka nala i ke kai la holo.
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This is an example of a pure recording of observed data. Briefly explained, this analysis is listing the observed phenomena as they occur. In this
example, a larger species is born and a smaller species is born; both are in the ocean, and both are sea travelers; then they swim. This type of data interpretation has three main characteristics: (a) it is a listing of observed characteristics of natural phenomena, (b) humans are close to last on the list, and (c) it is very, very old (Beckwith, 1981; Fornander & Thrum, 1919; The Kumulipo, 1897).

The second is a more global form of narrative. Stories transcend generations and are effective methods of communicating information. Ancestral stories or moʻolelo, or kaʻao, are valid forms of research and are part of a wider indigenous movement toward native research methods. In Aotearoa, an indigenous research movement, Kaupapa Maori provides a platform to represent valid research a pure and authentic form of cultural research (Lee, 2005; Smith, 1999). Below is an example of data interpretation through story methodology:

Hiʻiaka and Lohiau had many companions racing alongside them, like sharks, dolphins and other deadly fish of the sea. They swam out until the top of Waiʻaleʻale was covered by the sea. That was where they floated and Hiʻiaka said to her man, Lohiʻau: “here we are in Hawaii sea called Moanawaikeoʻo. This sea travels toʻOʻahu and further on to the horizons of Kahikikū where it crashes against Kahikimoe. This is where the surf swells. Get ready, the waves are coming, Kaʻonohiokalā is rising.” As soon as the rays of the Sun spread across the surface of the water, Hiʻiaka called out for the waves to come. A huge gust of wind blew in, bringing a large current inshore. When the surf comber rolled in,
it towered. Hi‘iaka encouraged Lohi‘au to soar like an akihike‘ehi ale bird and ride on the highest point of the waves. Hi‘iaka swam after and surfed the wave. At that time, all of the signs that Hi‘iaka mentioned to Wahine‘omao were seen in the heavens (Poepoe, 2002).

If you unpacked this data analysis, you would be able to deconstruct categorized data. For example, the first sentence mentions the species of sea dwellers that inhabited the ocean break at that time of the season. The second sentence describes their location—specifically, the part of the ocean break. This is a compacted analysis that holds a generous amount of data. This form of data interpretation is purely Hawaiian. A case study, for example, is arguably general to a specific context. Ethnography may be another consideration for this study because it offers a means of natural observation. However, this study requires an intervention, or an introduced curriculum in order to take the necessary data.

Setting and Participants
The research took place at a 7th- through 12th-grade charter school on the east side of Hawai‘i Island. This school is located in a small community that is situated within a Hawaiian Homes subdivision across the street from the ocean. It is approximately 10 minutes away from the largest mall on Hawai‘i Island and 4 miles away from Hilo Harbor. The school is on a piece of 14 acres leased by the Edith Kanakaole Foundation. The foundation’s office is directly in the back of the school. A preschool is also located right next to the office.
Besides the coastline, a fishpond system is located approximately 1,000 yards away from the school, and a community māla [garden] is located directly across from the school. These resources are available to the school and the students.

The direct research activity took place within the science classroom. The science class utilized the fishponds and other coastline resources within the curriculum.

Students

The students were all from the science class. There were 21 students among three different classes who participated in this study. The three different classes contained students ranging from Grades 9 to 12. There were 14 boys and 7 girls among all three classes.

The students came from all areas of Hilo. They were all of Native Hawaiian descent, among other ethnic variations, and all were raised on Hawai‘i Island. The fact that they were students of a charter school revealed that their families had all chosen to attend this school. The students all expected to learn basic Hawaiian cultural values as well as Hawaiian cultural practices; this was an expectation, not an exception. Academically, the students varied in ability and performance. Reading levels among the 21 students ranged from third grade to
grade level. Quarter-ending letter grades also ranged from “F” and “D” to “A.”

There is no evidence of academic or skill-based tracking.

These students had been exposed to scientific inquiry in one stage or another. The biology class was made up of new students who would have had at least three quarters’ worth of scientific inquiry work by field observation time. Four of the total students had been with the same teacher for at least 2 years and were therefore well versed in scientific inquiry.

Teacher

The teacher in this research was an active participant. She had been a secondary science teacher since 2001. Her area of specialty is the biological sciences, specifically marine science. The teacher was an integral component of this study. This 34-year-old teacher was a 9-year veteran science teacher. Her specialty area is marine science, and she earned her master’s degree in the subject. She had done science projects for many years, had focused her class on scientific inquiry, and had since changed her direction from science projects to science symposiums. The hosting school for this research was a culture-based charter school, and the teacher was a large part of this foundation. She admitted that she knows the culture more than the average teacher. Her cultural knowledge stems from her years in a Hula Hālau, her language background
from Kamehameha Schools, and her experience with cultural practitioners in chant and lomilomi (massage). Although it might seem that this teacher’s apprenticeship in the culture takes her several steps above other teachers, she is the first to admit that her weakest point is cultural knowledge. She is also in charge of the fishponds across the street from the school. Her class collects water and fish quality data on a consistent basis in order to maintain the health of the ponds. Her agreement and enthusiasm to promote this research were a positive reflection of her characteristics as a science teacher and a cultural student.

This teacher took on the responsibility of the fishponds located across the street from the school, as mentioned previously. This teacher was able to take on this responsibility and many other new projects because she made it a point to structure learning to the point at which each student is well aware of his or her responsibility to the project. Classroom management was not a variable in this classroom. The lesson did not have to be halted in order to deal with student behavior. Therefore, this research and many other learning strategies were possible in this teacher’s classroom. The all-encompassing characteristics of this teacher were an appropriate fit for this study.

_The Researcher’s Role_

The teacher was an integral part of this research. The decisions she made in the classroom were due in part to the discussions we had and in part to the
dynamics of the class session. Additionally, all activities of the class session were very important puzzle pieces that must not be corrupted, lest the picture be skewed. Therefore, the role of the researcher was that of observer during class times and colleague during non-class times. We kept a constant dialogue between class periods about the activities of the day and the next steps. Whether or not we should stay with the plan or deviate due to the observations made in the class was discussed and recorded as data. For the purpose of building a theory based on this research, close attention to observations and classroom activities was imperative. In order to amass the richness of this research, the principal investigator needed to spend all the time afforded in direct contact with the students, immersed in data gathering and observation. Therefore, it is necessary to become a pure observer in the classroom; moreover, it is important to become a co teacher beyond the classroom in order to build a curriculum transferable to other teachers and faculty.

Design

The design of this research is specific and has been distinctly organized for the purpose of this research. There had to be a means to present the intervention of the ancestral story into an existing science curriculum—hence the specificity of the design. Through full cooperation and collaboration between the
The researcher and the teacher on every facet of this project, the aspects of this doctoral research morphed the liquidity of field study into the flow of the setting.

The details of the project have been negotiated with the teacher; however, due to ever-changing schedules and unforeseen circumstances, changes have been made to suit the dynamic classroom setting. A precursor questionnaire or what we labeled a “preflection” was created and given to the students. This preflection was created to ascertain the level of confidence the students expressed toward science and culture. In order to see a change, a starting point has to be determined. These documents served as the starting point. We had planned to pass out this questionnaire to the students prior to delivery of the first story; however, as previously mentioned, the school schedule had changed for all classes to accommodate unforeseen testing circumstances. Therefore, the preflection was actually given out after we had started reading the story to the students. This was at least 1 week into the lesson.

The researcher and the teacher chose stories or ancestral narratives (which can be chants, poetry, or stories in the form of verse and metaphor) appropriate for the class. At this stage in the fieldwork, the teacher and the researcher chose the stories based on four criteria. Criterion 1 was that the story had to relate to the present science content. For instance, the marine science class was involved in fishpond studies; therefore, their story spoke of the goby, or oopu fish, often
found in these estuary environments. The second criterion called for the stories to be ancestral. An ancestral story is one that is old and passed down from generation to generation, created by many composers who contribute to the integrity of the story. Criterion 3 was that the story have several translations such as the story of Pele and Hiiaka, or Kamapuaa. Presently, there are at least four different versions of Pele and Hiiaka, and there may be more undiscovered. The last criterion that needed to be considered in choosing a story was that the written text contain a number of chants and names of people, places, and things. Each of these attributes of a story is packed with information—hence the criteria.

Following the story choice, each student read the story silently while the teacher read the story aloud. The teacher asked the class for the main ideas of the story and wrote them down on the board or chart paper. Contribution from the whole class was essential in the discussion. This activity was done in sequence; therefore, events in the story followed the sequence as they appeared in the story. The next step was the translation of names of people, places, and things in the story. This was done by simply portioning out the story and then dividing these portions among student groups. All the names in a certain portion of the story were the responsibility of the group that chose that portion. Then, in these same homogeneous groups, the students organized the main ideas and any other ideas not listed on the board into a graphic organizer, preferably
an idea web. The reason for this step was to establish a starting point of the
inquiry. After checking for understanding and efficiency, the groups then pulled
out the scientific—or what they perceived to be scientific—aspects of the story, or
extended out the arms of the main ideas into scientific concepts, or what they
perceived to be science. The following is an example of this process. Taken from
the 10th-grade biology class, this portion of the transcript recorded the
presentation of a graphic organizer done by two male students:

A: Off of the main source, we webbed out people, that’s Panaewa and
Hiiaka, and then we have one for gods and then off of gods, we have
the names and this one is wahine omao, and Papulehu and Pau o palai,
and we translated the meaning of their names, the green woman, and
the skirt made of ferns. Off of the meanings, we webbed out their
element or what they did.
K: How come you have the moo form and not the other forms, they could
turn into plants and stuff?
A: It doesn’t really say what they actually change into, it just says they
come into the battle.

This portion of the transcript exemplifies the organizing process prior to the
identification of the science concept. This portion basically demonstrates the
adherence of the organization to the source. The students were then asked to
come up with questions that pertain to each topic at the end of the arms of the
web. After this was completed, the students were asked to compose three
investigative science statements based on the questions and evidence, or “data,”
that they gathered from the story. In another lesson, the students were asked to
write down any questions they had about the story. In order to prompt
questions, students responded to the following statement: “If the author for this story was right here now, what questions would you ask him or her?” They listed a minimum of three questions.

It was decided that the researcher and the teacher would create several forms of assessment. The purpose of the assessment in this case was to qualify the exercise as a tool for utilization of this method with ancestral stories and scientific inquiry.

Throughout this process, there were several student work products. These documents were used as instruments in data gathering. This collection of documents included, but was not limited to, webs, questions, two-sided tables that included the research statement and the evidence that supported that statement, and questions (questionnaire in essay form) that informed both the teacher and the researcher of the students’ attitude toward this experience and their connection to the stories. Other documents that the researcher and the teacher planned on collecting were drawings in lieu of written descriptions and journals that informed the teacher and researcher of students’ comfort level with this curriculum. The teacher also decided that there should be questions that would prompt specific journal answers from the students that would allow the researcher and the teacher to give feedback to the students in regard to this experience.
The final step in this process not only provided closure for the students, but also served as a follow-up for the research questions. The last step was an initiation of a science project built on a hypothesis formulated from the activities mentioned above. This science project was a transforming instrument in this process.

*Instruments of Data Collection*

There are three distinctly different forms of data collection systems that were activated in this study. Student-produced documents including questionnaires and journals have been analyzed. An audio taped interview occurred between the teacher and the researcher. The researcher analyzed audio and video tape taken of the class, which provided the richness of the conversations and class discussions occurring in the classroom. One of the methods to be utilized in analyzing the data for identity emergence discovery was that of discourse analysis. Therefore, the video and audio taping was essential.

*Student-Produced Documents*

The documents were mentioned in a previous paragraph in this writing. To review, the types of documents that were collected are student class assignments that includes the feedback, and homework. These are crucial in the analysis of both academic understanding and identity redefining. As mentioned
in the literature review, students need to dwell and believe in the identity within a semiotic domain of a successful learner (Gee, 2003). The identity of their ancestors is one that contributed to the creation of amazing ancestral stories.

Other documents that were collected and analyzed were question-and-answer essays. These question-and-answer essays were constructed by the researcher/teacher team and focused on the progress toward making connections between science and ancestral stories. This connection building was important because another major point in the literature review is experience and education and the desire to understand (Wells, 1997). It was stated in the literature review that these stories provide Native Hawaiian students with experience—the experience needed to develop an inquiry frame of thought. Therefore, this reference in the literature review will be the basis of the coding.

Interviews

Interviews were conducted between the teacher and the researcher. This interview was found to be crucial to the data design. Within the mix of the fieldwork, it was appropriate for only one formal interview to be conducted with the teacher. Therefore, only one formal interview occurred approximately 2 weeks after the last classroom observation session. According to the theory of pedagogical content knowledge, as described in the literature review, reflection and review of teacher practices is a skill and, like all skills, must be honed
(Cochran et al., 1993). The last interview described the classroom, the students’ understanding and performance in science and scientific investigation, and a basic status review of the school and classroom environment. It also revealed the teacher’s struggle or ease with the integration of science and culture and student engagement in science subjects. This interview also informed the data concerning timeline adjustments, teacher needs, and student understanding. It also answered questions such as the following: What are specific skills a teacher may need to conduct this curriculum? What are the obstacles that teachers may face? What kinds of pedagogical changes are being observed among the students with the teacher? What adjustments would have to be made at this point and why? This interview was also comprehensive, and the questions that were assigned at the end of the semester had adherence to the characteristics of pedagogical content knowledge theory.

*Video and Audio Observations*

In line with discourse analysis, the students’ conversations are an essential piece of this research. In order to deconstruct and then reconstruct the data into a storied analysis, the video recordings are crucial. There were two video cameras in the room recording both teacher–student interactions and student–student interactions. A project field study completed in July laid the groundwork for the structure of grounded theory. The field study provided a
novice experience in videotaping classrooms. The experience extended to the
next step of data analysis, which is transcribing.

*Field Notes*

Field notes were taken by the researcher of choice situations and definitive
teacher–student interactions. The field notes focused upon teacher practice and
those strategies that bring about points of reflection that may be used to frame
successful facilitation of this curriculum. Research Question 2 refers specifically
to teacher practice and the possibility of teacher facilitation of the stories and
scientific inquiry. The field notes record teacher adjustments and decisions made
during class that changed the direction of the lesson. These adjustments were
important points of fact that were part of the lesson delivery process. As such,
these will be discussion points in our informal meetings and interviews.

*Confidentiality and Consent*

All students were given consent forms that required a signature from
parents or legal guardians. This form stated that all transcripts and student
documents would be kept in the researcher’s locked file cabinet and destroyed at
the end of this research. These consent forms informed parents of the research
being conducted, the documents to be collected, and the video. The consent form
also stated that in exchange for student participation, tutoring in science, science
project support, and assistance in the classroom would be given. Students that
returned signed agreements would be videotaped. Only the documents of these
students would be collected.
Grounded Theory

In the development of this research, a variety of literature in the areas of indigenous stories, stories in science, scientific inquiry, and indigenous ways of knowing nature were reviewed. These research pieces established a baseline for this study. Although these topics provided scores of information, they did not impart extraordinary material Therefore, the method of this study was grounded theory.

According to Strauss and Corbin (1998), grounded theory provides a “sense of vision, where it is that the analyst wants to go with the research” (p. 8). A prerequisite for grounded theory is the ability to think abstractly. The detailed procedures throughout this study required abstract thinking. It is very important to remember that this was an inquiry anchored in cultural pedagogy; therefore, it was imperative to observe records and assess research materials that were also anchored in cultural pedagogy. Abstract thinking was a necessary thought process for this study.

Another reason for the use of grounded theory is its characteristic of experiential data analysis and collection. According to Strauss and Corbin (1998), a researcher does not begin a project with a preconceived theory in mind. Therefore, theory comes out of the experience recorded by the data collection process (p. 12). The firsthand observation of the students’ experience with this
new curriculum and this introduction to the Native Hawaiian way of thinking was the source of the data. There were no sources of historical data, and there was no documentation of existing theory or practice for this study. All data emerged from this new experience. “Grounded theory, because they are drawn from data, are likely to offer insight, enhance understanding, and provide a meaningful guide to action” (Strauss & Corbin, p. 12).

Grounded Theory Analysis
The primary process was based on data reduction, data interpretation, and discourse interpretation. Analysis is an interpretive act, and data interpretation implies my understanding of the events (Corbin & Strauss, 2008). However, before interpretation occurred, the process began with cutting the data down to little manageable chunks. This was done by pockets or sections of time spent with participants.

The above description defines what Corbin and Strauss (2008) called open coding. They defined it as “breaking data apart and delineating concepts to stand for blocks of raw data” (p. 143). Saldana (2009) defined coding as “a word or a phrase that symbolically assigns a summative evocative attribute for a portion of data” (p. 143). The codes utilized in this study during the first phase pointed out unique methods, distinctive non-science teaching strategies, and strategies I would expect to see in a science classroom.
The second round of coding employed the method of memoing. Saldana (2009) stated that “coding and analytic memo writing are concurrent qualitative data analytic activities” (p. 33). Although memoing may have created an illusion of enumerating the data rather than reducing it, the process was instrumental in the valuing or devaluing of the data, thoughts, and codes. Memoing also “identified and developed the properties and dimensions of concepts and categories” (Corbin & Strauss, 2008, p. 118), which is the reason for the number of memos recorded during this data analysis. This process was useful in not only identifying concepts, but also opening up otherwise closed thoughts and dimensions. Additionally, when data clogged up the pipe, memoing my thoughts helped to clear up the pipeline that fed the data pool.

Open Coding

The design of this research was very specific. When conducting the open coding, this aspect was an important consideration. Due to the unique lesson plan designed to specify the data, the coding focused upon the characteristics of several ideal aspects of scientific inquiry. These aspects included but were not limited to asking questions, making discoveries, and rigorous discovery testing. Further, the coding flagged characteristics such as student-driven discussion, discourse integration (Gee, 2005), and questioning.
Again, due to the distinct research design, student reactions to the specificity of the lessons were also coded. These codes were listed either as student reactions, interactions, confidence (or lack thereof), and change in attitude. Student responses to the lessons were frequently described in the memo process. A function of memos is that they are reflections of analytic thought (Corbin & Strauss, 2008, p. 120), a function that allowed the researcher to describe the observation and reflect upon that observation.

The teacher/researcher collaboration was previously described. This collaboration consisted of many after-observation meetings and discussions regarding the student reactions, the sequence of the lessons, and any changes we saw fit to make. The effects of these meetings were seen in the next class period, and teacher strategies and student responses became part of the open coding.

**Memos**

The second phase of analysis incorporated field notes and memos. In other research instances, this second phase would be described as a form of axial coding. However, as expressed the third edition of *The Basics of Qualitative Research*, axial coding and open coding go hand in hand. Corbin and Strauss (2008) stated that “the distinctions between the two types of coding are artificial and are for explanatory purposes only” (p. 198). Axial coding or the relating of categories and concepts to each is a task covered by memoing. Memos began
with threading together literature and classroom phenomena. Ideas were formed within the memos, and categories were constructed. The most effective memos were those that allowed the researcher to free-write regarding the observation from that day. Free-writing memos sifted out the concepts and allowed the development of process.

Process is the interaction, action, or emotion taken in response to a problem or in achieving a goal (Corbin & Strauss, 2008, p. 97). Although this is a description of one of the main concepts in the grounded theory method, it also became a result of integrating concepts. Therefore, the idea of “process” encompassed several important interactions between the teacher and students, between students and other students, and among the researcher, the teacher, and the students. Memoing as part of the process and memoing the “process” of ancestral stories and scientific inquiry featured twists and turns throughout the data analysis task of this research.

The memos dictated the direction of the process. There were several incidences of discovery following a reflective session of memoing. For example, after reading a selected chunk of raw data, open coding was at a standstill. There were no indicators of scientific inquiry or student interaction that could become part or add to the pool of already collected codes. Memoing then began after reviewing a portion of the raw data. After a few sentences, a major theory
emerged. From that one chunk of uncodeable raw data, a two-page memo was created that revealed an impactful concept in this research. In following the example set in Corbin’s (2008) research on the Vietnam War, the memo process became the basic source of data. It replaced, in part, both open coding and axial coding. From the memos, the categories and discoveries of theory were achievable.

The pilot study laid the groundwork for the major data collection. Therein theoretical sampling was initiated. The initial data recorded and conditions observed during the first field work created more questions and hence opportunities for data saturation. Corbin and Strauss (2008) defined theoretical sampling as “a method of data collection based on concepts derived from data” (p. 144). Much like Corbin’s work on the Vietnam War, the theoretical sampling task was not clear until its utility was revealed in actual practice.

Theoretical Sampling

“Theoretical sampling identifies relationship between concepts” (Corbin & Strauss, 2008, p. 143). The method allows the researcher to build or sample the established concepts. For example, one of the concepts established in this research was lack of student confidence. As a concept, this was a headline code for a chunk of my data. After observing the class performing field work for their
science lab, I found that this characteristic was not observed. The absence of this characteristic was due to the fact that field work provided less time for the students to discuss anything. Ill confidence was not prevalent within this session. This led me to perhaps add vocabulary to this concept. Hence, when vocabulary was added into the same category, it could also be applied to other activities and interactions observed in the classroom. Theoretical sampling was conducted as much as possible throughout the data analysis; however, what must be understood is that theoretical sampling leads to data saturation and at some junctures, shallow raw data were as saturated as desired. To quote many a cultural practitioner, “it is, therefore it is.”

Diagrams

In addition to memoing, diagrams are important tools in grounded theory data analysis (Corbin & Strauss, 2008; Creswell, 1998). A diagram can illustrate the integration of concepts that can be then be textually translated. For example, in the theory-building process, with index cards, categories on colorful Post-its, and large chart paper, several diagrams were constructed. These diagrams demonstrated different road maps toward a theory. When one diagram revealed a comprehensive theory, there were two concepts regarding the participants that were involved in the theory but not integrated into the diagram. A matrix of concepts and participants was created as a result. The concepts were the
interacting factors or the row headings, and the participants, namely teachers and students, were the actors or the column headings. This matrix will be a guide for the narrative and will organize the data in a comprehensive manner.

The last point of data analysis to discuss is the notes and codes recorded regarding the teacher interview. The last teacher interview was conducted 3 weeks following the last observation session. The purpose of this strategy was twofold. First, in the period of time that passed, the teacher was able to schedule several forms of assessment and evaluation in regard to the intervention of the ancestral stories and scientific inquiry sessions. The results of these assessments were discussed in the last interview. Second, the time away from the sessions allowed me to conduct a partial analysis of the data collected.

Limitations to Grounded Theory

According to Strauss and Corbin (1998), grounded theory data are systematically gathered and analyzed. Critical data review is essential to this method. Due to the fact that there were many sources of data for this study and there were essentially two researchers, the teacher and the analyst, there would be conflicting categories and propositions. The basic issue is the accuracy and delicacy of the coding and category creation. Coding, according to Strauss and Corbin, is “conducted through microanalysis or a line by line analysis necessary
at the beginning of a study to generate initial categories” (p. 57). Microanalysis requires careful examination and interpretation of data.

Although very analytical and time consuming, analysis is not a structured, rigid process. It allows the researcher to flow between types of analysis depending on the data profile (Corbin & Strauss, 1998). This flexibility does not bind this research to a certain standard of collection. Other qualitative methods such as case study and ethnography detract from the data. Case study, for example, is arguably general to a specific context. Ethnography might have been another consideration for this study because it offers a way of natural observation. However, this study required an intervention or an introduced curriculum in order to take the necessary data.
Chapter 4
Results

Research Questions and Data Analysis

From previous sections in this writing, the research questions are brought forth and reviewed. This results section will review the research questions, describe the results through concept codes, and connect the literature to these results. The results section will also attempt to flesh out the patterns throughout the concepts for the purpose of satisfying the grounded theory methodology.

Research Question 1:

*How can Native Hawaiian ancestral stories encourage an increased level of student-driven interactions at all levels of feedback from Native Hawaiian students in a science classroom?*

The pilot study previously described in this writing was the precursor to this dissertation research question. The pilot study was merely a demonstration of the validity of ancestral studies in the science classroom. This research question expands upon that study and is concerned with the “how.” How does this happen? How can ancestral stories encourage engagement and encourage students to offer feedback that grows from simple one-word, one-phrase answers to discussion and volunteered explanations? The results of the data collection and analysis answered these questions.

The researcher observed three stages of student-driven interaction that occurred depending on teacher facilitation and commitment to the students’
involvement. Stage 1 was labeled *no immediate feedback*. The students were involved in the task of gaining information. The first step in the process that will be explained in the context of the next research question called for the students to read their story to themselves and follow along while the teacher was reading the story out loud. *Immediate* in this instance is defined as feedback that is instantaneous and without prompting.

*Concept-Deconstruction*

The theme that is actually a connection or even a thread throughout all the aforementioned topics is deconstruction. Deconstruction is a task, a method implemented for the purpose of comprehension and then reconstruction in an order that pulls the science concept that can be articulated.

There were different approaches observed to deconstruction. One approach came directly from the research design. This approach entailed story chunking, the search for scientific concepts, and author vs. inquiry question and construction of an inquiry question.

There are a total of 14 memos regarding this theme exclusively and a total of 28 memos regarding this theme under other topics such as student attitude and process teacher modeling.

The following transcript sample comes from the ocean class on 5/01/09. The letter T stands for teacher. The other letters accompanied by numbers represent students’ names, gender, and order of speaking.
T: K, so what happens first?
Rb1: Namakaokalani wanted to call off the battle.
T: (wob) So Namakaokalani sent msg to call off the battle, then what?
Rb1: Kaluaopalena said no.
T: Then what?
Kb2: Palila swung his war club and then knocking down.
T: Why did Kaluaopalena say no?
Hg1: Because he stayed all night and all day.
Kb2: He wanted to go all for it.
Hg1: ‘Cause he …
Sb3: Couldn’t sleep.
Rb1: :Planning for the battle.
T: We did that?
Hg1: The guy comes.
T: What guy?
Hg1: Namakaokalani.
T: With what?
Hg1: With his war club.

All of these points of the stories are written down on chart paper (wob, write on board) and displayed for several days as a guiding outline for further deconstruction and science concept construction.

Connection to literature

This first step is simply familiarization with the information. The information is in the story. The teacher’s job at this point is to coach (Anderson, 2002) students to contribute to the body of knowledge, which is the sequence of events. As Phinney (2001) has stressed, being committed to the group demands responsibility to the growth of the group, which means becoming more knowledgeable about the group’s traditions and history.

The next stage of feedback observed in these sessions is the participation of students and teacher in the story deconstruction and maintaining a high level
of student/teacher interaction. This stage began with minimal feedback initiated by the teacher at first. As shown in the sample transcript above, the teacher was the prompter, one who prompted for feedback in order to move the process along. However, this level of feedback was not evident throughout the class. The feedback became more student driven, to a point where the teacher was the recorder and a facilitator rather than a prompter and a coach.

*Concept-Deconstruction*

As previously mentioned, story chunking, the first step in stripping away the story, was the next step. After the initial reading, it was not necessary for the students to initiate the conversation, as seen in the above sample transcript. The next sample transcript is from a biology class attempting to conclude to an investigable science concept. The present discussion is in regard to sunlight penetrating the ocean surface. This discussion comes from the story of Hinaaimalama (Fornanders & Thrum, 1919):

T: *What is decreasing, decrease the sunlight, light is decreasing? (wot)*
Sg2: *The deeper you get..*
Sg1: *The deeper the depth, the …*
Sg2: *No, the deeper…..*
T: *What?*
Sb: *The deeper, the depth is increasing.*
T: *Say it*
Sg1: *Something like the increase of light is the ….the…*
Sg2: *The increase of depth.*
Sg1: *Yeah, yeah.*
Sg2: *The increase of depth is the increase of light.*
T: *K,K lets erase, cause that one is getting cleaner.*
Sg1: *Ho, I feel like we’re playing like*
Sg2: *Like charades*
T: *So clean this up a little bit more. What’s happening?*
Sg2: The more your depth decreases
T: as... (wot)
Sg1: as your depth, decreases, depth of the ocean.
T: As ocean depth...
Sg1: increases
T: (writes on table) increases
Sg1, sg2: the sunlight
Sb2: the light, the sunlight decreases
T: Sunlight decreases? So what you are saying, the science that you are pulling out from the story here is that as ocean depth increases, sunlight decreases?

As one can surmise, the conversational/discussion stage of student feedback has occurred. With teacher prompting and facilitation, the scientific concept has been constructed.

Connection to Literature

The teacher was influential in this study, as is evident in the above sample transcript. Anderson (2002) believes that the teacher who simply transmits information stifles inquiry rather than helping students process information. The teacher who possesses and utilizes that pedagogical knowledge has been observed to be able to engage the student in the discussion. The National Science Education Standards require that science teachers guide and facilitate learning through focusing and supporting inquiries, orchestrating discourse among students about scientific ideas, and modeling skills of inquiry through open curiosity (National Science Education Standards, 1994). In the sample given above, the teacher gave care to prompting, clarification, and summarizing. Part of the pedagogical learning for teachers is strategies that support further learning, or scaffold learning. According to Van Der Stuyf (2002), scaffolding
learning is the responsibility of teachers and others in supporting the learner’s
development and provides support structures to get to the next stage or level.
This is the basic premise in Vygotsky’s zone of proximal development
(Vygotsky, 1978) and also in Gee’s “regime of competence” (Gee, 2003, p. 71).
The regime of competence states that the learner receives “ample opportunity to
operate within, but at the outer edge of his resources so that at those points
things are felt as challenging but not undoable” (Gee, p. 71). The conversation
displayed in the sample transcript reveals the teacher’s ability to scaffold the
learning by prompting and clarifying, in turn being able to receive a higher level
of feedback than the teacher experienced at Stage 1.

The next stage of feedback resulted in a subcategory defined as
“volunteering.” The following transcript sample represents this stage of
feedback. Taken from the same class as the sample in Stage 2, this sample is a
continuation from the sample above.

T: k, Thalia, mark, set, ready, action. Explain how did we get that so we
Starting from the story.
Sg2: (points to board)
Sg1: (stands up to look out window for vog)
T: K, we looking at Talia.
Sg2: No, it makes me nervous.
T: Oh God, Mary,
Sg2: Our story (pointing to evidence). In the story, Kipapalaulu asks his
Grandfather a way out of Kahikihounakele which is their home and
their grandfather cracked open the ocean from the ocean floor to the
surface and this has allowed the sun rays to reach the bottom um and
then the land that they live in its in the deep ocean, it’s the land of
darkness and the way we came to this the rationale (points to table).
Kahikihonuakele is at great depths in the ocean, yeah, so there’s no
light, it’s dark, and the crack that Kipapalaulu’s grandfather made
split the ocean so there’s no water and only air in the space and since there is no water, there was nothing left to block the sunlight from penetrating that part of the ocean.....

There was no prompting by the teacher needed in this sample transcript. The student volunteered the extensive feedback and committed to the identity of knowledge holder.

*Concept-Volunteering, Discussion*

The code of discussion was developed because of the product this activity yielded. Although the codes entitled “discussion” totaled only eight, it was included in memos that regarded other coded items such as process. One memo included the fact that “talking through the concepts several times and repeating the evidence in the discussion” helps build the foundations and frame the inquiry. Although the sample transcript above is not necessarily a discussion, it does demonstrate the fact that the student feedback was extensive and teacher prompts were not necessary.

*Connection to the Literature*

At this point in the story deconstruction and science inquiry, Gee’s theory of commitment to a semiotic domain and Phinney’s theory of commitment (2002) is illustrated in the student’s willingness to teach the concept that has been pulled from the story deconstruction. To review, Gee defined the semiotic domain as the “any set of practices that recruits one or more modalities: oral, written, language, images, equations, gestures, graphs to communicate distinctive types of meaning” (p. 17). Volunteering requires taking on a new
identity and forming bridges to the student’s new identity. In other words, volunteering feedback requires working in this new semiotic domain.

As stressed in the literature review, the teacher is crucial in this process and the teacher’s knowledge of method drives the process. Anderson (2002) maintained that the fact that students’ roles in inquiry as self-directed learners demand that teachers become coaches and facilitators. A product of this research is to gain teacher/facilitators and ancestral stories/tools for science inquiry formation. Therefore, the teacher’s knowledge of inquiry pedagogy (NSES, 1994) and pedagogical knowledge (Van der Stuyf, 2002) are crucial in how Native Hawaiian ancestral stories encourage an increased level of student-driven interactions at all levels of feedback from Native Hawaiian students in a science classroom.

Research Question 2:

*How can teachers of Native Hawaiian students facilitate the construction of science inquiry projects from ancestral stories?*

**Concept – Process, Deconstruction, Names**

This description will display the practical nuts and bolts of the raw data. The previous categories were arrived at through a process that is dictated through the rules of grounded theory. The information or codes, the discoveries through memos, and the compilation of these memos into categories and concepts are all steps taken in this process of grounded theory. Extracting of science and the
deconstruction of the story are also dictated by a specific process. This research, in large part, has been witness to this process.

Much like several practitioners of grounded theory, the practitioners of ancestral stories also utilized learning tools such as tables and diagrams. The following is part of the science concept learning tools. This is a table. This organizer was used by the inquiry class (Appendix c) in order to deconstruct the existing storyline for evidence. Below is an example of a table:

**The sunlight does not reach the ocean bottom**

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandfather sent a crack</td>
<td></td>
</tr>
<tr>
<td>from the surf-ace to the</td>
<td></td>
</tr>
<tr>
<td>ocean floor</td>
<td></td>
</tr>
<tr>
<td>the water blocks the sun</td>
<td></td>
</tr>
<tr>
<td>from reaching the ocean floor</td>
<td></td>
</tr>
<tr>
<td>the ocean floor</td>
<td></td>
</tr>
</tbody>
</table>

in which the evidence is the part of the story that contains the concept. So there may be many pieces of evidence depending on the input of that story. The rationale explains how the evidence supports the science concept, as noted in the example. Again, this depends on the amount of pieces of evidence. Then the last part of that diagram was the science concept. This statement is revised until there are concerns in the group that this is the concept being described in the story by the evidence listed.
Another nut or bolt of the data is the confirmation or defining of the story. The story of Hiʻiaka and Pele is the activity of the volcano (Poepoe, 1999) or the story of Kamapuaʻa is the forest (Kameelehiwa, 1997). An important assumption of this research is that our ancestral stories are narrative descriptions of natural phenomena. The lessons observed were all done under that assumption. The first step in this process was to translate the names. As mentioned before, the names are aspects of nature (i.e., Wahineʻōmaʻo or Kipapalauulu). After this, these names were put back into the story, and discussion about the names and the context ensued. This discussion led up to the next step of a re-read and a reconstruction of the story with their new perspective on the purpose of the story. Again, steps led to a process, and a process led to either more questions or more discussion or an unlikely conclusion of a solid answer.

This concept of process was significant. Throughout all phases of data gathering, observation, document, and teacher interview, the concept of process was stressed. This leads one to ask this: Why is this concept such a significant part of this research? It was interesting to memo this question due to the fact that the very act of composing these very old narratives must have followed a certain process. There are many examples of this, but the most intricate example is the Kumulipo (Beckwith, 1951) or the creation chant regarding things that are born. This question initiated recognition of coincidence and perhaps a
recognition of an ancestral process that can be transferred to present-day
observers of nature.

A criterion for choosing a story is that it contains names, whether of
persons, places, or things. The definitive nature of Hawaiian names is an
impactful and significant aspect of ancestral stories. The names of the characters
and the names of the places and geographic features play a very important role
in the ancestral narratives. For a simple example, in the story of Pele and Hi‘iaka,
a traveling partner was named Wahine‘ōma‘o. Her name translates to “green
woman.” Hi‘iaka’s responsibility in these narratives is to re-flourish the land
and the forest. One can see that her traveling partner’s name explained their
purpose for their existence in this story following Pele’s travels. This example is
taken from one of the dynamic ancestral stories within the lineage of the volcano
clan, and therefore was filled with nature identifiers such as Wahine‘ōma‘o.

According to the design of the study, one of the students’ tasks was to
take each of the names in the story, be it a character or a place, and look for the
translations. If the word was not found in the dictionary, students were given
the right and license to partition the name into smaller words (e.g.,
Wahine‘ōma‘o, Wahine – ‘ōma‘o). The students translated these smaller
workable words. The multiple translations of one deconstructed name were put
back together in a manner that (a) made sense and (b) reflected an aspect of nature.

The number of codes under the category of names was less than all others; however, the codes were significant. There were only a few codes under this category, four of which signified turning points in the observation sessions. For example, the teacher asked a student at the end of the class period to summarize the science concept construction the student had just completed. After three attempted starts, she began telling the story of their class period by stating the name of the place in which the story is set. The reason for this is that the names of the heroes in this story reveal the major source of the author’s observation. It also focused the students in on the main scientific concept. One group of students translated the name of the story location, which is Kahikihonuakele, in this manner Kahiki [a place where gods reside, or the east, the place of foreigners] – honua [earth, land] – kele [very wet, dark]. Due to the many references to ocean within the narrative of the story, the students, armed with the translations, inferred two important features of this story: The location of this story was in the deepest part of the ocean, and it had something to do with sunlight. The next word mentioned within the text of two memos was Kipapalauulu, the name of the hero in the story. Another group deconstructed the name by separating kipapa [a platform, a stone trail], lau [leaf, many], and ulu
When the students put these translations back together, they discovered another characteristic of the sun, “the path of the many beams that leads to the ulu tree” or “the growing path of the sun.” This translation solidified the conclusions that the main science concept involved the sun and the deep part of the ocean. In ancestral stories, the names of the places and characters are equal to the natural phenomena and are pieces of nature that the students could grasp and utilize for conceptual construction.

After I read through a transcript of one of the classes, I observed a number of mistakes. The ocean class was one of the more experienced with scientific inquiry and experimental design. This is the class with a focus on a year-long fishpond project; therefore, the expectations were high for this assignment and this class. However, when students’ homework was reviewed, it was plain that this class still did not understand. After conferring, the teacher and the researcher team assessed that the students were asking author questions rather than inquiry questions. It was from this realization and discussion with the teacher that the concept of inquiry questions vs. author questions stood out.

The question asked by one of the students led the research to this concept. The homework questions were shared with the rest of the class. The first question shared was “How did Palila fly when he swung his club?” The hero Palila had a weapon, a club named Huliamahi that he used to not only win
battles, but also fly from island to island. The teacher then asked, “Is this an inquiry question or an author question?” to which the response was “author question.” The reason given for this judgment was that it was based on the storyline, the story of Palila. These types of questions are based on the plot and could not be referred to any other setting because it named the character and an object distinctive of that character. Inquiry questions, on the other hand, strip away the vocabulary that is characteristic of the story and pull at the statement that’s in that scene that can be generalized. For instance, after the question mentioned above was shared, the students and teacher worked to transform it into an inquiry question. The result of that collaboration was the previously mentioned statement regarding momentum (vocabulary), which was “How heavy does an object have to be in order to gain momentum to lift a person off the ground when swung?” This is the inquiry statement.

What happened? In order to create objective identifiable questions as opposed to author questions, “story lines” were taken out of the statement. The statement sans the name (in this case, Palila) and the object (his club) was specified by adding appropriate vocabulary for the intended subject matter of the statement. In the case of Palila and his club, the content area intended for the inquiry statement is physics. The explanation that came from the students and the teacher through the discussion was the fact that in order to look through the
storyline to find the natural phenomena or the objective science inquiry, one has to strip away the story or unwrap the plot. Two methods were observed. One method was mentioned in a previous description of the concept “names.” An example description was the word *Kahikihonuakele* taken from the inquiry class observation. As previously mentioned, the translation of that name informed the students of the setting of the natural phenomena. A second method and one that is a little more complex is the one mentioned in the Palila example. Another example of this method comes from an observation taken from the biology class. When the teacher asked for examples from the inquiry questions assignments, he shared, “Do birds have a language we can actually translate?” To that, the teacher responded with a story of experiences with whale and dolphin echolocation. The bird inquiry came from a part of the story where two birds, Alakawi and Alakawa, were Pana'ewa’s spies and reported Hi’iaka's movements to him. The question was devoid of identifiable names and author intentions. The mistake could be made that this question was constructed after a weeklong lesson about birds. However, it came after a day’s session of a story and a homework assignment.

After revelations of this concept, the prior transcription and memos were reviewed. In this review, there was the realization that the aforementioned categories such as names, deconstruction, and visualization could be listed under
this concept of “unwrapping the plot.” This idea will be explored in depth when addressing the research questions.

*Concept Data From the Postflection*

A question asked in the postflection that regarded this research question was “What was the most difficult part of the process and why—the story reading, word definition, science focus questions, summarizing, graphic organization, or author questions?” Out of 19 postflections that were returned, almost half (9) of the students stated that the hardest task for them was summarizing and graphically organizing the stories in order to adhere to a story source. Only 5 out of 19 students found scientific concept construction difficult, and 3 out of 19 found word definition to be the most taxing. These data were not expected, due to the fact that the activity of summarizing and graphically organizing this information is an old skill that these students had done many times in this class. However, the students mentioned that the difficulty lay in adhering to a source. These data reveal that there needs to be more practice with this task, especially with stories. Another question asked on the postflection was the following: “This process was long. Therefore we were not able to cover science concepts that would normally be covered because of this lesson. Do you think that this process is still important to do in school? Why or why not?” The following are examples of some of the reasons given:

“we are going through the process of making our own science concepts”, “it brings us back to our roots yet still lets us learn the essentials on science and realize that the ancestors were smart people”, “even after doing this all still learned a lot about
science and many more things, makes me want to learn more”, “yes because this will help in any other subject in school”.

Again, out of 19 postflections, only 1 expressed that this process was not important enough to allow skipping other science concepts. Eighteen of 19 students felt that this process was important enough to skip other science concepts that should have been covered in this timeframe. Students expressed reasons such as the following: They were interested in it, this way of learning science is local, and it helps us find the science in stories.

Connection to the Literature

The AAAS (1990) stated that the means used to develop ideas about the physical and biological world are particular ways of observing, thinking, experimenting, and validating. Kamiki, a very dynamic epic from Kailua-Kona (Maly, 2003), and other stories cultivate these particular ways of observation through the names and chants documented and archived within the story. To illustrate the process of extracting the biological and physical dynamics of ancestral stories, the following is a chant found in a section of the story that concerns the hero being chased by a demon-like character of the forest.

Nanaikekihiokamalama  
Nana the tips of sunbeams

E Nana, hoonanana ka la  
Nana, the sun flutters

E nana, hoonanana ka ua  
Nana, the rain flutters

E Nana, hoonanana ka makani  
Nana, the wind flutters

(Maly, 2003)
At first glance through one set of lenses, this chant has to do with rain, sun, and the movement it causes. Another look through a different set of lenses produces information on the time of year when this phenomenon takes place. The time of Nana, which is a specific month around March or April, is prevalent in this chant (Nuuhiwa, 2009). A third look at this chant through a different set of lenses exposes the weather conditions observed in that month.

This concept of observing chants through different lenses rings true for the names in the story as well. There are two names in the portion of the Kamiki story mentioned above (Maly, 2003). The first name is the guardian of the Mahiki forest. His name is Luanuuanunupolelekapo. After deconstruction of the name and definition searches in the *Andrews Dictionary of the Hawaiian Language* (2003) and wehewehe.org (2003, 2004), a Hawaiian online dictionary, the translation was “the scattering of darkness due to reverberation.” The other name that therefore must be deconstructed and translated is *Nananananuihoomakua*, the giant spider guardian of the same forest. Again, after deconstruction and dictionary searches, the translation of this name is “the giant spider web that causes maturation” or “the time of the year that organisms mature.” Remember that Nana is April or May (Nuuhiwa, 2009). This process, therefore, brings about many new discoveries into the dynamics of this forest.

Keys and Bryan (2001) confirmed that teachers are active curriculum creators. They can control their classroom curricula based on their own beliefs, epistemology, and knowledge on what a science education program should include. Therefore, if relying on ancestral stories to stimulate scientific inquiry in
their classrooms, these teachers need to ask critical questions such as “What is a story?” and “What is its place in the science classroom?”

Teachers must ask, “What does data look like in an ancestral story?” This study had the students reading a portion of Emerson’s “Pele and Hiiaka” (1997). The teacher then asked the students to come up with three science questions after reading. When reading through their completed assignments, the teacher/researcher team discovered that the students were asking questions that adhered to this story only. The questions could not be duplicated within any other context, and only the author could answer them. Teachers must remember that western stories revolve around resolving human need (Johnson, 2008). Native ancestral stories, on the other hand, “correspond with the Hawaiian view of the relation between nature and man” (Beckwith, 1970). Teachers must understand that ancestral stories are told in terms of natural phenomena and organic dynamics (Author, 1975, pp. 2–6).

Lastly, teachers must also understand that the ancestral story is text relaying data taken from observation of the natural world. It does not simply exist to support western science. Hence, the process needed to utilize this data plays a thematic role in the results of the data for this study.

Research Question 3:

*How do analysis and discussion of the stories connect Native Hawaiian students to their ancestral intelligence?*

*Envision/Visualization, discuss, vocabulary*
Another word was noted several times throughout transcription, such that coding this subject was required. The word *envision* or *visualize* was coded as more of a skill than a concept. The memoing of this code revealed that the skill of envisioning, or visualizing, was required for articulation of the science concept. There were several instances where these two words were used interchangeably.

The following is a sample of a memo that was written regarding a transcript on the a concluded science concept on light in the ocean:

**Memo – I429-31**

The teacher states that “so what does this say” (points to current science concept) about “if we were to go out and observe light in the ocean what would we see.” This tactic was based on the concept of place touching upon prior knowledge. Students are from the ocean community and are familiar with light in the ocean. 2030. Again, the teacher asks the students if they have a visual of the sunlight into the ocean and then asks how can we translate the visual into some sort of science concept. The students see it, but they just need to articulate that visual. They need to change the visual into words, which is what the ancestral stories do. “need to add to Process”.

In the transcription, the teacher mentioned, “if we were to go out and observe light in the ocean, what would we see?” After several seconds of conversation, the teacher asked, “ok, so you guys have a visual of the ocean now?” The students responded with “yes.” Then she continued, “How can we translate that visual picture you have into some sort of science concept that’s a little bit more specific than this, ‘cause you guys have it, just gotta articulate it.”
Therefore, envisioning nature, the place, and the things they know was a tool that had to be utilized unexpectedly for the purpose of articulation.

The skill of visualization and envisioning not only translated over to articulation, but also assisted with designing the experiment. Within the text of memos regarding the experimental design phase, the teacher mentioned the skill of visualization to the students before they confirmed the design and verified the materials list. A code entitled experiment that was incorporated into another code entitled process totaled six, hence the incorporation. These coded notes mentioned visualize or envision in five. It seems only natural to incorporate this skill in a comprehensive science curriculum involving ancestral stories.

An important skill in developing a successful science project is the ability to communicate. Communication not only with the audience, but also between the group members or team is crucial. The code of discussion was developed because of the product this activity yielded. Although the codes entitled discussion totaled only eight, it was included in memos that regarded other coded items such as process. One memo included the fact that “talking through the (concepts) several times and repeating the evidence in the discussion” helps build the foundations then frame the inquiry.”

Incorporation of the “discuss” code involves “student” reactions. The category entitled “students” incorporated the code discussion, which plays a
large role in this category. This is to be expected because it is the skill of student
discussion that pushed the science concepts through. One must also realize that
discussion of a subject, due to either a brainstorming session or a decision
session, is part of a process. As mentioned previously, process is a large category
in this study, and discussion is a reoccurring activity as observed in the
classroom. Discussion was observed as being a crucial part of forming the
science concept.

Vocabulary is another code that developed into a process rather than just an idea. Gee brings in the idea of intertextuality or the action of “gelling” the vocabulary of one domain with the context of another domain. Vocabulary integration or utilization of the new vocabulary in science concept identification focuses the discussion. According to Gee (2005), this is the first step into the science inquiry semiotic domain. First, in the beginning of the discussion, the students made the attempt to use the new vocabulary, even if they used it inappropriately. As the discussion moved along, the new vocabulary was contextualized and used more appropriately.

The following is a sample transcript taken from the inquiry class regarding the adoption of new vocabulary:

T: K
Sg2: and dark
T: So if there’s try, wait, let me write that down. (write on table) Water preventing light from coming in. What word can we use to describe what the sunlight is trying to do?
Sg1: Shining
Sb3: Get through the ocean
T: Hah?
Sb3: repeats his comment
T: Yeah, how can we use a better word than that?
Sg1: Oh, oh, oh
Sb1: Penetrate
T: Penetrate. Good word.
T: Penetrating where?
Sg1: Through the water.
Sb1: The sunlight cannot penetrate into the deep part.

As one can observe, the word was brought forth then to them by one of the male students, after which the remainder of the students started to incorporate the word into their attempts at science concepts.

A second point in regard to vocabulary is based on teacher subject matter knowledge. In the excitement of the discussion and science conception, it is possible to misuse the vocabulary and make errors in content matter. For example, in the ocean class, a science concept concerning swinging a heavy bucket was being discussed. The teacher, moving the discussion along, stressed the fact that the concept had to do with momentum. The concept actually had to do with centripetal force and rotational motion. However, at that moment, the importance of the lesson was the science concept through the story. If this concept went to inquiry and then to experiment, it would have been corrected.
Connection to the Literature

Again, identity theories and the potential ancestral stories possess to restore, change, and establish identity is the connection between the codes and concepts of discussion, vocabulary, and envision/visualize. The first concept in identity is that of discourse and discourse analysis (Gee, 2005). In discourse with a capital D, the student and his fellow science inquiry and ancestral story experts are recognized for being science inquirers and their speech and dialect mannerisms are those of science inquirers. In order to be within this discourse accompaniment, one must cross into the semiotic domain of the science inquirer; however, Gee stated that “people cannot learn within a semiotic domain if they are not willing to commit to seeing themselves in terms of a new identity” (p. xx). Phinney (2005) established that ethnic identity development involves figuring out who you are, finding a sense of directions and purpose, and finding a niche. The students are established within a semiotic domain and participate in discourse of place—in this case, the place being Keaukaha. Kanaiaupuni and Malone (2006) wrote about Hawaiian identity and its direct connection with the land and place. Therefore, Keaukaha is the origin of their visualization. The teacher encourages the students to visualize the concept, pulling on prior knowledge of Keaukaha and the ocean and existing identity in order to articulate science concepts within a new ethnic identity. Articulation of the visions builds the bridge into a new semiotic domain. The artifact of this bridge is that of new vocabulary and eventually science concept construction. The strategy the teacher
employs for new identity building and science concept construction is not only visualization, but also discussion.

Phinney (1996) declared that ethnic identity development into commitment through exploration involves activities of social mores within that ethnic identity. Progression through exploration of group membership in activities such as discussion reflects a secure, confident sense of oneself being a member of a group (Phinney, 1996). As seen in the transcript, the utilization of all three strategies—envision/visualization, discussion, and the use of new vocabulary—occurs in this process of science inquiry through ancestral stories.

*Teacher Perspective*

This portion of the research is taken mainly from the teacher interview that took place approximately two weeks after the last observation session. One of the main reasons of this prolonged data collection was validation of the transcript (Corbin & Strauss 2008).

The teacher began this project with assumptions. Student intimidation and apprehension toward the stories was part of her assumptions (Interview, 2009) However, according to her, this was not observed. She stated that “working with ancestral stories provided practice with inquiry. They perhaps didn’t notice that they were doing science but it wasn’t intimidating. The stories allowed them to comfortably hone their inquiry skills.”
Her assumptions came from years of doing science inquiry, science fair and science projects. This teacher’s science fair experience has seen many days and projects that have failed due to constrained timelines and delayed starts. She expects that the stories will allow the students to choose science inquiry with expediency and efficiency as she has observed throughout the study.

She observed that the students desired to find the answers. They never gave up. The interview transcript mentioned frustration several times. The frustration was aimed at themselves and their classmates and their inability to arrive at the science concept soon enough. Phinney declares that ethnic identity development into commitment through exploration involves activities of social mores within that ethnic identity. Progression through exploration of group membership in activities such as discussion reflects a secure confident sense of oneself being a member of a group. (Phinney, 1996). This idea of frustration also led to the concept of complexity and simplicity. The idea of complexity leads to the frustration or the supposed student assumptions that because these are stories it’s easier to deconstruct and build experiments. However “easy” inaccurately describes the discussion loop throughout the science concept session.

An example of a frustration scenario is given in the inquiry class. The science concept floating right above their conversation but they just could not grasp it and pull it down into the discussion. There were obstacles that prevented the class from this task. One of the obstacles was articulation, to pull
together the correct combination of words into a comprehensive science concept proved to be a very difficult task. Another obstacle was the inability of the so-called smarter students to aptly answer the questions as they do in other instances prior to this study. The teacher mentioned in this interview that she did not observe the “usual suspects” responding all the time to her questions. This was an obstacle in the beginning because the teacher mentioned, “only smart students were expected to be more vocal”.

What is happening?, previously non-participatory students voicing opinions? Gee describes this phenomenon as a “regime of competence” by stating that the learner gets “ample opportunity to operate within, but at the outer edge of, his resources, so that at those points things are felt as challenging but not undoable” (Gee, 2003, p. 71). This phenomena could also be described as a form of a “community of practice” (Lave & Wenger, 1991) with students that involve situated discourse that deepens inquiry regarding nature and science. The teacher did not observe the majority of the responses or comments from the “smart students”. She states “most maybe half are below grade level in comprehension but the discussion part helped a lot”. Other students started to initiate conversations and interactions. According to the teacher, all students began to put ideas on the table. This process evened the playing field. For all students and the teacher the lesson that came out of this study was dealing with
learning challenges. She states that identifying challenges and how to react to challenge were two of the major haʻawina [lessons] that had been realized. She noticed that students were starting to say things like “ooh its different but I understand this”. It led to other questions such as how can I handle this or what kinds of things do I need to handle this situation.

Limitations to the Study

One school, one teacher

As mentioned in the research design, the participants were limited to one school and one teacher. The teacher, again described in the design, was employed for this research because of the characteristics mentioned in the discussion section of this writing. A comparison study may be an integral step prior to dissemination of this method.

Confining time limitations

Although data were collected over a period of one year, data collection was not continuous and consecutive. The year is broken up by holidays, teacher waiver days, and special situations such as testing.

Classroom reality

There were no behavior problems in this classroom. The teacher employed an excellent management strategy. This is one of the reasons that she was chosen as the participant teacher in this study. Additionally, this teacher
was trained in inquiry and had an established reputation in science projects and science fairs.

_Homogenous cultural environment_

Among the student participants in this study, 90% to 98% were of Native Hawaiian ancestry. Not only were these students Native Hawaiian, but they chose to attend a Native Hawaiian-based charter school, thereby making a commitment to cultural learning. This is certainly not the case for all schools in Hawaii.

_Public DOE school implementation_

Although this field study yielded unique and meaningful data, this may not have been the case in a regular DOE public school. Classrooms in Hawaii’s public schools are standards-bound; therefore, if teachers at regular public DOE schools engage in this strategy, it may become a supporting lesson rather than the driving science curriculum.

_Time constraints during the school year_

The year consists of 4 quarters and 2 semesters. The HCPS III require that students know certain aspects of the science curriculum before the end of the year, as dictated by the Hawai‘i Standards Assessment (HSA). Ancestral stories are presently not on the HSA; therefore, inquiry and stories may take a back seat to the prescribed curriculum.
Chapter 5

Discussion

The incorporation of ancestral stories in the classroom, whether a science classroom or a social studies classroom, is a unique direction in today’s educational vision of standards-based classrooms and testing environments. One of the goals of this research was to find a place in today’s educational picture of standards-based classrooms and testing environments for ancestral stories so that it becomes a benchmark of academic progress and meaningful learning and not just a support lesson for the “real learning.” The most significant way to reach this goal is through teachers and cultural experts. The end product of this curriculum was the experimental data. For some classes the end product was the inquiry questions. Although these products provided meaningful data for the research it may not be the piece of assessment that provides closure. The continuation of the ancestral stories through the observation of natural phenomena and data analysis would be the highest form of student understanding and internalization of scientific inquiry and ancestral stories. Again, the successful facilitation of story composition will depend on the skill of the teacher. Resources maintain that due to skills lost such as language, poetry writing, and observation of nature, this art of story composition for the purpose of data perpetuation has discontinued (Kanahele, 2010). “However,”
Kanahele stated in a 2010 interview, “this is important to continue, it speaks of the journey, and if this art dies, then the journey stops moving forward.”

Teacher dissemination of ancestral story curriculum

Due to the culturally structured nature of the process and the method of using ancestral stories to pull out science inquiry and questions, there must be an education and training component attached to this undertaking and/or a certain kind of teacher to train and perform this strategy. Further, the fact that the pilot study involved elementary school aged children and the dissertation field study settled on the secondary school curriculum lends to the complication of this method and academic development.

Characteristics of a highly qualified teacher such as those listed on the website

http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/7qualities.htm, by Linc. Fisch is a comprehensive list of an effective educator. The same type of list exists for those who want to lead their curriculum with ancestral stories. A teacher who employs ancestral stories and scientific inquiry using the process listed in the data analysis should possess the following characteristics:

- The teacher needs to be able to manage the classroom enough to facilitate whole-group discussions, small-group discussions, and experimentation design. Student creativity can be explored and guided in this environment. Besides student management, the teacher also
needs to manage the time spent on each specific task. Due to the amount of time the teacher/researcher team allotted to the field study, time was a factor. As mentioned previously, taking the inquiry question to experimentation was necessary for this teacher.

- The teacher must possess skill in questioning, including asking, forming, and answering. The teacher needs to be able to model the appropriate questions that students should be asking each other or the data. The National Institute of Health (2007) published a section on scientific inquiry. The NIH report on inquiry maintained that not all questions can be answered using scientific investigations. “The questions must be testable questions answered through observations or experiments that provide evidence. Students need guidance and practice to be able to distinguish questions that are testable from those that are not” The NIH listed the following criteria for testable questions.

- The teacher needs to know how to incorporate new vocabulary and begin to infuse everyday conversation with this new science vocabulary (Gee, 1994).

- Going off of the topic of the last characteristic of modeling vocabulary, the science teacher who chooses to employ this strategy of ancestral stories and inquiry needs to be knowledgeable in his or her content area
in order to be able to adjust the author question to the inquiry question using all the correct concepts from specific science content. A reason for a teacher’s knowledge in a science content area is the ability of that teacher to relate the question and the story to science projects done in their field. This reason brings relevance to the activity.

The grounded theory that emerged from the data, codes, axial codes, category, and memo insisted that in order for the present and future generation of educational leaders to gain scientific inquiry from ancestral stories, a process must be followed. The inquiry does not just jump out, and the inquiry is not obtained by simply reading the story. The inquiry is gained through a process that involves the following steps:

Step 1. Choose a story – The choice of stories for this study is explained in the design section of the study. There are four criteria for choosing a story: (a) the story must contain chants and names, (b) the story must be ancestral such as Pele and Hiiaka (Emerson, 1997) or Kamapuua, (c) the story must have several sources of translation, and (d) the story must be related to the science topic.

Step 2. Read through the story – Although this might seem an obvious step, the manner in which this task was performed in the science classrooms seemed to be the most efficient. The teacher gave a copy of the story to everyone and kept one for herself.
Step 3. Deconstruction – The story was then taken apart section by section by going through the story from the beginning to the end. For example, the ocean class was assigned the story of Palila. This is the transcript of this interaction:

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S: He was planning for the battle.
H: The guy comes
Teacher: What guy?
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This continues until the whole story is taken apart and examined section by section. This process was the most tedious but necessary. Take notice of the section of this transcript that backtracks the momentum of the retelling. This strategy was done throughout the retelling. Observation techniques such as this should be standard in a science class when examining the subject of study. This is where discussion and envisioning take place.

Step 4. The names of characters and places were translated for better understanding of the phenomenon being described. The connection of the names translated draw the picture and the students become aware of what the
story is describing and the direction of their inquiry (Maly, 2004). Again, one can see the action of the categories of discussion and envision. Visualization is a very important strategy to employ at this point because the student not only had to see the description the translation brought to light, but also had to envision its place in the story.

Step 5. Unwrap the plot – After deconstructing the story and having all the observations written out, have the students ask questions about the story. One set of questions is addressed to the author. The questions in the other set are called inquiry questions or questions pertaining to the science of the story. An example should be done with the class or printed on the worksheet given out to the students.

Step 6. Stripping away the story – The last step in the process is called “stripping away the story.” The students took a statement from one of their approved inquiries and reformed it into a science concept. After the attainment of the science concept, it needs support from evidence from the story, and the evidence needs support from rationale statements. The $t$ table in Appendix C is an appropriate tool for this task.

Details of Dissemination – What Would it Look Like

As discussed previously, this strategy is not the same picture at the elementary level as it is at the secondary. The following is a suggested sequence
of training sessions for elementary teachers and secondary teachers. For elementary teachers, simplicity is the key; therefore, the sequence of suggested training sessions starts with basic observation skills. Secondary teachers will start intense integration in scientific inquiry; therefore, their training sessions will be complex.

Hula tradition offers a traditional and time tested method for teaching complex cultural processes and knowledge. It is an appropriate analogy to use in designing teacher training for the use of ancestral stories in science inquiry. The following structure is based on a traditional Native Hawaiian practice, one that starts from a very young age. Hula is a purely Native Hawaiian art form that has stood the test of time and has grown in design and popularity. Hula is this researchers family tradition and has been for 4 generations therefore this pedagogy is a familiar one.

*The Structure*
At a young age the children are taught through modeling and doing, a very elementary nature to leaning. Elementary teachers will be exposed to this through observation and images. Being exposed to nature specifically those phenomena described in stories brings in the experience base, or the base needed to build the relationship with the story. For example in the story of Kamapuaa the hero, Kamapuaa is a kupua or demigod that can change into many forms
such as the Humuhumunukunukuapuaa, the laukahi fern, and the kukui tree. If you have observed these forms or the details of these forms in nature the recitation of this story will spark prior knowledge or reminiscent images of these natural forms. In other words learning occurs when the observation is made, an image is saved, and the reference is recognized in a story or a song. In the children beginning class in hula the basic steps are modeled and the students are required to mimic the steps and the dances. These are the images observed and saved. These images will then be brought out in the dance and chant, hence meaningful learning occurs.

A separate training would involve secondary science teachers. This training would incorporate a controversial and traditionally untested strategy of grouping. In the Halau the older class is made up of a variety of ages beginning with age 13. They come to halau with a different set of skills but all starting points successfully come together within a very short amount of time due to this diversity. It is proposed that the primary cohort group be a mixture of secondary science teachers and the student participants of this research.

As a part of professional teacher development it was said that teachers should be involved in their own leaning, they should be open to learning with the students and be receptive to the idea of not having the right answer (National Research Council, 1994). The student participants are well trained in protocol,
language, story and culture. Also, their teacher’s science curriculum is a science project based curriculum. Like the halau, these varying abilities come together successfully. Therefore a group of secondary science teachers and research participant students will receive and develop an understanding through discussion and collaboration hence develop a sequence of instruction necessary for implementation.

Information dissemination

*Information dissemination for Elementary teachers*

As mentioned before the material will be different between elementary teachers and secondary teachers. Elementary teachers will spend a number of training sessions involved in active observation. Active observation describes the activity of knowing your environment through interaction and images conducted according to the story. This parallels the children’s beginning class teaching strategy in the Halau. These interactions and images will be gathered using journals, cameras, laptops, and basic media equipment. The images will then be brought back to the group for discussion.

Discussions will involve the source of the story which are the images and interactions and the references that are the characters and the place names of the story. These discussions will be instrumental in developing an instructional sequence for individual teachers and individual classrooms.
Information Dissemination for Secondary teachers

Secondary teacher student group will begin with the story. The training instructor will read the story as the class follows along. The story will be broken down and sequenced. Within this breakdown the names of the characters and places are important and will be included in the discussions. The groups will then be asked to determine the source of the story which could be the volcano, the rain forest, a fern plant, sharks, or a water source. At this point the groups will be instructed to ask their own questions of the composer of that story. This begins the process of inquiry. Students and teachers will then pull out the evidence and data from the story that inferences their query.

Lako i ka haawina – Rich with lessons

At the end of the sessions each participant will come away with more than a different experience. Each teacher elementary or secondary will come away with a set of stories and references. Elementary teachers will be able to take their images with the corresponding stories. Each group will be able to use their notes from their sessions to structure a scope and sequence plan for their individual classrooms.

The secondary cohort will be provided opportunities for continuation of training and discussion. A look into any culture will reveal a lifetime (or five) worth of stories, our culture is no exception. Therefore the initial session will
include a specific set of stories based on specific natural phenomena. For example, stories that include Hina and Maui explain the times of the year, astronomy, sun, and Moon, (Beckwith, 1981) the set of stories on Hiiaka and or Kamapuaa, involve biological sciences, growth plants animals etc. Following the initial meeting which will utilize the Hina and Maui stories, for example, follow up meetings will utilize other story series or sets that involve other areas of science. At the end of a specific set of meetings, 6 meetings over 2 years for example teachers will be in possession of a library of stories, images, science content materials, discussion notes and assessments.

*Where? When?*

As previously indicated teachers must be able to spend some time outdoors amongst the environment described in the stories. Access to the natural environment is required for teachers and students. A room with basic media and standard or above standard internet access is also required. It is beneficial to the participants of this dissemination training that this session be held in their area of origin, or in the story’s area of origin. For example if the session is involved with the story of Kamapuaa then it is beneficial to the students to experience the cliff of Kaliuwaa, a mountainous area on Oahu, or the Koolauloa, a mountain range on Oahu, that he leaned against to help his family escape tyranny.
In order to involve students in this process the ideal training would be a summer session where both teachers and student can earn credit. A summer session will allow time for environmental interactions and image sharing. Also, the weather in the summer is friendlier than that of the makahiki months and will allow the participants to gather images and make observations. This session will last for about 3-4 weeks and follow up session would last for at least 2 nights, once in the makahiki season (fall and winter) and once in the spring season. Each of these follow up sessions will include sharing of teacher experiences, a field trip and a workshop on another set of stories.

The structure for dissemination is based on an age old Native Hawaiian tradition. However, the data regarding student skill in inquiry and discussion was the instigating element for the structure of the dissemination method for ancestral stories and scientific inquiry.

*Creation of new stories through observation and documentation of nature*

The ultimate evaluation tool would be for the students to compose their own stories based on their data recorded at the ponds (Roxane Stewart, personal communication, 2009). The continuation of the stories pertaining to observations conducted presently is the ultimate evaluation tool for this endeavor. Ancestral texts such as stories and sayings are fluid and changing as the times, locations, and composers change. An example of this fluidity is the multiple versions of a single-story epic. There exist at least four known versions of the story of Pele
and Hiiaka (Emerson, 1997; Poepe, 1999). The stories change as the time and observers change and new versions are created. Cajete (2000) stated that “truth (in story, or science) is not one fixed point but rather an ever evolving point of balance perpetually new” (p. 19). Nuuhiwa (2009) stated that the premise is the same but the ingredients of the text may be different and certain aspects of the story may be more crucial in one version than in another. These authors and scholars maintain that the skill of documenting observation of natural phenomena through the continuation of ancestral stories is a necessary truth.

The one-word question remains: How? As mentioned before, one of the criteria for choosing a story is that it contains chants and names. Kanahele (2009) stated, “the chants are the information, they are condensed versions of the stories.” Therefore, it is safe to assume that a story composer should start at that point, with the poetry, the chant. It is also same to assume that the chants can follow the same format as other chants (Nuuhiwa, 2010). The content of the chant is the data. A very dynamic, very long piece of poetry is housed in the story of Kamapuaa (Kameelihiwai, 1996). The chant describes all of his victories and battles using very descriptive names of organisms and geographic features. This is an example of the poetry of scientific data and how story surrounds the data.

Implication for Assessment

Teachers need to prepare themselves for the complexity of the process and frustration of their students. However, teachers also need to prepare themselves for the open, uninhibited discussion initiated by the students. Both issues were
unexpected phenomena that occurred during the study. In knowing that this is a result of this process and is also an outcome that is desired among our high school students (i.e., communication and critical thinking; Hawai‘i Department of Education, n.d.), we need to know how to use it in the classroom, perhaps not only in our high school science classes but also as a Grade 2 to 12 cross-content curriculum. The only missing link in this research is assessment and evaluation. This aspect arose in the interview with the teacher. Every quarter, she delivers a test to her ocean and inquiry classes. This test consists of the same general elements that are on the Hawai‘i State Assessment (HSA website) in science. She stated that every quarter, they are given an investigative inquiry where they are given a set of stuff, most likely household items in Ziploc bags without labels, and a set of procedures and are expected to set up their experiment. The final exam includes a mystery substance. They have five substances that they have to identify by their reactions to other substances and by their characteristics. The students are given four white powders that are similar in appearance in and out of a Ziploc bag. One of the Ziploc bags had a combination of two of the powders. The students are allowed to observe reactions to water, to acid, iodide, to look at the characteristics and use any other tools of observation that they can use. The students are required to set up preliminary data analysis and confirm the dependent and independent variables. This setup also gave the students
clues to the identity of the powders. During the test, the teacher also threw the students clues such as “you would use this powder for this, or this powder is a…” The teacher described this exam as being investigative and analytical.

The teacher shared an interesting observation, perhaps as a result of the ancestral stories and scientific inquiry intervention delivered during the study. For the past 2 years, she had delivered this exam to her classes. She said, “for the past 2 years that I’ve done that, it hasn’t been the regular bell curve, kinda a lot of them did really poorly on that, they just couldn’t get it.” This year, although her students are not A and B students, they passed the test with all As and Bs. The teacher said that nothing in the year’s curriculum was different except for the ancestral stories and scientific inquiry observations in her class.

A formal assessment used in other formats but more or less the same, this type of test will perhaps be appropriate for a culturally significant practice such as the analysis of ancestral stories. It would be interesting to see how a formal assessment would translate students’ progress in inquiry after studying ancestral stories. Based on this research, students had actually developed new inquiry skills that have not been recorded, documented, or perhaps even observed before this study. Therefore, it would seem that assessments will also have to be uniquely distinctive to this process; however, this assumption is not confirmed until this is observed and analyzed Chapter 5
Discussion

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As discussed previously, this strategy is not the same picture at the elementary level as it is at the secondary. The following is a suggested sequence of training sessions for elementary teachers and secondary teachers. For
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Hula tradition offers a traditional and time tested method for teaching complex cultural processes and knowledge. It is an appropriate analogy to use in designing teacher training for the use of ancestral stories in science inquiry. The following structure is based on a traditional Native Hawaiian practice, one that starts from a very young age. Hula is a purely Native Hawaiian art form that has stood the test of time and has grown in design and popularity. Hula is this researchers family tradition and has been for 4 generations therefore this pedagogy is a familiar one.

The Structure
At a young age the children are taught through modeling and doing, a very elementary nature to leaning. Elementary teachers will be exposed to this through observation and images. Being exposed to nature specifically those phenomena described in stories brings in the experience base, or the base needed to build the relationship with the story. For example in the story of Kamapuaa the hero, Kamapuaa is a kupua or demigod that can change into many forms such as the Humuhumunukunukuapuaa, the laukahi fern, and the kukui tree. If
you have observed these forms or the details of these forms in nature the
recitation of this story will spark prior knowledge or reminiscent images of these
natural forms. In other words learning occurs when the observation is made, an
image is saved, and the reference is recognized in a story or a song. In the
children beginning class in hula the basic steps are modeled and the students are
required to mimic the steps and the dances. These are the images observed and
saved. These images will then be brought out in the dance and chant, hence
meaningful learning occurs.

A separate training would involve secondary science teachers. This
training would incorporate a controversial and traditionally untested strategy of
grouping. In the Halau the older class is made up of a variety of ages beginning
with age 13. They come to halau with a different set of skills but all starting
points successfully come together within a very short amount of time due to this
diversity. It is proposed that the primary cohort group be a mixture of secondary
science teachers and the student participants of this research.

As a part of professional teacher development it was said that teachers
should be involved in their own leaning, they should be open to learning with
the students and be receptive to the idea of not having the right answer (National
Research Council, 1994). The student participants are well trained in protocol,
language, story and culture. Also, their teacher’s science curriculum is a science
project based curriculum. Like the halau, these varying abilities come together successfully. Therefore a group of secondary science teachers and research participant students will receive and develop an understanding through discussion and collaboration hence develop a sequence of instruction necessary for implementation.

*Information dissemination*

*Information dissemination for Elementary teachers*

As mentioned before the material will be different between elementary teachers and secondary teachers. Elementary teachers will spend a number of training sessions involved in active observation. Active observation describes the activity of knowing your environment through interaction and images conducted according to the story. This parallels the children’s beginning class teaching strategy in the Halau. These interactions and images will be gathered using journals, cameras, laptops, and basic media equipment. The images will then be brought back to the group for discussion.

Discussions will involve the source of the story which are the images and interactions and the references that are the characters and the place names of the story. These discussions will be instrumental in developing an instructional sequence for individual teachers and individual classrooms.

*Information Dissemination for Secondary teachers*
Secondary teacher student group will begin with the story. The training instructor will read the story as the class follows along. The story will be broken down and sequenced. Within this breakdown the names of the characters and places are important and will be included in the discussions. The groups will then be asked to determine the source of the story which could be the volcano, the rain forest, a fern plant, sharks, or a water source. At this point the groups will be instructed to ask their own questions of the composer of that story. This begins the process of inquiry. Students and teachers will then pull out the evidence and data from the story that infers their query.

Lako i ka haawina – Rich with lessons

At the end of the sessions each participant will come away with more than a different experience. Each teacher elementary or secondary will come away with a set of stories and references. Elementary teachers will be able to take their images with the corresponding stories. Each group will be able to use their notes from their sessions to structure a scope and sequence plan for their individual classrooms.

The secondary cohort will be provided opportunities for continuation of training and discussion. A look into any culture will reveal a lifetime (or five) worth of stories, our culture is no exception. Therefore the initial session will include a specific set of stories based on specific natural phenomena. For
example, stories that include Hina and Maui explain the times of the year, astronomy, sun, and Moon, (Beckwith, 1981) the set of stories on Hiiaka and or Kamapuaa, involve biological sciences, growth plants animals etc. Following the initial meeting which will utilize the Hina and Maui stories, for example, follow up meetings will utilize other story series or sets that involve other areas of science. At the end of a specific set of meetings, 6 meetings over 2 years for example teachers will be in possession of a library of stories, images, science content materials, discussion notes and assessments.

*Where? When?*

As previously indicated teachers must be able to spend some time outdoors amongst the environment described in the stories. Access to the natural environment is required for teachers and students. A room with basic media and standard or above standard internet access is also required. It is beneficial to the participants of this dissemination training that this session be held in their area of origin, or in the story’s area of origin. For example if the session is involved with the story of Kamapuaa then it is beneficial to the students to experience the cliff of Kaliuwaa, a mountainous area on Oahu, or the Koolauloa, a mountain range on Oahu, that he leaned against to help his family escape tyranny.
In order to involve students in this process the ideal training would be a summer session where both teachers and student can earn credit. A summer session will allow time for environmental interactions and image sharing. Also, the weather in the summer is friendlier than that of the makahiki months and will allow the participants to gather images and make observations. This session will last for about 3-4 weeks and follow up session would last for at least 2 nights, once in the makahiki season (fall and winter) and once in the spring season. Each of these follow up sessions will include sharing of teacher experiences, a field trip and a workshop on another set of stories.

The structure for dissemination is based on an age old Native Hawaiian tradition. However, the data regarding student skill in inquiry and discussion was the instigating element for the structure of the dissemination method for ancestral stories and scientific inquiry.

Creation of new stories through observation and documentation of nature

The ultimate evaluation tool would be for the students to compose their own stories based on their data recorded at the ponds (Roxane Stewart, personal communication, 2009). The continuation of the stories pertaining to observations conducted presently is the ultimate evaluation tool for this endeavor. Ancestral texts such as stories and sayings are fluid and changing as the times, locations, and composers change. An example of this fluidity is the multiple versions of a single-story epic. There exist at least four known versions of the story of Pele
and Hiiaka (Emerson, 1997; Poepe, 1999). The stories change as the time and observers change and new versions are created. Cajete (2000) stated that “truth (in story, or science) is not one fixed point but rather an ever evolving point of balance perpetually new” (p. 19). Nuuhiwa (2009) stated that the premise is the same but the ingredients of the text may be different and certain aspects of the story may be more crucial in one version than in another. These authors and scholars maintain that the skill of documenting observation of natural phenomena through the continuation of ancestral stories is a necessary truth.

The one-word question remains: How? As mentioned before, one of the criteria for choosing a story is that it contains chants and names. Kanahele (2009) stated, “the chants are the information, they are condensed versions of the stories.” Therefore, it is safe to assume that a story composer should start at that point, with the poetry, the chant. It is also same to assume that the chants can follow the same format as other chants (Nuuhiwa, 2010). The content of the chant is the data. A very dynamic, very long piece of poetry is housed in the story of Kamapuua (Kameeliihiwa, 1996). The chant describes all of his victories and battles using very descriptive names of organisms and geographic features. This is an example of the poetry of scientific data and how story surrounds the data.

Implication for Assessment

Teachers need to prepare themselves for the complexity of the process and frustration of their students. However, teachers also need to prepare themselves for the open, uninhibited discussion initiated by the students. Both issues were
unexpected phenomena that occurred during the study. In knowing that this is a result of this process and is also an outcome that is desired among our high school students (i.e., communication and critical thinking; Hawaii Department of Education, n.d.a), we need to know how to use it in the classroom, perhaps not only in our high school science classes but also as a Grade 2 to 12 cross-content curriculum. The only missing link in this research is assessment and evaluation. This aspect arose in the interview with the teacher. Every quarter, she delivers a test to her ocean and inquiry classes. This test consists of the same general elements that are on the Hawai‘i State Assessment (HSA website) in science. She stated that every quarter, they are given an investigative inquiry where they are given a set of stuff, most likely household items in Ziploc bags without labels, and a set of procedures and are expected to set up their experiment. The final exam includes a mystery substance. They have five substances that they have to identify by their reactions to other substances and by their characteristics. The students are given four white powders that are similar in appearance in and out of a Ziploc bag. One of the Ziploc bags had a combination of two of the powders. The students are allowed to observe reactions to water, to acid, iodide, to look at the characteristics and use any other tools of observation that they can use. The students are required to set up preliminary data analysis and confirm the dependent and independent variables. This setup also gave the students
clues to the identity of the powders. During the test, the teacher also threw the students clues such as “you would use this powder for this, or this powder is a ...” The teacher described this exam as being investigative and analytical.

The teacher shared an interesting observation, perhaps as a result of the ancestral stories and scientific inquiry intervention delivered during the study. For the past 2 years, she had delivered this exam to her classes. She said, “for the past 2 years that I’ve done that, it hasn’t been the regular bell curve, kinda a lot of them did really poorly on that, they just couldn’t get it.” This year, although her students are not A and B students, they passed the test with all As and Bs. The teacher said that nothing in the year’s curriculum was different except for the ancestral stories and scientific inquiry observations in her class.

A formal assessment used in other formats but more or less the same, this type of test will perhaps be appropriate for a culturally significant practice such as the analysis of ancestral stories. It would be interesting to see how a formal assessment would translate students’ progress in inquiry after studying ancestral stories. Based on this research, students had actually developed new inquiry skills that have not been recorded, documented, or perhaps even observed before this study. Therefore, it would seem that assessments will also have to be uniquely distinctive to this process; however, this assumption is not confirmed until this is observed and analyzed
Conclusion

Hawaiian culture and Hawaiiana information can be found and accessed in just about any library, as well as through bookstores, websites, and Hawaiian studies classes. Today, even deeper sources of information about the lifestyles, language, government, art, and science are being opened up to allow more of the public to access this information. We celebrate these achievements and have been the beneficiaries of such endeavors.

Treasured sources are being printed and reprinted every day so as not to lose this vital information again. These sources of Hawaiian cultural information reveal cultural riches such as creation chants, songs written by past kings and queens, and stories. Stories have been recited by past and present generations in order to appreciate the creativity of our ancestors and view the scene of a past world.

However, it is my true belief that my ancestors did not intend for us to just read and appreciate the stories and chants. Furthermore, it is not my belief that my ancestors intended for us to just create song and dance in honor of those stories and chants. It is with conviction that I say these stories and chants gift us with a method to learn about our world. More specifically, these chants and stories display a form of data recordation data analysis and documentation.
The storyline is the thread that connects the data and context. This is the necessity of the storyline, whether it be of a great hero or a heroine, or of a great love or a family’s journey. These storylines carried the data set within them through generations and across lands. This study insists that stories are our pathway to the ancestors’ methodology of scientific study. The purpose of this research is to reveal this pathway to the descendants of these ancestors and to start their journey on this pathway by giving them access to this methodology. It seems that this pathway is accessed not through notes and information, but through process. Process is the “how” in the accessing of ancestral stories and chants and the unwrapping of this story package to reach the data within. The development of a process rather than a theory was hard to realize, but this is what the observation and interview data revealed. This revelation is the result of a grounded theory method that, like the ancestral story, stripped the theory out of the observation data.

Thus, the revelation was logical and in a way made sense. Our ancestors expected the intelligence of their descendants to have surpassed their own. Therefore, the answers were not just given, handed out like information from a book or newspaper. The answers are, actually, more questions, and the process is a tool that will reveal more answers. Through this process, the descendants
can fulfill the ancestral expectation of intelligence, critical thinking, and investigation.
APPENDIX A

Science “Pre-flection”

Name_____________________________ Date_____________________________

Science “Pre-flection”

Use the scale below to rate your comfort level with the examples given in
questions 1-5 below.

0  1  2  3  4
Not comfortable at all  somewhat comfortable  Very comfortable

1._______ I feel comfortable talking about science, math and other academic
subjects
2._______ I feel comfortable talking about my test or homework scores with my
teachers
3._______ I feel comfortable talking about colleges and what major(s) I’m
interested in with ....
       __________my friends
       __________teachers
       __________family
4._______ I feel comfortable talking about planting kalo, uala, etc. to my
teachers, friends and family.
5._______ I feel comfortable talking about hula and chant to my family,
teachers and friends.
6. Do you think our native Hawaiian ancestors were intelligent? How do you know? EXPLAIN

7. EXPLAIN why our classes are trying to find science concepts in Hawaiian stories?

8. EXPLAIN how reading and discussing Hawaiian stories can/does help you learn science.
APPENDIX B

Post-flection

Please write either 1, 2, 3 or 4 with 1 being “I am not comfortable at all” and 4 being “I am very comfortable in all situations”.

1. I feel comfortable talking about the story in classroom discussions ______

2. I feel comfortable asking questions about the stories
   To the teacher ______
   To other students ______

3. I feel comfortable creating science questions from ancestral stories ______

4. I feel comfortable bring up ideas about the story in class ______

5. I feel comfortable in the fact that if I had to do it again I will be able to.....
   Web out a story ______
   Summarize a story ______
   Come up with a science focus question ______
6. We worked in groups most of the time. It is true that you learn from the exciting discussion that goes on in that group, so please answer the following questions

a) What are good things about working in a group

b) What are bad things about working in a group?
**APPENDIX C**  
Science Inquiry Through Moolelo Data Analysis Sheet

Name__________________________ Date______________________________

**Science Inquiry Through Moolelo Data Analysis Sheet**

*Directions:*
1. Use your data to complete the data analysis chart below by first identifying the overall results of your experiment.
2. Write in ONE result per square. Your must state a conclusion for each number in the results column. Be sure to make final connections in your conclusions so the reader is not left asking “and so…..?”

**Focus Question:**

**Hypothesis:**

<table>
<thead>
<tr>
<th>(What Happened?) RESULTS</th>
<th>(Why did it Happen?) CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

Science Concept Identification

Story ______________________________________________________

1. Look through the story carefully to identify the science concepts that are covered within the story.
2. Write the general science concept on the lines provided
3. Pull out specific evidence from the story that you used to identify that science concept and record that in the first column of the table
4. Use the second column to explain HOW the evidence led you to the science concept. The rationale will allow others to understand your thought process of identifying the science concept from the story.

Science concept #____: ____________________________________________

<table>
<thead>
<tr>
<th>Evidence From the Story</th>
<th>Rationale (Inferences, Interpretations, Explanations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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