EXPLORATORY RESEARCH OF THE BIG HORN MEDICINE WHEEL ACTING AS AN INDIGENOUS PLACE-BASED PEDAGOGICAL INSTRUMENT FOR LEARNING SKY-EARTH RELATIONSHIPS, SKYWATCHING FUNDAMENTALS, AND CELESTIAL MECHANICS

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree

of

Doctor of Philosophy

in

American Studies

MONTANA STATE UNIVERSITY
Bozeman, Montana

April 2014

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DEDICATION

I dedicate this study to my mother Carrie Fisher (Caroline Catherine Herriges) whose fierce fine fettle of ethical character underlying her pragmatic witty wiles of wisdom, ever inspires me to courageously find the frolic in each day's troubles. And to my father Roderick Garry Neal Fisher whose nimble creative mind illustrates through his ever-lengthening published compositions: books, art, music, and games, the attainable effervescent quintessence of geezer-hood.

I appreciate the careful attention and enthusiasm of my committee members: Sara Mast, George Horse Capture, Jr., Geoffrey Gamble, Jeanne Moe, and Colleen Moore.

In admiration of his expertise, I thank Jack H. Robinson for the wonderful discussions concerning archaeoastronomical methods and for sharing his research and knowledge of stone circles in America and England.

ACKNOWLEDGEMENTS

I acknowledge the supreme editing prowess of Gail A. Fisher-White and thank her from the fullness of my being for every constructive criticism she weighed on this work. Her electric intellect prodded me to resist hiding behind recondigious pedantic discourse, persuaded me to delete grand propositions, and begged me to proffer comprehensible ones within the vernacular instead. Sometimes, I listened. *Victoria Bochniak* shared excellent editorial comments and has been a reliable colleague and friend during this study. *Anne Ore* has shared her enthusiasm for Native Studies, history, and nature. Her excitement over my work always fueled my fire of exploration. *K.C. Cassidy's* enjoyment of the night sky, gave me a friend among the stars for these many years. Her own determination to be fully alive is contagious. *Cassidy Medicine Horse*, my wise and witty comrade, knows when to engage humor and when to seriously ask, "why?" Thank you *Jan Sublett, Jessica Burgard, and Kathy Gottlieb* for sharing your students and class time with me and advising for the Project Archaeology lessons. Nothing is as valuable to me as my students' insights and the adroit counsel of my teacher-friends.

In the end, I owe all my ability to work on this endeavor to my best of all friends: my husband Rob Bargatze, with his instructive life mottos: "What doesn't kill you, makes you stronger" and "Wherever you go, there you are." As the years lengthen, my admiration for him ever deepens.

VITA

Ivy Therese Fisher-Herriges Merriot was born in Missoula, Montana in 1957—the year of Sputnik. Her parents are Caroline Catherine Herriges "Carrie" Fisher, daughter of Nicholas and Anastasia (Strunk) Herriges, and Roderick Garry Neal Fisher, son of Halton and Cicily (Umber) Fisher.

Music flowed through both the Fisher and Herriges families' blood and at sixteen, Ivy dropped out of high school to join the family band as an electric bass guitarist. She traveled the West with her family playing "on the road" until her first child was born. She then played locally and started a plant business, taking care of indoor plants and outdoor flower gardens In Idaho Falls, ID.

Ivy earned her Bachelors of Science in Philosophy with a strong science curriculum from Montana State University in Bozeman, MT. She is the second woman in her family ancestry to have achieved a four-year college education, preceded by her sister, Gail A. White of Blackfoot, Idaho.

The motivation for a college education came from Ivy's children: Eben Howard, Even Howard, Andy Cullison, and Max McKinnon. Their inquisitiveness and questioning spurred their mother to continually seek knowledge. All her children hold degrees, one BA, two MSs and the oldest--closing in on a PhD.

As a critter lover, Ivy was happy when her science knowledge helped her eliminate the need to use live mice in experiments in Mark Jutila's immunology lab at MSU. The revised protocol also yielded higher antibody concentrations.

In 1994, Ivy earned her Montana teaching certificate in Broadfield Science, grades 5-12. She taught physics and astronomy in public and private schools. For professional development, she worked with solar astronomers Dr. Piet Martens and Dr. Alexei Pevtsov, researching solar prominences at the National Solar Observatory at Sunspot, NM, later creating a web database, with the programming expertise of Dain P. White, to make images of H-alpha accessible to the global community.

Ivy learned the operation of large telescopes with stellar and black hole astronomers at the Kitt Peak Observatories above Tucson, Arizona. In 1996, she and Rob Bargatze powered the original team for the astronomy outreach, *Stars Over Yellowstone* with James Manning in Yellowstone National Park.

Ivy taught and co-designed the first astronomy courses taught online through NASA, Montana State University, and Abaetern Academy. In 2001, Dr. George Tuthill introduced her as a "pioneer" in the field of online learning.

She earned her Masters in the history of science at Montana State University in 2010, continuing on to a PhD in American Studies in 2014.

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ABSTRACT

This study explored the ability of the Big Horn Medicine Wheel to act as a pedagogical instrument for learning sky-earth relationships.

The Big Horn Medicine Wheel is one of six large stone wheels in the northern plains that show astronomical potential. It is a National Historic Landmark and Sacred Site, created before all known histories--oral and written.

Forty years ago, John Eddy and Jack Robinson proposed the first stellar alignments at the Wheel. My own study between 2009 and 2014 concluded that the Wheel's placement, its "Place," reveals extensive symmetry with celestial mechanics and offers pedagogy for learning skywatching fundamentals.

My study combined the methods of Native Science and Western science. I collected oral histories, compared images of the Wheel taken by various photographers over 100 years, and tracked stars and the Sun through summer and fall seasons for five years using the naked eye, binoculars, transits, GPS, and a Meade Cassegrain 8" electronic telescope. I sought Native ceremony to prepare for the immersion of my senses in place-based cognition while allowing my intelligence to learn from "inert" materials such as stars, mountains, and stones.

My results showed the Wheel accurately mirrors the sky using embedded stones on the ground to correspond to the major north polar stars over the Earth's 24,000 precessional cycle. The Wheel is perfectly situated on the shoulder of Medicine Mountain to make use of the dip in the northern mountainous horizon to cradle the precessional north polar stars as they roll through their millennia cycles, creating a stellar circle in the sky above the Wheel's stone circle on earth. I found the latitude of the Wheel is a "sweet spot" for detecting small angular changes in heliacal stars over time and for the nightly, yearly, and 5000-year circular movement of its zenith star Capella, which also holds a symmetry with the northern landscape. And I found the twenty-eight segments of the Wheel correspond to stellar grid systems based on asterisms.

I make no conclusion about the builder's purpose, only about the possible pedagogical uses of the symmetry of the Wheel in its contextual Place.

CHAPTER ONE

HOW I CAME TO STUDY THE WHEEL

Introduction

This study has delighted my senses, expanded my heart, and quickened my mind. Before starting my doctoral research, I performed a ceremony where I approached the ancestors and humbly requested their aid in my attempt to gain knowledge of the Big Horn Medicine Wheel. Feeling cool blades of grass between my toes, a warm wind brought a slow smile to my face as I faced East into the morning Sun. Lifting my arm, I held a pinch of tobacco toward the sky, announcing to the ancestors that I did not want this knowledge for myself but for sharing with my students. A thunder roar of laughter jolted me from my supplication.

The ancestors made it quite clear that they were capable of speaking directly to anyone interested in learning; they did not ask for my help, I asked for theirs. I awakened abruptly from the illusion that I was full grown. I realized that I was but a babe before these ancient beings. I hoped my dull-mindedness did not make me unworthy of their help. I paused to consider what I would do with knowledge that was for me alone. How could I share it as an educator? The reply came quickly, “enlisting the ancestors to help you learn does not replace using your own heart and brain. Once knowledge is transferred to you, it is yours. The knowledge you gain is for your benefit, to improve the quality of your life by improving your understanding. The Big Horn Medicine Wheel has much to teach many, do not think your experience is rare.

My study concluded that place-based pedagogy at the Big Horn Medicine Wheel is an intimate *learner*← →*Place* interaction. The Big Horn Medicine Wheel, in its context of Place, is able to stimulate knowledge generation *directly*. I spent nights with the Wheel. I stood on the shoulder of Medicine Mountain, attentive to the impulses seeping from rocks and starlight. When the Sun leaves the sky on a Moonless night, all turns to black with the exception of the Wheel's gleaming white rocks, brightly conversing with the stars overhead.

I found it was effective to give the Wheel's Place permission to express itself unhindered by roles for knowledge transfer defined by a 21st century society, whose golden city lights I could see thousands of feet below me in the basin. I also gave myself permission to learn without confining my thoughts to Western science categories or comparing my experiences to textbook answers. No human teacher was present to inform me of what I should be learning or to loom over me, ready to grade correct and incorrect answers. I allowed the Place to have full pedagogical agency.

Do not be concerned that I am anthropomorphizing Place. I know this is not the case because the Place does not act like an anthropoid. I capitalize Place out of respect for its "be"-ing.

It is one thing for a Place to teach me directly and personally, but as an educator, I was tremendously interested in whether I could find evidence that this pedagogical agency of Place has an objective form, useful to other learners.

Learning from a Place is academically called, "place-based learning." I already knew from my own teaching that connecting my students to anything real from a Place or

allowing them to visit a Place first-hand, heightened their interest in learning, keeping them engaged long after the experience. However, could a Place speak with them directly? If so, how does this type of place-based learning compare with other place-based pedagogies, such as environmental education, civic involvement in one's local community, or understanding one's place by listening to Elders? When should a teacher design a lesson and when should the Place take over the lesson? Because I believe teaching is an art (and art is extremely difficult to write about), I will take the easier route and instead discuss the history and science associated with the Wheel as a pedagogical instrument.

My Reasons for Studying the Big Horn Medicine Wheel

I realized the broad applicability of place-based pedagogies in 1997 when I assisted with the redesign of an astronomy course for the National Teacher's Enhancement Network at Montana State University (MSU) to make it more suitable for our specific audience of high school science teachers. This course's pedagogical design later became a template for courses in the Masters in Science in Science Education (MSSE) degree at MSU. The redesign template consistently received high scores in national evaluations and was used in workshops to help other instructors design their courses.

While teaching this astronomy course, the following questions would come up every semester, "Will we learn the constellations?" "Will this course help me show my students the night sky or will I only learn how to manipulate physics formulas?" "Can

you (the instructors) actually find anything outside at night or is this all book-learning?" --all good, practical questions. These science teachers did not beat around the bush. They desired useful knowledge, meaningful to their students.

This inspired me to go beyond the book knowledge of astronomy and learn to run telescopes. I started with a borrowed 10" Dobsonian home-built telescope from the Southwest Montana Astronomical Society (SMAS). Within a few years, I had learned to run scopes from an electronic 60mm Cassegrain in my backyard to the three-meter scope inside a large observatory on Kitt Peak in Arizona. l had picked up enough information about major stars, nebulae, galaxies, clusters, and the occasional comet, that I could pass on the fun nightly to hundreds of international visitors during the summers at Yellowstone National Park. In about the eighth year of helping with this event at the Madison Campground bison meadow, a young Park Ranger confided in us that it was while she attended one of our skywatching events as a child that she fell in love with the night sky in the Park and chose to become a Park Interpreter.

Over a period of fourteen years, I have shared astronomy knowledge and excitement through public talks, pre-school constellation story times, school yard Moon viewings, planetarium shows, spacetime programs for gifted students, high school courses in special astro topics, professional development workshops for teachers, and international viewing through a kaleidoscope of telescopes at Yellowstone National Park. Like Forrest Gump with his box of Whitman's chocolates, I enjoyed trying an assortment of available pedagogies in these programs, always attentive to the learner's own interests

and what they took away from the experience. It never occurred to me during those years that a pedagogy designed by a Place was even a possibility.

This dissertation is a report of my discovery that the Big Horn Medicine Wheel is capable of creating pedagogy by its design of stones and its placement in the landscape. The power of this place-based pedagogy is that it links the mountain and rocks to the sky, demanding the attention of the learner, without the need for a human intermediary. I was curious if this type of pedagogy could be tested by Western science methods and be brought into American education systems.

The Interdisciplinary Aspect of this Research

The roots of this research tap the disciplines of art, astronomy, mythology, philosophy, history, education, linguistics, archaeology, and indigenous ways of knowing. Integrating so many knowledge structures to develop a thesis acceptable to any one discipline has been a daunting task. I apologize to those in any of these fields other than philosophy, education and astronomy and ask for your allowances that I may venture into your disciplines without formal training in your methods. I have depended on my training in philosophy, education, and astronomy to steer me through this research and land my thesis safely on tenable ground.

Exceptional Thinkers

Throughout my research, a few people stand out from the rest of their civilization in their remarkable understanding of the workings of the celestial sphere. One of these is Thales of Miletus, an astronomer-philosopher who could predict eclipses 2600 years ago.

In Thales' case, he predicted an eclipse that changed the course of a six-year war.[1] Looking at only the archaeological evidence of Thales' culture, we may never be able to make the claim that his society was capable of predicting eclipses. The evidence of his skywatching ability would not be discernable by pottery fragments or stone tools used for farming or hunting. When individuals carry knowledge very different from the basic survival knowledge of their culture, they do not appear in the historical or archaeological record unless their activity amazes their society or ours. Transfer this idea to the Medicine Wheel. A whole society did not need to understand how the Wheel could work astronomically, for this to be the case. How many of us know how to mix the fuels for a rocket to the Moon? Yet, we live in a society where this happened.

Today, few astronomers or non-astronomers could predict eclipses as Thales did 2600 years ago. This level of skywatching and the ability to teach about it are currently outside any one academic discipline.

Stone Circles in Other Places

A few years prior to my visit to the Wheel, I had an experience that anticipated my research on the Big Horn Medicine Wheel. I had traveled to the Pueblo ruins of the Chaco Canyon culture in New Mexico. There, I sat inside the Great Kiva of Casa Rinconada, a circular, deep-set masonry room, where people performed ceremonies up until about 1000AD.[2] The roof had long ago decayed and was now gone, thus giving the desert stars robust access to the inner kiva. Unrestrained, starlight danced freely in Casa Rinconada.

Rinconada's circular rock wall held twenty-eight niches, unevenly spaced. The skill of the Puebloan women who designed and built these structures was impeccable.[3] I assumed therefore that their reasons for spacing the niches unevenly must be intentional. At that time, I did not realize the Big Horn Medicine Wheel's twenty-eight sections were also unevenly spaced and these also could have been laid down in equal divisions, yet were not.

The artist Anna Sofaer accidentally discovered a remarkable astronomy connection to the Chaco Canyon's rock art in the 1970s. While researching petroglyphs high on Fajada Butte, she contemplated spiral petroglyphs in the sides of a rock wall. Light from the Sun danced through a slit between large rocks as a dagger of Sunlight slowly sliced across the spiral petroglyph, terminating at its center.

Anna did not realize she had chosen noon on the solstice to do her research on Chaco Canyon rock art. Archaeologists and astronomers would later be envious of her discovery. An artist had obtained a major breakthrough in a field in which she had little expertise. Anna Sofaer, an artist, had changed the way archaeologists and astronomers viewed their own skills and knowledge. She changed the field of archaeoastronomy of the Southwest.[4]

Many ancient sites around the world show evidence of their culture's awareness of celestial mechanics. Chaco Canyon' is not an isolated incident. The Sun's position in the sky on the longest day of the year is commonly depicted through the art and architecture of many cultures from ancient times to the present. Early engineers designed

"temples" and entire towns to "clock" the Sun's movements through the seasons, providing an astronomical calendar as useful as today's wall calendar.

The Big Horn Medicine Wheel is one of these ancient astronomy sites. I had not yet visited the stone wheel high in the Bighorn Mountains when I sat within the stone circle of Rinconada that day in Chaco Canyon, but somehow, the Big Horn's unique circular pattern already owned a part of my brain.

Evening at the Wheel

> The Wheel's white limestone rocks began to glow brighter as the night became darker. Soon the solid earth faded to merely a ragged dark horizon, cutting off the bottom of the setting crescent Moon. Stars above, darkness below. The stars fell around me, landing beneath my feet. Above my head, the Milky Way splashed across the inverted celestial bowl, flowing up one side and down the other—the ancestor's trail. Thus began the night's skywatching lesson: the pedagogy of the Wheel.[5]

The Big Horn Medicine Wheel is a large circle of white stones lying on the ground at nearly 10,000 feet in the Bighorn Mountains of Wyoming. It has twenty-eight spokes, radiating out from a central group of stones. Along the rim of the wheel lay five other groups of stones of various dimensions and shapes, with a sixth group, in the form of a much smaller circle, at a slight distance from the main wheel's rim, connected to it by a short line of stones. The whole wheel is about eighty-five feet across. It rests alongside an ancient well-used road where many human artifacts have been found, dated to over 8000 years before the present.[6]

Ancient Well-traveled Trail to the Wheel

Regardless of the elevation, this wheel is not hard to reach. Many ancient trails still exist from the basin to the top of the mountains and the widest of these is road-sized and takes the traveler directly to the Wheel. Even in winter, when the modern asphalt road is covered in snow and closed for the season, one can still snowshoe up old trails. The size and deep cut of the old road indicates that many people traveled here, but why would they want to? The Bighorns are high above the hot basin, above flies and human conflict. The Sheepeater Elder Aggretta said her people chose to live high in the Bighorns for these exact reasons.

William Matthews, archaeologist for the Bighorn Forest Medicine Wheel District has found evidence that ancient humans lived at high altitudes for months at a time. This counters the belief that high altitude was used primarily for short duration hunting camps. Matthews found household tools showing that people were involved in much more that hunting above 8000 feet.[7]

At high altitude, weather changes abruptly in the Rockies and the ability to predict these changes would be extremely useful for moving family groups with children and Elders. Solar astronomer John Eddy and astronomy educator Jack Robinson researched the astronomical functions of the Wheel in the latter part of the 20th century and concluded that the Wheels' design gave evidence of alignments to morning star positions. These alignments could give visual warnings for the upcoming change in seasons.[8] In this way, the Wheel could act as a seasonal calendar.

Scarface and the Creation of the Ft. Smith Wheel

Jack Robinson's work intrigued me because he showed how another wheel, not far from the Big Horn Wheel, had similar stellar alignments. Joe Medicine Crow, an historian and Crow Elder tells the story of a man named Scarface who went to the Wheel for a Vision Quest and afterwards built another wheel similar to the Big Horn Medicine Wheel. This is now called the Fort Smith Wheel due to its proximity to the old Fort Smith. Upon inspection of the Fort Smith Wheel diagrams, I found it was not an exact copy of the Big Horn Medicine Wheel. The spokes of Scarface's wheel were adjusted for the change in latitude of the site as compared to the Big Horn Medicine. The Fort Smith Wheel contained fewer spokes, only showing the major alignments for Sun and stars, most of which were the same alignments as found at the Big Horn Medicine Wheel.

Scarface was not just mimicking an aspect of the design. He somehow learned and reproduced elements of the Big Horn Medicine Wheel's design that connected the Wheel to the Sun and stars. How could Scarface know about the alignments? No other human was reported being present at the Wheel during Scarface's Vision Quest, so whatever Scarface learned, he learned directly from the Wheel in its contextual landscape.

Place-Based Learning

This way of learning is termed, "place-based learning" and is one of several types of indigenous ways of learning. The indigenous pedagogy experienced by Scarface was a pedagogy devised and executed by a Place, quite different from textbook-delivered classroom pedagogy so familiar to American school children.[9]

How could a person learn about the sky from a Place without instruction from another human? Obviously, Scarface engaged in a pedagogy informed by the source itself.

The decrease in American students' interest in science over the past three decades has caused a flurry of research in science education strategies. Creating a science curriculum full of exploration, rather than facts, is a method the National Science Teachers Association believes would better engage students in science. Science teachers' training now includes inquiry and experiential methods. These methods are also essential components of place-based pedagogies.

Anthropologists assume that a culture changes when their needs change.[10] Tracking the seasons may become a cultural skill when the need to know when to plant and when to harvest becomes important.

The cultural needs that inspired the design of the Big Horn Medicine Wheel are not known. White limestone rocks, still quietly waiting on a windswept shoulder of Medicine Mountain, have conveyed Sun and star knowledge to people who were not the original builders. If designing the Wheel came from a need to track the seasons, only a few rocks would be necessary to mark the positions of the Sun and a few stars. Nothing as complex as the Big Horn Medicine Wheel's design would be required for these limited needs of annual season-tracking.

Pedagogy and Content

An educational curriculum holds two identifiable parts: pedagogy and content. The content is "what" is taught, the pedagogy is "how" it is taught. Pedagogy is defined

as “teaching methodologies.” Therefore, pedagogy can be created and delivered by a teacher yet never result in content learning by the student. We have all experienced this at some time or another.

Prior research focused on “what” the Wheel reveals to us, the study before you explores “how” the wheel reveals the “what.” How does the Wheel perform as a tool of instruction, creating its own pedagogy by its placement and design within the landscape?

Pedagogy is the method of teaching, not necessarily the method of learning. The best pedagogies would result in learning, but the word itself does not guarantee learning will take place. In summary, pedagogy describes the transmission of knowledge, not the reception.

In my early years of astronomy teaching, I was obsessed with Einstein’s relativity and spacetime travel, with gamma-ray bursters and black holes, with the magnificent physics of exploding stars and bright nebulae. I was surprised to find these topics in astrophysics were easier for students to learn than basic skywatching. How could that be? Why was it so difficult for my students to understand simple skywatching concepts? The short answer: skywatching concepts are not simple.

Skywatching Concepts Are Not Simple

The angle of the Earth’s polar axis combined with the latitude where one lives, gives each of us our own view of the sky. During an online astronomy class for NASA, my students lived in widely separated latitudes, such as Alaska and Arizona, affording each of them a different view of the sky. Some students lived in well-lit urban areas and

others in the countryside by deep, dark lakes. This was a wonderful opportunity for me to experiment with pedagogies affecting student learning.

The first chapters of the college astronomy text we were using attempted to cover the "fundamentals" of astronomy (the stuff of skywatching). This was the most grueling chapter for my students. They stumbled, fell, and stumbled again.

The students begged me to allow them to move on to the advanced astrophysics sections where they could show their science-math prowess in abstract thinking. They wanted to get to the chapters with difficult formulas where the rules were apparent and familiar. However, the students were required to continue to work on these "fundamentals" until they mastered them. The mastery learning pedagogy I employed required a mastery of the content of each chapter before moving on to the next. A "B" grade was not acceptable.

Without this pedagogy in action, I might not have recognized the discomfort the students experienced with their personal interaction with the sky. They would have earned higher grades further on in the astrophysics section and the difficulty of these earlier "fundamental" chapters would not be evident in their final grades or their final thinking. Skywatching fundamentals are not necessary for manipulating formulae in astrophysics.

This experience caused me to realize the importance of pedagogy for awakening awareness. We can learn facts, but the danger in learning enough facts to achieve a good grade is that we become unaware or unconcerned about the importance of what we did not learn.

Pedagogy, "how we are taught," became more important to me than content, "what we are taught," because the "what" is never complete. The satisfaction in the "what" we learn causes a dullness of mind that can obstruct further learning. Instead of using pedagogies that promote satisfaction with a bucket of facts, what happens if a teacher purposely chooses a pedagogy that promotes awareness of the extensive size of the bucket? The teacher has the power to choose a pedagogy that stimulates an enduring appreciation for what we do not know.

Conclusion

In conclusion, I came to realize that new knowledge (not necessarily contained in textbooks) can be acquired through place-based indigenous pedagogies as Scarface demonstrated. The pedagogy of Place--in place--at the Wheel has not been previously articulated in scholarly texts. Scarface learned skywatching, not by simply copying the alignments but by understanding their function, as demonstrated by his replicating the fundamental alignments of the Big Horn Medicine Wheel at a different latitude and elevation. The actual scientific information about the sky that Scarface learned was real Western science factual knowledge, the "fundamentals" of skywatching.[11] How did Scarface learn from a mountain, what my graduate level physics students had difficulty learning from textbooks and teachers? [12]

I was determined to study the indigenous pedagogy embedded at the Big Horn Medicine Wheel. This dissertation describes the outcome of that research.

CHAPTER TWO

OVERVIEW OF STUDY

How this Study Contributes to Scholarly Discussions in American Studies

This dissertation begins a scholarly discussion within American Studies on indigenous pedagogies of place-based education. American Studies scholars rarely write about indigenous pedagogies. America as a pluralistic society has deep cultural history within indigenous traditions, yet often Native Americans are lumped in with minorities based on their numbers, not on their longevity and deep connections to the land of America. Even less common is research on indigenous place-based learning. This dissertation and accompanying study begins a new discussion within American Study literature.

"For we must consider that we shall be as a city upon a hill; the eyes of all people are upon us." John Winthrop, circa 1630

Elizabeth Winthrop, writing in *A New Literary History of America* (2009), reminds us that John used this rendition of the Bible's "city upon a hill" passage to alert early Puritans about their behavior in the New World. Almost 400 years later, the "city on the hill" phrase continues as a meme implying that Americans are doing something worth watching, they are engaged in a grand cultural experiment. The term, "American exceptionalism" is invoked to set this experiment apart from all others.

American Studies scholars work as historians with a passionate obsession for evaluating societal views about what it means to be an American.[13] They question where

America begins and ends, literally and figuratively. Are we "exceptional?" Do ideas such as the city on the hill grow into memes, then icons, ultimately creating expectations of our reality?[14] Does this expectation live on to color the perception of reality so that we make sense of our experience by aligning our perceptions to these memes and icons, rather than seeing reality for itself? [15]

One romantic idea that informs our 21st century reality is the notion that pre-colonial Native Americans lived a better life than today's Americans. Since at least the 1970s with the American Indian Movement, the media attention given to Native American culture has persisted. Americans willing to claim their Native ancestry on the U.S. census has increased as they become proud to be classified as the indigenous people of this continent. Contemporaneously, non-Native people have increasingly adopted indigenous American values, such as a deepening environmental awareness of the circular nature of life and the concept of sustainable living enabling seven generations from now to enjoy the resources we enjoy today.

American Studies' publications contain few essays on Native Americans. While scholars write about pluralism and minorities, Native Americans' identity is not bound within the category of "minority." The indigenous people of this land stand apart in cultural knowledge from the heterogenic groups that came to America in the last 400 years. Because Native Americans carry a unique knowledge base concerning this continent, they require their own category based on the qualitative type of their contribution, not the quantitative number of their members. The reason for this is that

Native Americans contain a deep generational knowledge of *this land,* unlike other minorities whose deep (if not forgotten) knowledge comes from across the seas.

Discussions in American Studies usually focus on societal changes since Columbus. Nonetheless, this is not when American culture began. The indigenous people, living on this continent before European, Norse and Chinese ships landed on these shores, *are still here* and continue to add their culture to modern America. Indigenous ways of knowing influence our pluralistic society, even though authors may not comprehend or acknowledge the contribution.

While few scholars focus on Native American's contributions and lifestyles, fewer yet are concerned with indigenous pedagogies. Pedagogical topics stay mostly within education and Native American Studies' journals. The influence of indigenous pedagogies within American culture still awaits discussion within American Studies scholarship.

Other topics of indigeneity currently discussed within American Studies scholarship include methods for researching indigenous contributions, changing statistics on Native American populations, land and law issues, and Native American scholar's changing role within non-indigenous academic environments.

Researching Indigeneity

Chadwick Allen, writing in "Indigeneity at the Crossroads of American Studies," a special edition of the journal *American Studies,* believes that the "primary aim of any project in the field of indigenous studies…[should] engage…the complex and even

contradictory realities of indigenous experiences…."[16] Allen fears that without the acceptance of the "contradictory realities of indigenous experiences," our perceptions of indigenous culture will coalesce from sources *about them* instead of *by them*. The limits of a filter created by a culture believing in one reality trying to explain a culture believing in multiple realities would present an inefficacious result.

Russell Thornton, in the same volume, writes about tribal survival into the twenty-first century. He reports that in 1960 the American Indian population (not including Aleut and Inuit) was 523,591 and only twenty years later in 1980 grew to 1.37 million. This was due not only to Indian births, but to Americans self-identifying as Native American who had not done so in the earlier census. The trend continued, for the same reasons, to over 4.1 million in 2000; 41% listed themselves as enrolled in tribes and 26% did not list any tribal affiliation.[17] Americans are increasingly self-identifying as Native American. The willingness and pride in acknowledging indigenous heritage is evidence of the reconstruction of indigenous identity within the American population.[18]

Writers outside of American Studies whose research is fundamental to this dissertation topic include Vine Deloria, Keith Basso, and Gregory Cajete.

Vine Deloria has been politically involved with indigenous topics since the 1960s and wrote *Power and Place,* sharing deep insights into indigenous knowledge pathways.[19] In his book, *Wisdom Sits in Places*, Keith Basso is interested in ancestral drama that becomes embedded in a landscape and thereby continues to instruct descendants. Gregory Cajete brought indigenous pedagogies right into classrooms with his books, *Native Science* and *Igniting the Sparkle*. He describes how to design lessons

based on the Plains Indian four-sectioned medicine wheel. Through this method, Cajete found a way to share the concept of circular time and circular learning with teachers.

This dissertation extends Cajete, Basso, and Deloria's concepts of indigenous pedagogies of place-based education into American Studies scholarship. These pedagogies have continued within indigenous communities from pre-colonial times to the present. They began making formal headway into Montana public schools as recently as 2005 with the funding of the 1970s Indian Education For All Act.[20] At the time of this writing, Montana has become a national leader for its public incorporation of indigenous knowledge into the state's K-12 classrooms.

Educational Pedagogy's Influence on American Society

Public educational pedagogies used for large groups of students came into being in America in the same decades when American authors were making a name for American fiction. The influence of Emerson, Whitman, Thoreau, and Hawthorne showed that worthy literature could be produced in America. At the same time that America gained a literary culture of its own, the public school systems in America came into full swing.

American schools inherited their first pedagogies from the European model. This meant tutors and small private schools for those who could afford it. Later, with public schools, "mass" education pedagogies became the model. Like the industrial work model, this meant organization, timelines, deadlines, conformity, and a hierarchy of who controlled the learning. The efficient industrial education "product" (the educated

student) was one who could read, ‘rite and do ‘rithmatic. With this 3-Rs foundation, American youth were thought to be ready to unlock the doors of success, regardless of social class, race, or creed--or so the story goes.

Like the products of industry, the products of education were best when they appeared identical coming off the educational assembly line. Uniqueness within a “batch” was not a good thing. This type of “mass” pedagogy has affected America at every level, causing a fear of working outside the system, of being unique in a way the system does not recognize as valid. The hippies of the 1960s and 70s are a recent example of how standing up against inane wars gets you branded as druggies and dropouts of society, not as thinkers and do-ers.[21]

Mass education is the exact opposite of indigenous education. Public school education moves closer to an indigenous pedagogy when it incorporates smaller classrooms, more individual attention to each student’s learning style, and adjusts to the community and the seasons for its lessons. However, America in 2014 does not fund public education at a level that allows for indigenous pedagogies. Regardless of the teachers’ and curriculum writers’ wonderful ideas, even the best lessons turn into mass pedagogies and the outcomes of these are very different from the outcomes of indigenous methods.

For example, mass pedagogies rely on all students receiving and returning to the teacher the same knowledge. Facts are the simplest type of knowledge to take in and return (often called regurgitation. In mass education, efficiency in grading is important and the correct return of facts provides a common yardstick for efficient grading.

In stark contrast, indigenous pedagogies place students in an environment of choice, allowing the student to construct new knowledge by learning facts *in relationship to context*. Answers vary in relation to the students' experience within the context of the their learning. Grading this type of learning leaves the teacher without a common yardstick and demands more attention to individual student growth.

Research in science education in America continues to show positive effects of the use of indigenous pedagogies such as inquiry and experiential methods of learning. The quantifiable results of these types of instruction show that facts learned in context integrate better into long-term memory and are more easily retained and added to existing knowledge. The qualitative result of these types of instruction show that students stay interested in learning long after the formal lesson is over, adding to their knowledge without outside persuasion. They become internally willing to continue to build knowledge.

Private schools are able to offer more indigenous-like pedagogies such as inquiry and experiential methods due to the smaller class size and attention to each student's learning style. Home schools often have disastrous results because they try to emulate mass education practices. However, when the home-school teacher applies indigenous pedagogies, it produces better results, able to flex and evolve at the student's pace and learning style, without dulling the student's enthusiasm.

Place-Based Pedagogy

Place-based pedagogy is one type of indigenous pedagogy. The subject of this dissertation, to explore whether Place on its own can offer a pedagogy, extends these

current scholarly discussions of place-based indigenous pedagogies to concepts sometimes uncomfortable to navigate through written language. This may be due to the closeness of the topic to spirituality. Nonetheless, we will proceed and attempt to find words to access the process of place-based pedagogy at the Big Horn Medicine Wheel.

Place-based pedagogies are at their best a transformative process that allows the learner to generate knowledge that can be objective and factual or entirely new and personal. The common field study is a minor subset of a deeper place-based pedagogy. This dissertation uses one specific place, The Big Horn Medicine Wheel, as an example of a type of pedagogy where Place creates the lesson design, Place creates the pedagogy, and Place interacts directly with the learner.

Research Methodologies Used in this Investigation

The methodologies used in this research varied over time, beginning with a Western academic approach of researching written histories and peer-reviewed scientific papers. Scientific experimental methods were employed with the hypothesis, “Can the Big Horn Medicine Wheel perform as a place-based, indigenous pedagogical instrument for learning sky-earth relationships?”

As part of the scientific method, site surveys at the Big Horn Medicine Wheel in Wyoming were performed. Data on star positions, solar rising and settings, extinction angle of stars, positions of the Moon, and headings for other landscape features were collected.

Western Science Research Methodologies

For the Western science approach, astronomy methods used in skywatching and archaeoastronomy research were used to compare the rising and setting positions of the stars and Sun to the alignments as proposed by John Eddy in 1974 and Jack Robinson in 1986.[22]

The tools used for these measurements included a surveyor's transit, a digital 8" Meade Cassegrain telescope, GPS, magnetic compass, and digital landscape astrophotography equipment. Through these instruments, new information was gained that supported Robinson, not Eddy's, heliacal star positions and confirmed Eddy's solar alignment for the solstice Sunrise. The conclusion for the Western science research gave evidence that the Big Horn Medicine Wheel was last aligned in the year 1100AD +/- 100 as suggested by Robinson.

Drawings and photographs of the Big Horn Medicine Wheel have been investigated to note any possible changes in stone arrangements since the first photos and diagrams of circa 1905.

The symbolic nature of the Wheel's image is repeatedly seen across the globe as an archetypal symbol. The current use of the symbol for the Sun in astronomy and physics is among these uses with its circle enclosing a central dot.

Later in this dissertation, reasons will be given for the spokes and smaller cairns not representing the Sun, but other celestial objects. Therefore this symbol of the Sun is a likeness of the Big Horn Wheel's symbolic design when the non-Sun aspects are removed.

Archaeological excavations were performed at the Big Horn Medicine Wheel in the late 1950s and again in the 1970s. The Wyoming Archaeological Society (1957) and Michael Wilson (1977) excavated the Wheel and found few artifacts, probably because hunters and looters had previously disrupted the site. For a short time around the turn of the 19th century, a small nearby mining town existed at Bald Mountain. It is possible that curious townspeople had already disrupted the site with artifact collecting and therefore archaeology is not considered in this study.

Historical and Oral History Methods

At all times, my research engaged the integration of multiple, and usually separate, academic disciplines. These included Western history, Native American Studies, indigenous studies of European tribes, astronomy, education, archaeology, linguistics and art. Research into the overlapping fringes of these disciplines inspired research into global ancient archaeoastronomy sites and archaeoastronomy research methods. This prompted a contemporaneous flurry of research into religion, mythology, and astrology.

For clarification, astrology is not synonymous with astronomy or archaeoastronomy. Western science pundits label astrology as a pseudo-science. In practice, astrology is an art that begins with hard science. The reason it cannot be categorized as a full science is because it is unable to be tested through the scientific method. Neither can love, hope, the power of generosity, etc. This does not mean astrology does not have its usefulness within culture. However, astrology methods were not used in this study's research.

Native Science Approach

Native Science is more complex than Western science due to its relational, personal, and holistic nature. Native Science includes the objective within the larger subjective. Whereas physics may be concerned with orbital mechanics that gives a spaceship the ability to land on another planet, Native Science is concerned with the relationship of our Moon as a being. The larger question may be asked, "Should we land a spaceship on the Moon?"

Western science promotes objectivity, employing the scientific method by limiting the variables. Large systems are very difficult for Western science. Examples include weather prediction and understanding the evolution of a species.

While Western science attempts to be objective and free of human interference, Thomas Kuhn argues that it is impossible for Western science to be devoid of subjectivity.[23] Philosophers of science had previously argued this, but philosophers' ideas tend to be difficult to read and stay for the most part within their own circles, whereas Kuhn's voice came from within the science community.

Kuhn proposed that it is an illusion to believe that people can conduct Western science experiments and not put something of themselves in the design and interpretation of the data. However, Western science has given good results that are predictable and repeatable to a point. Western science, therefore, is a subset of Native Science. The two are not at odds.

Western Science is very useful for non-complex systems and has clear uses in society. Native Science brings all the Western science facts and procedures into a complex and holistic view of our lives within a larger system. Native Science understands

that there is no way to take humans out of the relationship when humans attempt to understand their universe.

Robin Wall Kimmerer in the 2013 anthology, Contemporary Studies in Environmental and Indigenous Pedagogies, A Curricula of Stories and Place, points out that in indigenous systems of knowledge generation, "…knowledge is more than a body of information, it is a suite of relationships."24

One Native Science method used in this study included ceremony. Within Native science methods, ceremony is important for its role in preparing one for learning. By requesting a ceremony, one personally prepares to receive the new knowledge.[25]

If the ceremony is effective, the opening of the learner's perceptions may also stir great fear. This is a common predecessor to vision quests, but happens at lower levels of pedagogy as well. Fear often comes just before large advances in learning even in non-indigenous pedagogies within public schools. To learn, one faces the unknown and courage is required.

The research methodologies included case studies. I asked individuals about their experiences at the Big Horn Medicine Wheel. I carefully employed Native Science methods of *listening*. This means listening with one's whole attention: no writing, no pre-formed questions, no recording devices.[26] The desired outcome of the interviews was to gather personal impressions. I determined these to be of a higher value for this particular study than choreographed questions that confine answers to specific parameters.

Overview Of Research

High on Medicine Mountain, the Wheel has been a center for interactions between humans, stones, and stars, for hundreds and possibly thousands of years beyond current human memory. My exploratory investigation provided evidence that the Wheel can indeed act as a pedagogical place-based instrument for learning celestial mechanics.

In the beginning of my study, I relied on Western science and education research methods but that soon expanded. While speaking with local descendant populations whose cultural activities included the Wheel, a few Elders became interested in my project and offered their collaboration. One Elder offered a ceremony meant to prepare me for learning about the Wheel, another Elder offered to act as a continuous prayer liaison between the mountain and myself for the duration of my research.

Through these interactions with indigenous Elders, another method of research emerged, academically termed, “Native Science.” By engaging in Native Science research, I found not only objective knowledge, transferrable to others but also personal knowledge, meaningful to me alone.

This study moved between scholarly work and personal knowledge generation. In this dissertation, I will describe only the objective knowledge gained through my research that is testable by anyone willing to stay up all night at the Wheel and apply an effort of intellect toward understanding the patterns of celestial movements. I make the same appeal Copernicus requested when he published his research exposing his work showing the Sun (not the Earth) was the center of the solar system:

> I have no doubt that talented and learned mathematicians [in my case—skywatchers] will agree with me, if—as philosophy demands in the first place—they are willing to give not superficial but profound thought to what I bring forward in this work in demonstrating these things.[27]

Copernicus brought to the attention of European society a science that had been known and documented thousands of years before his time—that the planets revolved around the Sun, not the Earth. The idea that Europeans could believe the Earth was the center of the solar system sounds humorous today, but this belief was so pervasive that out of fear of the backlash, Copernicus waited until his deathbed and the coaxing of close colleagues before publishing his research.

The Big Horn Medicine Wheel and Ancient Astronomy

The Big Horn Medicine Wheel represents a symbolic structure known to the Northern Prairies for over five thousand years. If there is doubt that the people of the past could create such a technologically sophisticated device for tracking the heavens, please humbly remember that Western science believed the Sun revolved around the Earth only 500 years ago. Copernicus' work was not original. He made over twenty references to heliocentric knowledge known by ancient people. Copernicus' ideas were not new to humankind, only to Europeans. The history of astronomy gives a clear example of the loss of astronomy knowledge in Europe, India, China, and Iraq between 3000 BC and 1500 AD. This trend may also have occurred in North America .The Majorville Medicine Wheel in Canada, with a similar design to the Big Horn Medicine Wheel, shows continued use from 3200 BC to about 1000 BC and then little use for over a thousand

years between 1000 BC and 200 AD.[28] It is unknown whether the next group to incorporate the Wheel in their lives after 200 AD understood the Wheel's original use.[29]

We have not yet fully recovered ancient humanity's astronomy. Indus Valley and Mesopotamian astronomy predates the Greek astronomy that Ptolemy compiled. The cuneiform of Mesopotamia and the Indus script is still being translated. Historically, many who translated ancient scripts were rarely experts in astronomy and therefore often misunderstand astronomical references.

In a translation of Herodotus' *Histories*, the editor describes an "autumnal solstice." There is no such thing. I do not believe this is a typo because the translator uses the same word choice twice in separate places. I assume he meant "autumnal *equinox*." Solstice and equinox are words describing almost opposite events. Interchanging them would be like a translator calling a cat a bird—not something a writer could easily mistranslate if they knew the meaning of the words.

Our current use of satellite telescopes combined with powerful computers gives us a window on distant galaxies and exo-planets; however, we have forgotten to maintain the skills of naked eye skywatching from the surface of our spaceship Earth. It is not unexpected that we may not recognize astronomical purposes in archaeological remains. When asked if the archaeological ruin of the Saturn V launch pad for the Apollo missions could have any evidence of a culture that looked at the skies, only two people out of 300 thought it might.[30] Their guess was based on its round opening, not on the fact that the culture that left this ruin actually sent humans to stand on another planet And did this within the timeframe of their grandparents' memories.

If we cannot judge our own culture's archaeological ruins for their astronomical purposes when those purposes are merely one lifetime before us, I believe it is rigorous and scholarly to give the old medicine Wheels the opportunity to speak for themselves without our ethnocentric, epistemological, or ontological biases.

Ancient Skywatching Skills

In my research, I found that ancient skywatching science used the same astronomy tools as are present today at the Big Horn Medicine Wheel. I cannot conclude this was the original purpose of the Wheel, only that the design elements needed for tracking time using the sky are indeed present at the Big Horn Medicine Wheel and are still capable of teaching about the sky.

Physical Description of the Big Horn Medicine Wheel

Above the tree line in northern Wyoming's Bighorn Range, a large circle of bright white rocks lies quietly in an alpine meadow at nearly 10,000 feet elevation. Many accounts of this circular 'wheel' attribute its origin to the Plains Indians, even though the Plains Indians' oral histories disagree. Tribal groups contend this "Big Medicine Wheel" (now known as the Big Horn Medicine Wheel) existed before their arrival on the plains.[31] The wheel has twenty-eight spokes, none of which split the wheel into the four directions symbolic of the Plains Indians' cardinal directions.

The Wheel's appearance is striking—glowing white rocks laid in symmetry against the green and golden grasses of the high meadow ridge of Medicine Mountain. The location sets the Wheel thousands of feet above the basin landscape and high above

the life that exists there. The hub of the Wheel appears like the remains of a stone hut, and is called the central cairn. The wheel's spokes curve outward from the central cairn like a many-limbed starfish climbing over a coral head; the wheel's outer rim presses in, flattening the circle; five smaller cairns connect to the rim. Three of these cairns are in the shape of horseshoes with 'doorways' pointing in divergent eastern directions, inviting a different view from each cairn. This factual description falls short of the reality of the experience when visiting the Wheel. The state of "awe" is a common state of being, reported in many documented descriptions of the wheel.

The Big Horn Medicine Wheel's rim is 40 feet from the center with the twenty-eight rays or 'spokes' extending between the center cairn and the wheel's rim. Connected to its outer rim, four cairns face out and one faces in. Reports by those who visited the wheel between 1880 and 1920, called these cairns 'huts.' At that time, these structures were tall enough to house a person against the wind, large enough for vision quests or hunting blinds, and had roofs made of wood.[32]

This wheel is one of more than one hundred and thirty stone circle structures labeled as "medicine wheels" that exist across the western prairies of Canada and the United States.33 In 1885, George Dawson published the first account of medicine wheels in North American and numbered them at 20,000. 34 Dawson's survey included stone circle tipi rings that by the turn of the 21st Century were categorized separately.

Astronomical Category of Medicine Wheels

John Brumley, who has studied all types of stone circles, cautions against the use of the term, 'medicine wheel' due to the great variety of wheels and the loose use of this term among investigators and the media. He has helped group stone circles into distinct categories based on their apparent physical characteristics. Brumley defines medicine wheels as surface rock circles with a center cairn and either spokes radiating from that center cairn or concentric circles beyond the center cairn, or both.[35] In 1988, Brumley categorized these wheel structures into several distinguishable categories.[36]

Anthropological research on many of the North American wheels first surveyed by Dawson showed a connection with Plains Indian culture. Many, of course, are tipi rings, not nearly as large as the Big Horn Medicine Wheel. The Blackfeet and other groups also created burial mounds for honored ancestors that take the form of wheels with rays toward notable cultural or geographical directions, but these are also much smaller structures than wheels like the Big Horn Medicine Wheel.[37]

The surface features around and within the Big Horn Medicine Wheel have changed over time as the Forest Service built roads and fences, Boy Scouts dutifully replaced stolen rocks from the wheel each year, wind and water eroded soils, animals kicked over stones, and visitors left offerings.[38] William Matthews, an archaeologist with the Bighorn National Forest who is responsible for the protection of the site, believes the original builders and uses of the wheel can no longer be determined due to the past surface alterations.[39]

Images of the Wheel over Time

Photographic images of the Wheel over time show little changes in the structure of the Wheel's spokes and cairns. However, change has occurred beyond the Wheel. The Forest Service used outlying cairns to build a protective stone wall around the Wheel, not recognizing that the outlying cairns may have had an important role to play in the Wheel's skywatching landscape. Current descriptions of the Wheel in modern texts include only the main wheel. Nonetheless, there is evidence of a much wider distribution of associated cairns in the site description written by the anthropologist George Bird Grinnell in 1922.[40]

Jessamine Spear Johnson (1906-1978) and her sister Elsa Spear Byron took many photographs of the Big Horn Medicine Wheel in the early years of the 20th century.[41]

From 1930 to 1943, Jessamine managed her father's dude ranch and led pack trips to locations such as the Big Horn Medicine Wheel. Jessamine was one of the very few Western photographers who added the Indians' names to her photos.[42]

In 1974, John Eddy, the first Western science astronomer to research and publish his data in a peer-reviewed journal compared early photos to the physical wheel and determined the Wheel had not changed appreciably over time.

Stephen C. Simms, and anthropologist from the Chicago Field Museum published the first diagram of the Wheel in his 1905 paper.[43] Simms' diagram did not match photos taken of the wheel thirteen years later. Simms may have drawn the diagram after returning to Chicago without keeping notes on exact measurements or attention to engineering details--or he may have been describing a different wheel in the Bighorns. George Bird Grinnell wrote in his 1922 paper that Simms probably drew his sketch from

memory. Grinnell's paper included a diagram that was drawn by the same men who photographed the Wheel for his article.[44]

The most accurate diagram, still in use today, is from the Wyoming Archaeological Society (WAS) excavation, published by Don Grey in 1958. John Eddy found the 1958 WAS diagram to be accurate enough to be useful for his purposes in showing solar alignments.[45]

The Wheel as a Pedagogical Instrument

I have concluded that the Big Horn Medicine Wheel is able to function as a pedagogical instrument for learning sky-earth relationships, including skywatching fundamentals and celestial mechanics. Whether this was the purpose of the Wheel as designed by the original builders I was not able to determine.

The Wheel is able to perform as a pedagogical instrument for teaching about sky-earth relationships because every aspect of the Wheel has an astronomical function. Like a carpenter's hammer that has a metal head for pounding nails, a claw for removing nails and a wood handle for a good grip, the Wheel's design elements combine to provide a useful tool for learning skywatching fundamentals and celestial mechanics. This is discussed in depth in chapter seven of this dissertation.

Celestial Mechanics

The Wheel is better able to convey knowledge of celestial mechanics than a college textbook. The 'simple' foundations of astronomy, described in college textbooks are actually complex spatial relationships not easily shared through diagrams and words. In contrast to textbook explanations, the Wheel sets the learner inside the spatial

complexity of the real sky-earth environment, offering a personal relationship with the movement of the celestial objects. At the Wheel, the universe immerses the human body in a sea of stars. The effect of this authentic experience on the human consciousness cannot be imitated through modeling with paper diagrams, color-coded star charts, or planetarium shows. None of these models can replace the act of being in the universe.

Humans are adept at noticing patterns. At the Wheel, a skywatcher can easily discern the cyclic motions of the Sun, Moon, stars and planets. These motions are immediately associated with the landscape features that harbor their rising and setting positions. I found the Big Horn Medicine Wheel an excellent instrument for learning celestial mechanics and tracking celestial movements over time.

The Big Horn Medicine Wheel as A Calendar

The Wheel acts as a timekeeper that is able to track hours, days, months, years, and our place in a 24,000-year precessional cycle.[46] Hours can be tracked by adding a gnomon (upright stick) into the center cairn; days can be tracked by the rising and setting positions of the Moon; Months can be tracked by the rising and setting positions of the Sun; and the 24,000-year precessional cycle can be tracked by the rising and setting positions of a few bright stars. The Wheel as a calendar gives us a fuller view of our planet's position in space. Our current wall calendars are based on the change in seasons; however, the seasons are not in actuality in step with our movements in relation to the Sun. A slow change in the angle of the Earth toward the Sun, that takes place over the long 24,000-year precessional cycle, pushes the seasons ahead by one day every 66.6 years. Our current calendars keep us unaware of this fact. The Big Horn Medicine Wheel,

used as a calendar, keeps this change obvious. The effect of the lengthening of seasons on other environmental changes is worthy of consideration in long-range forecasting of environmental conditions.[47]

Dating the Wheel

No one knows the age of the Big Horn Medicine Wheel. Fortunately, a very similar type of wheel in Alberta, Canada has been dated by archaeologist to circa 3200 BC.[48] The Majorville Wheel in Canada gave a dependable date for the 5000-year duration of the design of the large, twenty-eight spoked wheel on the Northern Prairies. Native American oral history supports this antiquity. Questions concerning both the Canadian and Wyoming wheels' origins repeatedly receive the same replies whether asked in Canada, Montana, or Wyoming: "Ancient ancestors built the wheel before our people arrived" and, "It was here before we came."[49] Even during the proceedings to establish the Big Horn Medicine Wheel as a sacred site, no indigenous group came forward to claim the wheel, even though this would have greatly helped its adoption and resulting protection under the law. James Calder's 1977 excavation dated the Majorville wheel site as being in use from 3200 BC until 1000 BC and then left idle until about 200 AD where use began again by albeit a *different material culture*. This coincides with the oral history of the Majorville Wheel's existence as predating the arrival of the immediate ancestors of the current Plains' People. Both the Canadian and Wyoming wheels have similar proposed astronomical alignments.[50]

For archaeoastronomers, the question was simply whether the large medicine wheels could be used as skywatching instruments. For the archaeologist, the question was

more complicated. They attempted to understand the practical or ideological purpose(s) the Wheel may have within culture. If ancient skywatching people performed astronomical observations at the wheel, how would this practice influence the people's perceptions of the 'power of place' at this site? Would this power have a material counterpart in the societal interactions of the people living within its influence? If so, what would it look like? Because archaeologists interpret objects within the context of the material culture, they searched for cultural evidence of astronomy's influence in people's motivations and actions.

Archaeologists found little cultural evidence of normal activities, such as preparing food, scraping skins, etc. at the location of the Wheel. Archaeological excavations have been unable to date the Big Horn Medicine Wheel accurately due to the disruption of the site in the mid and late 1800s possibly caused by treasure hunters.[51] In 1958, an excavation took wood from a cairn and dated it to the late 1700s by its tree-rings, but this wood came from a wall of a cairn not from a foundational layer in the cairn's structure.[52] Nor was there much evidence of ceremonial use, thus the archaeologists had to leave the evidence of astronomical use to stand on its own.

Place-Based Pedagogy and the Big Horn Medicine Wheel

The Wheel's contextual place within its landscape creates a unique environment for learning. The Wheel's design elements could not be set on another mountain or in the basin below and continue to work as they do. If the Wheel was engineered for astronomical purposes, it was built specifically to be used within the context of its Place.

The Spectrum of Choice In Place-Based Pedagogy table created for use in this study shows the various ways in which the Wheel can be incorporated into a place-based lesson. The spectrum of choices elaborated in this table show attributes of place-based pedagogy and the quality of their indigeneity. These attributes have been discussed by Vine Deloria, Gregory Cajete and others and are combined here for ease of use within this discussion. See the end of chapter four for to view of this table.

Many educators believe that Indigenous pedagogies such as inquiry-based learning and experiential learning are more effective than fact memorization. John Dewey influenced educational pedagogies to allow students to actively take part in their own learning and build on their experiences, not to passively memorize a teacher's instruction. Whether place-based indigenous pedagogies will be useful within mass education is still to be determined. The factors that result in effective learning are often the level of individualized instruction. Lesson plans designed by the teacher with care for individual learners and connected to a Place by making use of real objects, and local resources may increase the value of indigenous pedagogies inside the classroom. However, taking students to the Wheel enables each student to interact directly with the complexity of the Place, thus increasing the indigenous quality of the lesson.

Informal education activities in after-school programs, museums, and camps use place-based pedagogies to increase student enthusiasm and knowledge generation.[53] By adopting effective pedagogies designed to interest the learner (instead of to grade the learner), these programs are able to make extensive use of indigenous place-based pedagogies.

In a museum setting in Zurich, Switzerland, "Native Ways of Knowing" was presented at their NONAM, Nordamerika Native Museum, Indianer und Inuit Kulturen with the exhibition, *Learning to Survive: Education in Native American and Inuit cultures*.[54] The Swiss museum presents the concept, "Learning without school?" and shows the ways in which Native Americans could learn from being in a Place and interacting with the people and environment of a Place. "What seems unthinkable to us formally educated Europeans was a tried and true method for Native Americans and Inuit. But how did children learn when there was neither school nor script?"

This is a modern question about an ancient indigenous pedagogy.

Research Conclusions

This study brings together previously scattered fragments of historical and cultural knowledge about the Big Horn Medicine Wheel and combines past scientific research done at the Wheel with new scientific research. In addition to the Western science methods and results, this study engaged in Native Science and indigenous pedagogies, learning from the Wheel and its Place directly.

My interpretations herein are filtered through the lens of this work's usefulness to educational pedagogies. My findings include the following:

1. The Big Horn Medicine Wheel is able to act as an instrument in place-based pedagogy and act with its own agency for designing instruction.

2. The Wheel's original purpose is unknown, however I offer evidence for astronomical functions associated with the Wheel's design elements. These are pedagogically useful for teaching about changes in the sky over time.
3. The Spectrum of Choice in Place-Based Pedagogy Table includes activities useful inside and outside of the classroom.

Additions from this Research
to Current Scholarly Knowledge:

- An introduction of the term, "conquerors' pedagogy" as compared to "indigenous pedagogy,"
- The Spectrum of Choice in Place-Based Pedagogy table,
- Place-based lessons for grades 4-6 using the Wheel as a pedagogical instrument,[55]
- A table indicating astronomical functions expressed in each element of the Wheel's design along with a description of the Wheel's specific uses as a pedagogical instrument for learning sky-earth relationships:
    - Wheel's rim= precessional ecliptic north circle
    - Wheel's spokes= segmented star chart
    - Wheel's cairns= precessional star positions
    - Wheel's outlier cairns= long baseline sighting watch posts
    - Wheel's northern landscape horizon=circumpolar star rotation
    - Wheel's latitude=45 deg "sweet" spot for precessional changes
    - Capella's path mirrored in the Wheel's latitude and landscape
    - Wheel's flattened side=Sundial's equation of time

Conclusion

In conclusion, the methods used in this study are interdisciplinary, consistent with the nature of American Studies research. As the research moved from a purely Western science approach to a Native Science approach, the evolution felt natural. Western science methods were useful, but could not hold the full complexity of the study. The more inclusive Native Science approach was necessary.

My investigation into scholarly discourse concerning place-based pedagogies showed me that Native Science methods are often difficult for scholars to discuss, perhaps because Native Science methods border on the spiritual. The written word, used for reporting on research, is at best an abstraction of spiritual concepts, unable to describe the reality of the spiritual process. [5657]

This study started with Western research methods and ended with indigenous ones. This emerged from collecting objective Western science data while listening attentively (indigenously) to the land.

Robin Wall Kimmerer states, "In the spirit of the intellectual pluralism which the meeting of traditional and scientific ecological knowledge demands, this essay [in my case, this dissertation] arises from a diversity of knowledge sources. An important principle of knowledge transmission in many indigenous cultures, is the acknowledgement that there are many truths, depending on the perspective and experiences of the teller (Sinclair 1994, Simpson 2000) so it is important to identify that perspective from the outset." Kimmerer goes on to speak about her identity as an Anishinabe and her perspective from that basis of identity.

My Perspective

In this dissertation, I identify most readily from the perspective of a skywatcher. In American Studies scholarship, I have not found one paper written by a skywatcher. My background in the hard science of astronomy combined with my passion for history and education methods gave me a particular view into the workings of the Wheel. Although I set off on un-trod ground within American Studies, I do so with great appreciation of this opportunity to share what has come of this interdisciplinary research that would not have been possible within the strict parameters of astronomy, education, or history.

This study contributes new evidence for place-based pedagogy at a specific National Historic Landmark site. It also offers scientific evidence about the relation of the Big Horn Medicine Wheel to the cosmos. Most importantly from the author's viewpoint, it offers an indigenous method to be scrutinized by the Western academy--a challenge to approach the possibility of a pedagogy that allows learning from the land itself.

CHAPTER THREE

HISTORY OF PLACE-BASED PEDAGOGY

Do Today's Students Need Place-Based Indigenous Pedagogy?

This study answers that question with a firm, relentless, "Yes." I found few people understand anything about sky-earth relationships. Dulled satisfaction with abstract knowledge has caused many of us to think we are educated when in reality we know very little *within* our real environment, even when we know a lot *about* our environment. If the lights go out, who knows how to fix the power source? Our most useful real skill in the northern latitudes is the ability to build a fire.

A trip with high achieving physics students from a public high school in Boston, MA, shows the usefulness of their "A" grades in physics. These students came to Arizona and New Mexico to experience astronomy in the field. They toured telescopes at Kitt Peak and Sacramento Peak, and camped at Chaco Canyon to learn about indigenous astronomy of the ancient Puebloans. On their last evening after viewing the supernova pictograph and learning the night sky from local astronomers, it became cold on the high desert and I built them a fire. They seemed to have no knowledge that hot air rises even though they would have had to pass tests concerning thermodynamics to be able to be in the elite group of physics students allowed to come on this trip.

I decided to let nature teach them. As the fire burned down, I handed them newspaper to get it going again and every one of them opened the newspaper sheets and laid them flat over the dying embers of wood, like you would lay a blanket on a child.

They dropped their papers on, noticed the fire went up, not down and they better add wood above the paper. While they all went to get wood, their flat papers, already on fire, lifted off the warm embers and floated off toward the dark desert--toward dry shrubs and grasses. One person saw this and screamed. Strangely, the students did not act. Instead, they stopped and looked at me while the newspapers, on fire, flew beyond our reach, off into the night.

They were well trained to let authority do the thinking in new circumstances. However, I stayed sitting and waited to see if anyone would analyze the situation and do something. When none of them moved to chase the papers, I finally urged, "Don't you think you should put those papers out before they catch the desert on fire?" They all looked out at the flying papers, some had landed in the grasses, but no one moved, instead, they asked, "how?" I told them, "stomp 'em, pour water on 'em, cover 'em in sand--whatever it takes." They all went running after the flying newspapers, grabbing water bottles.

I had no intention to allow the desert to burn, but saw this as a good opportunity to test these students' superior physics knowledge that had won them a trip to the Southwest. A layer of snow had blanketed the ground that morning, melting into the ground only an hour or so before dinner. I knew they had time to put out their fires but wanted them to learn by cause and effect.

Our brightest students from one of the highest achieving public schools in our nation could manipulate physics formulas well enough to be top of their class yet could not apply the formulas' concepts to real fires, to thermodynamics in action.

The campfire story demonstrates the difference in learning from books versus learning from life experiences, in “Place.” Indigenous pedagogies, being place-based and experiential, connect the learner directly with what is learned. The students interpret their own experience. In the case of the campfire, the students experienced first-hand the concepts of thermodynamics. They created their own interpretation based on their own lived experience. Their interpretations will later be molded and remolded again by new experiences. Teachers may play a role in guiding students toward useful experiences, but the learning is acquired and owned by the student, being a direct outcome of their interaction with a Place.

In contrast, conquerors’ pedagogies train us to remember facts, not necessarily how to best apply the facts. Knowing how to keep our own species alive on planet earth will take more than factual knowledge. We desperately need to remember what sustains us.

Indigenous pedagogies are effective in our modern world, partially because they actually make it easier to learn and retain facts. When learning via indigenous pedagogies, the facts have a context and therefore have meaning. In this type of learning, facts are no longer the drudgery of the short-term memory. They go deep into long term, contextual memory and become useful in the students' life beyond the classroom.

On a cold, desert night, the fact that hot air rises can be very useful.

A Discussion of the Terms,
"Indigenous" and "Conquerors"

The term "conqueror" is used throughout this dissertation to describe an attitude. It is a way of behaving. Native peoples are just as able to behave with a conqueror's attitude as "white" people. Indians themselves have a term for this type of a person. The term, "apple" is applied to a Native who is "red on the outside and white on the inside." The terms, "white" or non-Indian are not appropriate in this dissertation because historically, "white" men conquered "white" tribes in Europe with the same attitude that "red" Sioux attempted to conquer the Sheepeaters' "red" tribe.[58Á] It is the conqueror that is the common attribute, not the color. For the discussions herein to be rigorous, the use of skin color to describe a conqueror's behavior is undesirable.

The opposite of the conquerors' attitude is the indigenous attitude. Indigenous is used here not in its definition as, "the original people of a region," but as an adjective describing the characteristics common to indigenous peoples. These characteristics include an appreciation for the complexity of living systems and the desire to sustain relationships that aide survival.

Indigenous is different from "traditional." One Blackfeet man, who was very indigenous in action, told me, "The problem with tradition is tradition." In this, he meant that in their attempt to keep up traditional ways, some of his people were trying to force these ways on others in the tribe. Pressuring people to act in a particular way, especially if the acts work against their own survival, is a conquerors' method of coercion, not an indigenous one.

The grey line between indigenous and conquerors' attitudes is found at the crossroads of "traditional" survival and today's survival. It may be the hardest burden that Native Americans bear as it separates them from each other and their Elders in their attempts to sort out what methods or combination of methods are useful in this modern world.

Native peoples and immigrants, who were once indigenous to other lands, share the burden of deciding which traditions to keep and which to let go. Americans may find a common cultural trait in this experience of sorting out tradition. For this discussion, the terms "indigenous" and "conqueror's" are useful in exploring the changing attitudes of Americans and their educational pedagogies.

Conqueror and indigenous also describe Western science and Native Science pedagogies. Conquerors' pedagogies often used in Western science do not take the individual into consideration. Like an army that allows the loss of some soldiers to promote others' wealth, conquerors' pedagogies produce a small percentage of learners who achieve "A"s while many learners never gain high status and others drop out, like dying soldiers left without the rewards of battle.

Conquerors' pedagogies are the pedagogies most often employed in mass education systems. In contrast, indigenous pedagogies care for the individual learner. A learner taking part in indigenous pedagogies is likely to be one's own arbitrator of a quality education, whereas in a conquerors' pedagogy, an authority beyond the student is the arbitrator and is concerned with a quantifiable proof of education.

In a mass educational system, conqueror's "mainstream" pedagogies forfeit complex cultural heritages for efficiency and quantifiable results. They forfeit real history for created histories. A small group (local school boards or state boards) create guidelines in attempt to give all students equal opportunities for an education. The idea that 'one size should fit most' is a conqueror's idea. An indigenous program would not be as concerned with efficiency or cost as it would the quality of the education.

The term "conqueror" for this type of attitude is established in American legal history. John Marshall, the longest-serving Chief Justice in U.S. Supreme Court history, dominated the Court for over three decades, playing a significant role in the development of the American legal system.[59] In the 1823 Johnson vs M'Intosh case, U.S. Supreme Court Justice Marshall wrote, "Conquest gives a title which the courts of the conqueror cannot deny, whatever the private and speculative opinions of individuals may be…" [60]

In this, he divided the people of America into conquerors and others. This was not a division of white against Indian, for the "conqueror's court" upheld not white ethnicity but greater powers over lesser powers. In the Johnson vs McIntosh case, a white person had title to previous Indian-owned land, yet the court decided that title was not legal because the land did not belong to the Indian or the white buyer, but to the conqueror--the English and later the US government.

Writing about the Johnson vs M'Intosh case, the historian, T.S Twibell revisits the case and states,

> *Johnson v. M'Intosh* should be looked to for what it is: law of the conqueror over the conquered along ethnic, racial and religious lines, for the resource exploitation and colonization of the less powerful ethnic group. The Court justifies its decision not on the

> common law of legal precedent, but the common law of the powerful over the powerless and looks to other conquerors as additional validation. Through the Court, the government subordinates entire classes of humans. In order to dominate and control the resources of those it conquered, it even goes to the depths of claiming that they and their lands were 'discovered.'[61]

Twibell reminds us that the conquerors attitude has long been an international legal attitude, in this case in the acquisition of someone else's home:

> Historically, international law has always been at the heart of the discourse about sovereignty and property in the Third World. Beginning with medieval discourse about the rights of infidels (Pope Innocent IV), and extending through sixteenth- and seventeenth-century discourse about the rights of Indians (Vitoria, Las Casas), nineteenth-century discourse about the standard of civilization (Westlake), and twentieth-century discourses about development and democracy.[62]
>
> According to one of the World Bank's resettlement guidelines, "all involuntary resettlement should be conceived and executed as a development program." [63]

Conquering happens not only between whites and Indians but also between whites and whites. It may be accurate to speak of the white/Indian dichotomy if those groups are truly the ones involved, however, too often "white" is used for the bad guy, even at times in history when Whites were on the side of the Indian. For this reason, I feel it is important to clarify the attitude of conquerors from ethnicity, race (if such a thing exists), and religion.

Walter R. Echo-Hawk uses the title, *In the Courts of the Conqueror* in his 2010 book about court cases involving Native People in the US.[64A] Echo-Hawk borrows this title from the Marshall document about the Johnson vs M'Intosh case. Marshall's focus is not limited to Native vs European interactions. His focus is on the power of the conqueror, regardless of ethnicity, to impress an assimilating will on another people.

Marshall makes it clear that the court must bend to the will of the conquering people, for those conquerors are even mightier than the courts:

> When the conquest is complete and the conquered inhabitants can be blended with the conquerors or safely governed as a distinct people, public opinion, which not even the conqueror can disregard, imposes these restraints upon him, and he cannot neglect them without injury to his fame and hazard to his power.[65]

This Supreme Court case is a founding American document describing the legal ownership and management of resources. If we view the education of America's youth as a resource managed by the public school system, then this resource is managed to perpetuate a conquerors' pedagogy, just as land ownership, according to Marshall, is managed to serve the conqueror. Whether this was a conscious choice or not, in America's mass education systems, the values of the conqueror have generated the prevalent educational pedagogies.

Place-Based Education in American Schools

Place-based education in the public schools of the United States is a reaction against the military-industrial model of education where students are taught using the same methods used to manage soldiers (military) and create identical, efficient products (industrial)--in David Sobel's words, the "drill and kill" method of education. [66] Place-based education attempts to balance the students' abstract and generalized learning inside a classroom with the students' real and specific life events outside the classroom. Concern with local matters is common to all place-based pedagogies. These include local places, local people, local issues, and local natural environments. Civic issues,

environmental concerns, Elders' knowledge, histories of place, local artists, and craftspeople are all resources enlisted for inclusion in place-based education.[67]

Place-based pedagogies are not new. In Western history, the trail leads back to Aristotle's concern about connecting learning to the real landscape of the learner's life. The philosophical underpinnings of educational practice in Europe and America swing back and forth between two opposing views: indigenous worldviews and conquerors' worldviews.

Public school education in the US currently sustains the conquerors' methods of training the young: ontological agendas, epistemological biases, ethnocentrism, and a competitive attitude toward knowledge generation.

In contrast to conquerors' worldviews, Indigenous worldviews have in common a concern for the individual student and believe each student's education should be an asset to the family and community. Conquerors' worldviews have in common a concern for managing large numbers of students in an efficient and cost-effective manner and believe all students' education should be an asset to continue the hierarchy of power. Table 3.1 compares the two worldviews and describes how aspects of each worldview result in pedagogical differences. (See Table 3.1.)

Where the conquerors' worldviews also desire students to be assets to their community, they do not expect or plan for each student to succeed and accept that jails or poverty will claim many. In this way, the United States currently employs a conquerors' worldview in its educational practices.

A conquerors' pedagogy relies on a human authority hierarchy that is exterior to the student and exterior to their local community, local Elders, and local culture.

John Dewey and Place-Based Education

John Dewey (1859-1952) influenced American education toward indigenous practices when he helped educators see the importance of students being active participants in their learning rather than passive absorbers of teachers' lectures. His concept of problem-based learning is similar to inquiry learning, which is considered highly valuable in education today.

Dewey believed learning should increase the individual's capacity to make wise choices in a democratic society. Not all education philosophies start with the individual. In doing so, John Dewey propounded an indigenous pedagogy. Dewey set in to motion the Progressive Movement in education which believed the sciences taught in school should be connected to the real world outside school, not with abstract fact-memorizing.

> Dewey's criticisms resonate strongly with the condition of contemporary science education in the United States with its overemphasis on generic standards and teaching to a single high-stakes assessment. While the reforms of the last few decades in science education have emphasized the importance of laboratory experiences and hands-on inquiry science, they have not adequately connected scientific curricular content to the lived experience of students beyond the classroom. Indeed many students still complete their education in science having primarily learned that science is little more than a "peculiar vocabulary."[68]

Dewey's student, Mary Hammett Lewis facilitated a place-based school in Buffalo, NY, called the Park School, where students had ready access to the outdoors, with their own small farm and garden.[69] Her methods were repeated across the country in

the Country Day School movement of the mid 1900s. In these schools, students cared for farm animals, raised gardens, and conducted live experiments on school grounds. Cory Buxton and Eugene Provenzo believe Lewis' place-based school model would have continued to grow had it not been for the push after Sputnik by the US Department of Education to accelerate "rigorous" science and engineering methods (memorization) in the curriculum.

> The Cold War stimulated the first example of comprehensive Federal education legislation, when in 1958 Congress passed the National Defense Education Act (NDEA) in response to the Soviet launch of Sputnik. To help ensure that highly trained individuals would be available to help America compete with the Soviet Union in scientific and technical fields, the NDEA included support for loans to college students, the improvement of science, mathematics, and foreign language instruction in elementary and secondary schools, graduate fellowships, foreign language and area studies, and vocational-technical training.[70]

After the US landed men on the Moon in 1969, place-based and environmental education began to thrive again. In the 1970s, the origin of the best-selling Foxfire books began as a place-based curriculum in the Georgia schools initiated by the high school teacher Eliot Wigginton. His students interviewed their local Elders for interdisciplinary knowledge about living successfully in their local area.

Indigenous pedagogical practices are obviously not new. They are in fact the oldest pedagogies, beginning in song, stories and art. These ancient pedagogies tenaciously survived, entwined among the philosophical thoughts that have impacted--and continue to impact--education in America.

Margaret Gillette, Chairman of the Department of History and Philosophy of Education at McGill University in 1966 suggested, "Education is concerned with

tradition--the preserving and transmitting of values, ideas, practices which have proved over the years to be worthwhile. Throughout the ages, one of the aims of education has been to induct the child into the established ways of society."[71]

What traditions are worth transmitting to the next generation? Ken Kay, President of the Partnership for 21st Century Skills, lists the skills students will need to succeed in global economies, "…only people who have the knowledge and skills to negotiate constant change and reinvent themselves for new situations will succeed."[72] He then describes the "why" of education, tying it directly to economic success. Michael Stephen Schiro, a professor of curriculum theory at Boston College has explained four curriculum ideologies, each dependent on how one views the "why" of education. Ken Kay's focus on economic success would reside within Schiro's Social Efficiency ideology. Other ideologies Schiro describes include, Scholar Academic ideology, Learner Centered Ideology, and Social Reconstruction Ideology. Schiro explains that "why we educate" is based in the curriculum designer's ideas of reality and what they believe is important in life.

Indigenous place-based pedagogies could be found in any of Schiro's ideology categories, but in this dissertation, I focus primarily on indigenous pedagogies within a Learner Centered Ideology. My own beliefs about education filter out ideologies that ignore individual capacity for knowledge. I have not seen in my teaching that any one student has been like another. Learning Style groupings, Meyers-Briggs personality categories, Multiple Intelligences, and other ways to group learners are theoretical constructs that help us think about teaching and learning. These do not match reality

100%. Teaching, I found, is still an art wherein one consciousness attempts to understand another.

Learner-Centered Education

Basing learning within a certain "Place" allows the full diversity of experience to play upon each student. Because each student will grasp what is available to them based on their preparation and readiness to learn, each learning experience is unique to that student's learning style, multiple intelligences, and specific personality. Inside a classroom, this place-based learning is difficult because the environment is contrived by a few human minds, the original architects, administrators, and the teacher. Contrast the classroom learning environment with the environment of a Place where the context of learning has been developed over millennia by natural forces including the impact of all flora and fauna that have ever existed at that Place. The complexity of a Place is what gives it the ability to stimulate learning in a myriad of ways to so many types of learners.[73]

Place-based pedagogy is learner-centered when it falls near the right end of the Place-Based Spectrum. (See Table 3.2.) After the student learns from a place, she may choose to change her behavior in a manner that brings more success of every kind to herself and her community, but the pedagogy involved while learning is entirely learner-centered and unique to the learner. In the early 1800s, Bull Lodge sought out learning in the mountains north of what is now Lewistown, Montana. His father had been a French trader, the first their tribe had ever seen. At some point, his father had left the tribe and

Bull Lodge desired to increase his usefulness to his mother's tribe and be worthy to live among them. Through many years, Bull Lodge learned much from seven different Vision Quests—how to heal the sick and to be successful in battle. His individual learning, centered on his own development, gave him practical knowledge that helped his people immensely.[74]

The idea that learner-centered ideology can power the individual's ability to act in a socially responsible way is a repetitive theme, seen from Aristotle to the European philosophers to Bull Lodge to Schiro.

Heritage Education

Heritage education brings a local and cultural aspect to student learning. Many heritage programs began inside informal learning settings but are continuing to reach into formal learning settings.

These programs range from museum "teaching trunks" full of authentic objects students can experience first-hand inside their normal classroom, to those programs which take students from the classroom to a local Place where Elders and other local experts can interact with students as students explore ancestral stories, flora, and fauna.

Programs created to bring heritage education into the classroom include Project Archaeology, a national Bureau of Land Management (BLM) supported education program. Project Archaeology relies on actual archaeological evidence from real sites across the US, to help students connect to land and peoples of the past. Project Archaeology lessons, designed for elementary and middle-school teachers, and include interviews with cultural Elders whose heritage connects to the site being studied.

The Project Archaeology staff believe the whole of the country and the whole of its past is a local resource for all students in America. Project Archaeology curriculum is inquiry-based, uses authentic archaeological data, and includes descendent communities in the development and presentation of curricula.[75]

Other heritage education programs focus on connecting students to Elders in their own community through one-on-one interviews, even when these Elders are not connected through blood or culture to the student. This type of interaction is highly indigenous because it brings students to those people who have experienced their local environment for much longer than the student and are able to share this experience of a local nature. With so many grandparents living at a distance from their own children's children, these types of heritage programs offer formal learning the opportunity to share knowledge within a community in an indigenous manner based on shared Place. Students in these Elder-interview programs often present what they have learned from Elders in works of art and public presentations. Other heritage programs focus on the study of local flora and fauna, connecting the Place to ecology and the interconnectedness of the environment to local lives, past and present.

The more these heritage programs include local knowledge, local Elders and *local* objects, flora, fauna—and I will add local sky views of the Sun, Moon and stars—the deeper their indigenous pedagogical value as illustrated in the Spectrum of Choice in Place-Based Pedagogy created for this dissertation discussion. (See Table 3.2.)

Types of Indigenous Pedagogies

"In this jet age with its increasing cross-cultural contacts and international responsibilities, it would be myopic for educators to continue to ignore the non-Western areas."[76]

There are many indigenous pedagogies:

- *Oral histories*: stories passed down through generations to share experiences, values, instruction concerning the physical world, survival, getting along with other people, etc. "The legends and stories often had highly symbolic meanings and involved intricate relationships - an aspect often ignored by non-Indians. The use of symbolism, anthropomorphism (giving human characteristics to animals, gods and objects), animism (giving life and soul to natural phenomena such as rocks, trees, wind, etc.) and metaphors appears to have been an extremely effective method of teaching very complex concepts. These methods allowed the learner to understand at his or her level of cognitive and emotional development. When the learner recalled the story or legend a few years later, it acquired an even deeper meaning—use of legends therefore being somewhat similar to the notion of the spiral curriculum in today's education system."[7778]
- *Demonstration of skills*: more experienced members show by example how a skill is accomplished, such as preparing food, tanning hides, hunting, making clothing, making weapons, bead-working, etc.

- *Storytelling:* the use of the term, "storytelling" varies. It may include oral histories yet sometimes is a distinct class of stories separate from oral history. Oral histories continue to be created because they are a record of a people's life through generations, whereas, storytelling may be a looser and more malleable set of stories, with the storyteller creating a rendition of an older story to fit the present company. Any firm line between these two terms is culturally specific.
- *Vision quests:* a person gives oneself over to the forces of nature by fasting, praying and ceremony, in hopes of gaining knowledge that will help one's people and oneself.
- *Sign language:* although this is not used as thoroughly as it was when different groups spoke different languages, the wave of a hand as a comment is still actively practiced (those unaware of Native American sign language may not notice).
- *Body movements:* the "pointing" of lips and other body movements convey direction and attitude in indigenous interactions between Elders and youth.
- *Ceremony:* this is a large category that includes a diverse sum of deeds, the common factor being that the action of a ceremony is an action separate from other survival or artistic tasks. The waving of a feather, the shake of a rattle, the creation and use of a bundle, and the performance of a dance for specific reasons at a specific place. The word ceremony is the most cast-about word by anthropologists, archaeologists, and ethnologists.

It is often the word used when the researcher does not know how to categorize an act or a process. This does not make the use of the word incorrect because any act by indigenous people could be called a ceremony if the spirit of the act is one of respect for the interconnectedness of all things. There is no universal guiding "line" between any act and a ceremonial act.

- *Dance:* dancing tells stories; it connects the dancer with the spirit world.
- *Singing:* the voicing in indigenous songs is not required to make meaningful words in a language known by anyone present. Often, drumming accompanies singing. The drumbeat connects the singers to the heartbeat of the earth or universe. It moves the song with the flow of life.
- *Songs:* these are different from singing. All beings (even rocks as they are considered alive) have a song. The song is made up of all of a being's experiences since the moment of its creation. Life's experiences continually add to the original songs instilled in each being. To hear another being's song is to understand how one's own song is in rhythm or syncopation with that other being. It is the height of wisdom to listen to the songs of all beings.
- *Arts:* beadwork, painting, weaving, etc. all are able to tell stories which instruct. All are pedagogies, waiting to give their lesson when the student learns enough to be able to decipher what is being conveyed.

- *Place-based learning:* the song of the land, sky, air and water, i.e. the "Place." Place issues out learning constantly, attempting to aid humans in their existence on the Earth. The learning by definition has to be personal because each person's journey is specific to that person.[79]

Indigenous pedagogies separate themselves from Western ways of learning in that they allow the learner many opportunities to learn. Arthur J More in his 1987 paper, "Native Indian Learning Styles: A Review For Researchers and Teachers," summarizes indigenous methods of learning,

> The notion of 'teaching' was conceptualized in a completely different manner in many traditional Native Indian cultures:
> Children are expected to constantly observe the world around them and learn from it. From this it can be seen that one does not 'teach' a child to learn. This amount of intervention in the child's autonomy would risk forever destroying the child's ability to observe and learn from his own motives. The child is encouraged only to seek out knowledge of human experience and skills by being present in practice or their telling (Scollon & Scollon, 1983, p. 101).
> A major characteristic of traditional Native life was that children were allowed to explore and be independent as soon as they were able. They were allowed to learn from their mistakes. A policy of non-interference existed unless there was real danger. Often misbehaviour was ignored so that the child would learn the natural consequences of misbehaviour and learn to be in charge of his or her own behaviour. Another major factor was that grandparents and other elders in the extended family were responsible for much of the teaching of the child (Scollon & Scollon, 1983; Tafoya, 1982).
> Communication style was another important aspect of traditional life, and has important implications for the study of Learning Style. Communication was both verbal and non-verbal, but the non-verbal was much more important than in contemporary Western society. Silence was also used as a means of communication. Eye contact and quiet calmness were important methods of discipline and communication. Children were not tested or questioned after a learning situation—they were expected to self-test (Philips, 1972; Scollon & Scollon, 1983; Erikson & Mohatt, 1982).[80]

In some Plains Indian tribes, grade levels (of sorts) exist within "societies." All ages from youth to Elders may belong to different societies as they grow, according to their skills and duties. Elders take great interest in each child's innate skills, guiding each youth based on the youth's unique set of qualities. Family members show concern for the best education for each child. Even the very young have responsibilities, such as carrying wood for their grandparents[81]

This dissertation discusses only one of these indigenous pedagogies, that of place-based learning. However, it is important that the reader remembers that there are many other indigenous pedagogies. This dissertation describes the possible usefulness of place-based pedagogy in learning about sky-earth relationships (for celestial mechanics and skywatching fundamentals at the Big Horn Medicine Wheel.

Native Science and its Subset Western Science

Michael Wilson, the last archaeologist to conduct research at the Big Horn Medicine Wheel, gave this advice about scientific research and human perception,

> As I have tried to emphasize in earlier work, the hallmark of good science is not that it "tries to prove something" but that it searches for multiple hypotheses. Science proceeds not by proof but by disproof. We first must develop an appropriate range of hypotheses, then we test them one by one and reject the failures. This allows us to narrow down to the "best" one, but always in the knowledge that a new and better idea could come along at any time. That is why science does not claim absolute truth…[A]bsolute truth is the hallmark of religion, not science. In science, observations can always overturn theory (by theory I mean our body of accepted knowledge)…. A hypothesis (which the public like to call "a theory," wrongly) is only a hypothesis if it is testable. Otherwise it is merely an idea or a proposition, with limits to its value. So the

> key thing to do is to find ways to make these ideas testable -- to make them hypotheses.
> If you are not able to do this, then you are in the realm of cultural process (human perceptions and interpretations of natural phenomena)….must be admitted that people respond not to what is happening, but to their perception of what is happening. People faced with a drought will not simply move to a better place, but will often resort first to ritual in attempts to make it go away. From a purely scientific perspective this is irrational (What if it will be a 100-year drought or even worse? How long will they suffer before they move?). But cultural responses are not easily modeled with pure science.[82]

In this description of science, Wilson speaks of Western science with its emphasis on the results of the scientific method, beginning with a hypothesis and ending with a data-supported conclusion. Western science offers one way to obtain knowledge and understand simple cause and effect relationships. The broader category of Native Science adds to Western science the ability to comprehend large, complex systems. In Native systems of knowing, perception of the individual plays a larger role. (Note on capitalization: Native Science is capitalized where Western science only capitalizes the "Western" part. This is because "Western" describes the type of science, whereas Native Science is a complete term. "Native" is not describing "Science," the two are an integrated concept, perhaps because Native Science is an integrated endeavor.

In this book, *Native Science: Natural Laws of Interdependence*, Dr. Cajete makes a case for the high quality and usefulness of indigenous pedagogies in today's classrooms. He sets the stage for thinking about indigenous ways of knowing by reminding his readers that Western science (as compared with Native Science) is not the most direct or most real way to experience the world. Cajete quotes Maurice Merleau-Ponty:

> "We begin by reawakening the basic experience of the world, of which science is the second order expression…To return to things themselves is the return to that world which precedes knowledge, of which knowledge always speaks, and in relation to which every scientific schematization is an abstract and derivative sign language…"[83]

Western science is easy to describe, although hard to put into practice due to its strength coming from the scientific method, an isolated, reduction-driven, and (ideally) perfectly repeatable experiment. Scientists usually have to accept probabilities and statistically acceptable data ranges because identical results are intensely difficult to repeatedly achieve. However, when written as a method on the printed page, Western science appears reasonable.

Native Science research can be difficult to describe on paper using a conquerors' vocabulary. Additionally, written descriptions can be static, whereas, the world is dynamic.[84] Native Science is all about relations in the world that are dynamic and never perfectly repeatable. Vine Deloria, Jr., in *Power and Place,* addresses the differences in Western ways of knowing and Native "Ways of Knowing:"

> A great gulf exists between these two ways of handling knowledge. [Western] science *forces* secrets from nature by experimentation, and the results of the experiments are thought to be knowledge. The traditional peoples *accepted* secrets from the rest of creation. [Western] science leaves anomalies, whereas the unexplained in traditional technology is held as a mystery – accepted, revered, but not discarded as useless. [Western] science operates in fits and starts because the anomalies of one generation often become the orthodoxy of the next generation.

Journalists and TV news announcers change the nature of science when they sensationalize scientific findings, using words such as "proved" and "truth." While scientists may search for truth, they are only able to find facts. "Truth" is not

synonymous with “fact.” In Western science, new experiments may find new facts that overturn ideas once thought to be “true.” Theories can never be proved in a final way in Western science. Facts linger in the waiting room awaiting more evidence and the next experiment. Western science reduces a system’s relationships until the experimental method ideally yields a “yes or no” answer. The conclusion gives suggestions for this “yes or no” answer based on the data collected. The conclusion is no more complex than the experiment itself. Western science’s power hinges on its experimental method being repeatable; the next scientist should be able to do the same experiment and acquire similar data. In practice, this is quite difficult and so graphs are created to reveal preponderance within the data. Regardless of how well an experiment can be repeated, the facts found and the conclusions of the experiment still need to undergo testing in a real-world scenario. The real world, being much more complex than Western science experiments, may topple the old conclusions and send the researcher back to the hypothesis room. This is all normal and expected. Western science methods have given humanity many useful devices and advances in knowledge.

Native Science works from a different philosophical direction. Instead of reducing, it broadens. It does not reduce or artificially extract relationships to understand the physical world. Instead, it leaves things in their place, in all the complexity of their real, lived relationships.[85Á]

I view Western science as a subset of Native Science, a first step in understanding. It is an attempt to understand the players before you try to understand the

game. Native Science keeps the whole game together as it learns of the players through their interactions with other players.

The philosophical basis behind Western science methods supports "conquerors'" pedagogies. The philosophical basis behind Native Science methods supports "indigenous" pedagogies. While Western science can be viewed as a subset of Native Science, conquerors' pedagogies contrast sharply with indigenous ones.

The Philosophical-Astronomical Foundations Of Education

Amelie Oksenberg Rorty is Director of the Program in History of Ideas at Brandeis University and editor of the book, *Philosophers on Education*, a "comprehensive history of philosophers' views on the aims and directions of education." Her thesis: "philosophy…is implicitly pedagogical." She believes that philosophers consider themselves,

> …the ultimate educators of mankind…[by] interpreting the world aright—understanding it and our place in it…[to] free us from illusion, [and] direct us to those activities that best suit us. Even 'pure' philosophy--metaphysics and logic—is implicitly pedagogical. It is meant to correct the myopia of the past and the immediate. [86]

She reminds us how philosophers' work on theories of knowledge informs the educational reforms; how work on ethical theories informs how morality is treated in education; how work on political theory informs education for citizenry; and how work on metaphysics informs the education of the enlightened.

All pedagogies build upon philosophical foundations, even when the creator of the pedagogy is unaware of the philosophy in use or its origin. Philosophers established

new ways of understanding the human mind and condition and left their imprint on today's curricula.

Philosophy's origins trace back to the time of heroes and oral history. Ancient stories come down to us through the *Rg Veda* from India before the onset of writing in Sumeria. Astronomy knowledge entwines with philosophy in the *Rg Veda*. Ancient peoples of Greece, Mesopotamia and India believed the order of the cosmos gave humans an order for behavior and action. Astronomy and philosophy together gave advice on how to live, how to educate.

Threads of astronomy, philosophy, and education weave together throughout the tapestry of human knowledge history.

Identification of seasonal patterns, animal movements, and plant growth prepared the human brain for discerning patterns in the sky. Those sky patterns, such as star risings at particular times of year, coincided with patterns of survival. For thousands of years, Egyptians kept track of the star Sirius, noting that its rising coinciding with the flooding of the Nile River. Other patterns on earth appeared synchronized with the sky: women's menstrual cycles corresponded to the cycles of the Moon, tides corresponded to lunar phases, and weather patterns corresponded with the changing angle of the Sun. These repetitive, observable patterns connected the sky to human life.

Philosophy and astronomy are twins, born of one human longing to understand, a human desire to make sense of knowledge and perceptions. Why do some things change and some things seem immutable? We may not know the exact thoughts of humans prior to oral histories and written languages, however, when modern science compares human

brain capacity, it finds that long before the advent of writing, human brains were just as capable as ours are today.[87] Obviously, the focus was different. We have no evidence that humans in 3000 BC played video games or communicated across the world using the Internet. However, this difference would only give past humans more available attention for noting changing patterns in stars, skies and seas.

Whoever built the Big Horn Medicine Wheel demonstrated a sophisticated awareness of its geographical and stellar setting. This Wheel could not accomplish its stellar tracking without its exact location in the landscape. This careful attention to the landscape would be an obvious advantage for survival. Those who had knowledge to understand celestial movements and their connection to the hunt, to planting and harvesting, and to weather-related danger, could fulfill a desired role in society.

It was human's recognition and analysis of patterns that became the basis for philosophy. Later, philosophy became the basis of science, which continues today to be a subject founded in recognizing patterns. Tracing the astronomical scientific heritage of the Big Horn Medicine Wheel and the educational practices that inspire and produce learning at this site, we see that knowledge generation is internally and externally perceived. The full spectrum of place-based pedagogies are able to generate knowledge at this Place. The Big Horn Medicine Wheel is not only a Place, it has a symbolic structure in its design, possibly left for other humans who seek and track patterns.

The Wheel's design within its landscape gives us an avenue to study the thoughts and actions of people who left no words but did leave evidence of their thought and actions. If they meant to leave other travelers of their own time or those of us in their

future a "message in a bottle," it seems worthy of at least one scholar's attention to consider the possibilities of what that message might mean. Philosophical thought, physical patterns, and pedagogical practices have longevity as close companions in human cognition.

Oksenberg Rorty tells us that Plato advised that education should include, "astronomy [because it] reveals the ordering principles of the cosmos that serve as a model for the polis [political state]."[88] How does one learn of these ordering principles? Plato believed something inside a person instructs them, for that is where the perfect forms exist. Aristotle, however, felt that practical concerns should be our advisors. Almost 2000 years later, Loyola, a Jesuit educator, suggested that starting with the physical senses and working back toward the mind is most useful.

Place-based pedagogies make use of both pragmatic and internal ways of knowledge generation. As a pedagogy moves from left to right on the Spectrum of Choice in Place-Based Pedagogy table, the activities inspire the learner to bring what is within to meet what is outside (Place) to realize the relationship between self and Place. (See Table 3.2.)

Philosophers through the ages agreed and disagreed *ad nauseam* over whether knowledge comes from within or without. These inside-outside aspects of learning are at the very heart of every philosophical discourse. They continue to remain at the heart of educational pedagogies and at the heart of this dissertation's study.

The main problem in the inside-outside debate derives from the lack of certainty concerning how one could ever know whether reality as they perceive it is real. How does

one determine what is outside when the only way to perceive the outside is through inner perceptions. Rene Descartes (1596-1650) boiled it down to "I think, therefore I exist." However, George Berkeley (1685-1753) made many convincing logical arguments showing that thinking you exist in an external world, is not a verification that you do. You may certainly exist and are able to think, but you do not necessarily exist in an external way, nor can you confirm a common external experience with anyone else. In education, the tension between beliefs in an objective shared external reality versus beliefs in subjective personal reality is often the crux of disagreements about pedagogy.

Even in modern times, a shared external reality cannot be proven. Society forgets this and moves along as if somehow external reality has been proven by science. Surely the banks and stock exchange do not want to consider that a people can have their own legitimate personal reality, for a personal reality may not include the need for banks of stock exchanges. What is interesting for this dissertation's purposes, is that externality cannot be verified, yet it is not the external that we suspect and discredit. Societies deny credibility to radically different internal perceptions, when these are in logical fact, the only realities that can be verified. "I think, therefore I am."

The problem comes because we cannot verify each other's internal realities, even if we agree that separate internal realties can exist and are present. This unknowing state brings fear of what possibilities might occur if those with whom we live give more credence to their internal self than the one we think we can all view. I believe that fear is the basis for enforcing restrictive ways of knowing. Ways of knowing are significant here because Western science and Native Science have different ways of knowing. This

fundamental philosophical basis for investigating our world (in this case the Big Horn Medicine Wheel) is also the basis for types of pedagogies that can be tolerated. The most obvious example of this is the need for "correct" and objective answers where every student can be "graded" compared to each other based on the shared assumption that they all experienced the same external reality. This also assumes that students' internal reality is also similar.[89]

As we move along the Spectrum of Choice in Place-Based Pedagogy, a greater awareness of the students' personal internal and external realities is incorporated into the pedagogy as it advances toward becoming a Vision Quest. In this way, this spectrum is also a spectrum of educational philosophies throughout the ages of humankind. Not in its linear form, but as a repeating pattern of understanding individual perceptive realities and then limiting these realities, understanding the relations of an individual to their environment, and then fearing individual perceptions.

While this dissertation has no desire to prescribe where on this spectrum pedagogy should take place, it does prescribe how to design a teaching lesson to include the philosophical bent of the teacher or learner. Some students would not want to be expected to have a discussion with a Place. They want to talk with their friends, compare fill-in-the-blank answers, and know they are correct by an outer authority.

This spectrum is only a theoretical framework for designing a place-based experience for students. I employ the Big Horn Medicine Wheel as an example of place-based learning to determine if it is possible to learn directly from a Place (the Wheel in this case).

Place-based education is one type of indigenous pedagogy. Many philosophers and educators throughout the history of education have attempted to bring place-based learning into education settings because of the power of Place to connect abstract, generalized learning inside the classroom to the students' real, specific lives outside the classroom. When learning connects to students' real lives, students are likely to become more engaged in the learning process, more likely to stay in school, and more likely to find meaning in their knowledge generation. To bring real life connections to the classroom, place-based pedagogies rely on local resources, including people, places and things.

The Spectrum of Choice in Place-Based Pedagogy alerts the curriculum designer to extensions of place-based learning that may be available to the learner. Place-based education commonly takes the form of environmental education, civic engagement, and learning from the people in one's own community. These choices exist within the left side of the Spectrum created for this study. Learning at the Big Horn Medicine Wheel includes all of these forms and invites learning to include choices toward the right end of the Spectrum. How the Wheel's design within its context of Place is able to do this, is the subject of the next chapters.

Place-Based Lessons and Their Evaluation

As part of my dissertation work, I created six lessons for use within the special topics units of Project Archaeology, a BLM supported educational outreach whose national office is located on the campus of Montana State University.[90] My task was to create lessons that would help fourth through sixth graders learn about archaeoastronomy.

This type of curriculum unit was difficult for me to create because I did not personally know the students who would use the lessons or the classroom resources they would have available. Additionally, the students needed to know a certain amount of astronomy before they would understand archaeoastronomy. The astronomy taught within the national science standards for this age group was not an adequate background to launch into archaeoastronomy without a bridge.

Students needed a foundation in the real, visual sky. Beyond the static Gods-eye view diagrams found in textbooks, they needed to know how the sky above them changes over time in order to understand stellar motions based on Earth's rotation and revolution about the Sun. Students needed this bridge to be easily digestible in order to quickly form these spatial concepts into a foundation ready for immediate use.

Foundational Knowledge in Archaeoastronomy

The basis of archaeoastronomy is the comparison of star positions over time. The change in a star's position gives the change in time. Stars shift about a degree every 70 years in relation to the position of the Sun.[91] The students needed to know how this works and why it is important. I decided to create the bridge, I would keep to the oldest pedagogies known: pictures and stories. Dragon stories are irresistible and in the sky, at the center of everything, is the heart of Draco the Dragon. Mythologies from many cultures describe the dragon (or serpent) engaged in continuous battle with humans. The hero in these stories has many names but is seen in the sky as a human figure leaning into the dragon with the body language of engagement: one knee down, the other lifted up, one arm overhead, the other in action to strike at the dragon's head.

The International Astronomical Union (IAU) officially names celestial objects (The IAU made the final decision that took Pluto off the planet list). For the Western science world, the IAU calls our hero Hercules. However, this constellation has been called many names even while the stories' plotlines are quite similar: humans continually engaged with the dragon of time. The dragon's heart represents this hub of cyclical time. The hero interacts with the dragon over and over again as the ages repeat—a drama played out in the sky describing scientific precessional shift of seasons on earth over a long 24,000-yr cycle.

I decided to base the lessons on stories concerning the stars near Draco that would be pole stars at some time in human history. I drew circles around these stars on a star chart, so I could define which ones maybe significant enough to have stories about them. I thought if I created the lessons around these stars, the students could acquire the foundation for the fundamental movement of the cosmos and be prepared for archaeoastronomy activities based on the movements of stars over time.

The "Aha" Moment

I drew circles around six stars that were either the most prominent or the closest to the North Pole position, and then drew a line to connect these stars. This also made a circle. I sat back to think about how to proceed, which stories to pick, what the names of these stars might be, etc. When I examined the entire circle of stars that would be at the North Pole at some point in the precessional cycle--I was stunned to find I was looking at the design of the Big Horn Medicine Wheel.

This means the most fundamental aspect of astronomy that is important to anyone who looks at changes in the sky relative to earth *happens* to be the same pattern made of limestone rocks high in the Bighorn Mountains. How could I not already know this? The answer is easy; we are taught (and teach) the sky based on our own North Pole in the current era. The Big Horn Medicine Wheel's design represents the way the sky would be organized if you were teaching about the sky over all times, which was why I discovered this design when I attempted to create a lesson that would show children how the sky works over long periods of time.

This was the initial "aha" moment that caused me to wonder if the Wheel was created to teach about the changes in the sky. Without having evidence of the builders of the Wheel and their intentions, I could not answer that question, but I could answer whether the Wheel works as a pedagogical instrument, regardless of whether we know for certain that it was designed for this purpose.

I concluded that it works very well for the purpose of teaching about the changes in the sky, and I used this foundational relationship found in the design elements of the Big horn Medicine Wheel to inform the activities in the lessons I created for Project Archeology.

Applying the Spectrum of Choice in Place-Based Pedagogy

The lessons were tested in Jessica Burgard's fourth grade class in Bozeman, Jan Sublett's fifth grade class and Kathy Gottleib's fourth-fifth grade gifted class in Belgrade, MT. These teachers' suggestions helped modify the lessons to work well with their age

group and their public school classrooms. After two years of using these lessons in these classrooms, I was pleased to see my expected learning outcomes occurred for each lesson. Project Archaeology plans to test these lessons on a wider set of classrooms in the near future. To view the *Project Archaeology Special Topic Unit: Archaeoastronomy* lessons I created, please go to Appendix A at the end of this dissertation.

The Spectrum of Choice in Place-Based Pedagogy table is used here to gauge the depth of indigenous pedagogy in these lessons. As you will see by the assessment Table 3.3, all of these lessons were limited to the left-hand of the Spectrum because they did not take place at the Wheel. This is often the case in teaching *about the world* rather than teaching *in the world*. The parameters for these lessons limited the design to use in a classroom, although a creative teacher could adjust them easily if he or she wished to take the students outside to build their own Wheel or take them to the Big Horn Wheel.

The parts of the lesson that make them place-based is that they taught about a real Place near the community where the children lived, included stories connected to the Place, and were created by a local teacher. Although I categorize these as place-based lessons based on their location on the Spectrum of Choice in Place-Based Pedagogy, these lessons do not include the students learning from the Place directly, therefore these lessons fall mostly on the left hand side of the Spectrum. (See Table 3.3, Assessment of Project Archaeology Lessons.)

Indigenous pedagogies have the power to reset American thought, to connect human values to their common mother: the air, land, and sea. These words could be dismissed as non-scholarly, but I challenge that dismissal. What could be more scholarly

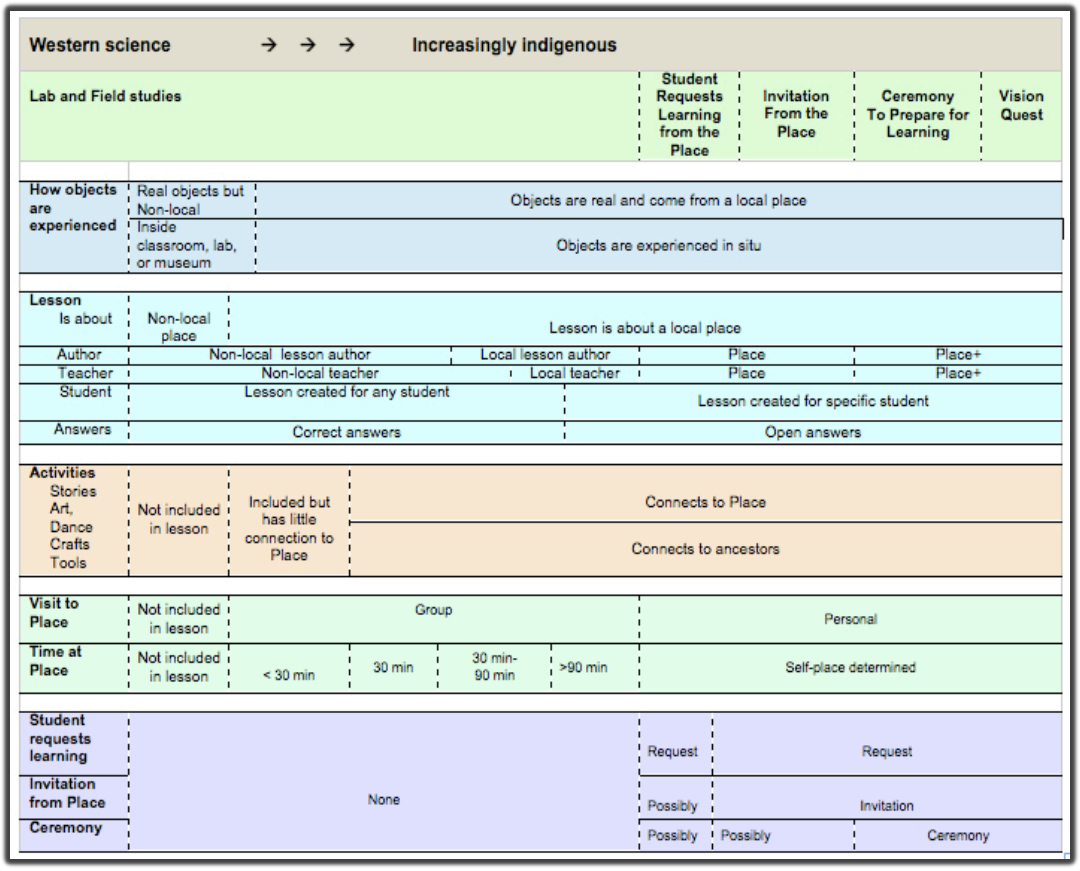
than an honest discussion exploring solutions for the current human condition through the collaboration of Western science and Native Science?[92]

Tables

Table 3.1 Indigenous and Conquerors' Pedagogies Compared

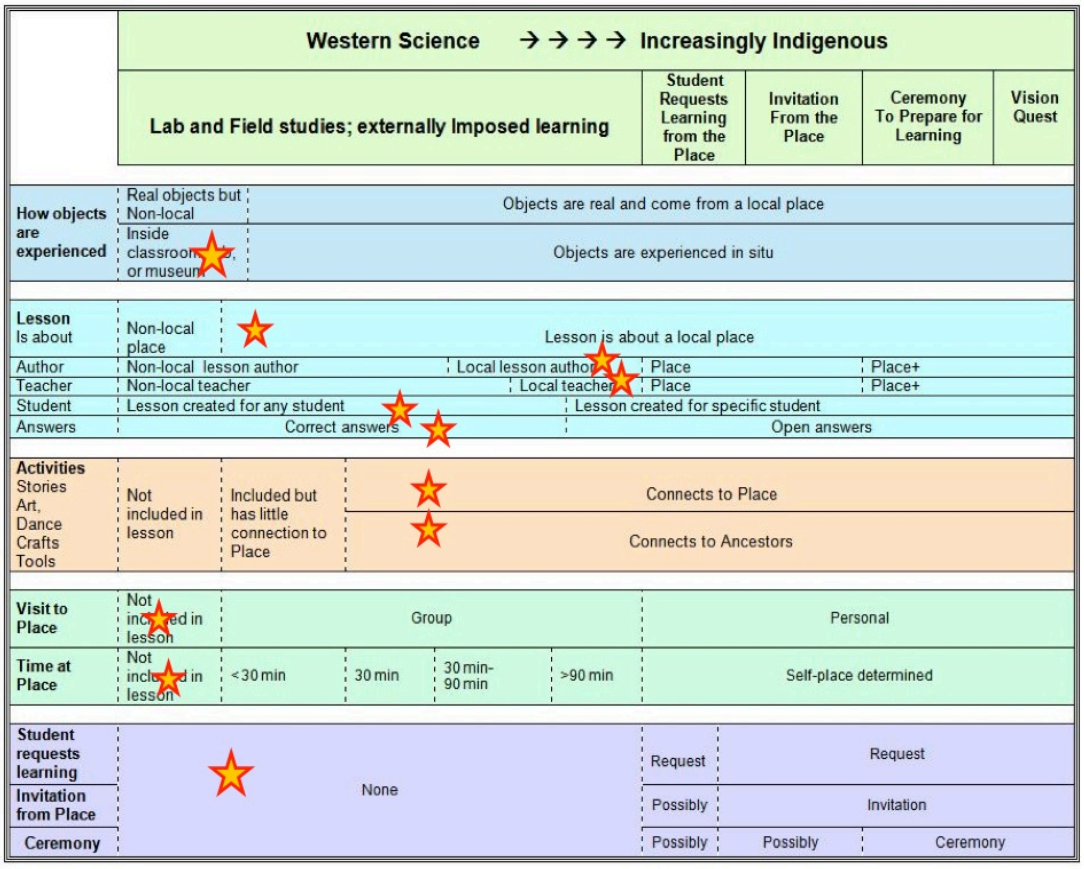
INDIGENOUS AND CONQUERORS' PEDAGOGIES COMPARED		
ASPECTS OF WORLDVIEW	**INDIGENOUS PEDAGOGIES**	**CONQUERORS' PEDAGOGIES**
Epistemology	Self-determined	Authority-determined
Ontological view	Locally defined, ancestrally transferred	Politically defined, brutally transferred
	All being is connected	Beings are separate and in competition for resources
Why educate?	Quality of life for self, family, and community	Maintain government and economic stability
Student population	Based on learning activity	Based on age
Time:	Based on learning activity	Based on the clock
Location	Wherever best appropriate, local places, farms, wildlife areas	Inside classrooms
Content of learning	Knowledge & skills for student success in personal, family, and community life	Knowledge & skills for economic success and the maintenance of government hierarchies
	Natural world	Human-created world
	Real and specific to students' lives	Abstract and generalized to an idealized demographic
	Student centered	Subject centered
Origin of learning	Inside the student	Outside the student
Family role	Responsible for students' education	Expected to support Government education methods
Elders role	Extremely important	Not needed
Who teaches student	The entire environment	Gov't Certified teachers
Treatment of students	Concern for the individual and multiple learning styles	Mass education, large group management practices
	Flexibility in students' pacing and performance of skills	Efficiency in reaching testable standards
	Mastery learning	Competitive grading
	Lessons rely on local resources of people, places, flora and fauna	Lessons rely on textbooks written by non-locals about non-local topics
	Lessons concerned with real events in students' lives	Lessons concerned with standardized topics
Mode of Learning	Active	Passive

Table 3.2 Spectrum Of Choice In Place-Based Indigenous Pedagogy



Western science → → → Increasingly indigenous								
Lab and Field studies						**Student Requests Learning from the Place**	**Invitation From the Place**	**Ceremony To Prepare for Learning**	**Vision Quest**
How objects are experienced	Real objects but Non-local	Objects are real and come from a local place							
	Inside classroom, lab, or museum	Objects are experienced in situ							
Lesson Is about	Non-local place	Lesson is about a local place							
Author	Non-local lesson author			Local lesson author		Place		Place+	
Teacher	Non-local teacher			Local teacher		Place		Place+	
Student	Lesson created for any student			Lesson created for specific student					
Answers	Correct answers			Open answers					
Activities Stories Art, Dance Crafts Tools	Not included in lesson	Included but has little connection to Place	Connects to Place						
			Connects to ancestors						
Visit to Place	Not included in lesson	Group				Personal			
Time at Place	Not included in lesson	< 30 min	30 min	30 min-90 min	>90 min	Self-place determined			
Student requests learning	None					Request	Request		
Invitation from Place						Possibly	Invitation		
Ceremony						Possibly	Possibly	Ceremony	

Table 3.3 Assessments of Project Archaeology Lessons



CHAPTER FOUR

INDIGENOUS HISTORIES OF THE BIG HORN MEDICINE WHEEL

Indigenous people acquire their identity through their creation stories. Other oral histories remind them of their duties to other living things, of loyalty to family and honor in right behavior. Stories of Place remind them of their ancestors' interactions related to a Place and the outcome of these interactions. Keith Basso in *A Sense of Place* describes how descendants can continually learn from the behaviors of their ancestors by merely recalling the Place.[93] Stories, called myths if they are old enough, furnish many facts and relational information connecting a people to a place.

Cultures across time may not share the same type of house, the same wardrobe, or the same dinner menu, but they do share the same sky. Stories of a place can include the sky as seen from that place. The Milky Way makes a "road" across the sky that points travelers to their destination if they know how to interpret the stories and follow the road signs--or in this case the sky signs. However, none of the stories known to scholars describe the creation of the Wheel or relate its purpose.

The Sheepeaters

The only first hand story from one who actually participated in ceremonies at the Wheel comes from the Sheepeater Elder Aggretta. She claimed the Wheel to be an integral part of her culture but did not describe when or why the Wheel was built. W.A. Allen interviewed Aggretta in 1877.[94] At that time, Aggretta was 115 years old. She left the earliest first-hand account of a people's use of the Big Horn Medicine Wheel. If Aggretta's people, the Sheepeaters, were the original builders of the wheel, this has been lost from written and oral histories.

W. A. Allen--a soldier, dentist, hunting guide, and amateur anthropologist had heard of a Sheepeater woman living among the Crow and eventually sought her out. Allen found Aggretta in the Big Horn Mountains, shared a meal, and interviewed her on two separate occasions. He later popularized and romanticized her oral history in a 'last of the tribe' narrative in his 1913 publication *Sheepeaters*. Allen communicated with Aggretta through sign language and translating of her speech into English by the Crow, with whom she was living at the time. One criticism of Allen's story is whether she was the last of her tribe. She could have been the last of her band and Allen misunderstood this.

Little remains of the Sheepeaters' stories. misunderstandings have mingled Shoshone with Sheepeater cultures in written histories. Larry Loendorf and Nancy Medaris Stone have attempted to untangle these misunderstandings in their book, *Mountain Spirits: the Sheep Eater Indians of Yellowstone*.

The Sheep Eaters did not make a distinction between the natural and supernatural worlds. This paradigm—called *animism*—accepts that the entities that today are classified by science as inanimate are actually living beings. In this worldview, strangely shaped rocks, animals, and human beings are all "animated" or given life by an indwelling spiritual power. One could say that Sheep Eater religion was ecological in focus, for the spirit entities embodied in meteorological forces and various animals were seen as controlling the dynamics of their mountain environment. The Sheep eater universe consisted of a layered spiritual hierarchy: at the apex or zenith were the "sky people," below them were the "ground people," and still lower were the "water people." Physical phenomena were also hierarchically ordered, with the Sun and lightning at the pinnacle and rattlesnakes occupying the bottom rung of the cosmos….

Consistent with this spiritual hierarchy, the Sheep Eaters were recognized as "living among the powerful spirits" and absorbing some of their power. When in the 1870s Sheep Eater groups were moved to reservations, they were regarded as particularly powerful medicine people.[95]

The disruption of Aggretta's Sheepeater cultural heritage, due to the encroachment of other Native Americans and later from miners and settlers, may be the cause for the loss of extensive oral history of the Wheel. Compared to other tribes of the Plains and Rocky Mountains, Sheepeaters have little written about them. Many accounts list these Indians as scarce or extinct by the early 1900s.[96] The culture of the Sheepeaters as high-altitude hunter-gatherers ended abruptly circa 1870s when Yellowstone Park government employees aided in the last "round-up" of this cultural group from the

Greater Yellowstone Rocky Mountain region.[97] If other oral history remains within the Sheepeaters' modern descendents, it has not yet become apparent in the literature concerning the Big Horn Medicine Wheel.

Early on, before Allen published his book, fur traders in the Big Horn Mountains had already heard of the "Medicine Wheel" from Indians and fur trappers that visited the trading post at the conjunction of the Yellowstone and Big Horn rivers.[98] Trappers described the majestic wheel as sitting atop Medicine Mountain in the realm of the Sheepeater Indians who they described as still living in the high mountains of what is today Montana, Idaho and Wyoming. Aggretta joined the Crow after her band had all died from disease. The early fur trader accounts correspond with much of Aggretta's oral history. [99]

In Allen's account, Aggretta explicitly recounts the direct experiences of her people's relationship with the Big Horn Medicine Wheel. She tells of climbing to the wheel when she was an adolescent to pray to the Sun. Loendorf and Stone give background on the Sheepeaters' view of the Sun.

In the seamless world of matter and spirit, Ta Apo, or "Our Father," was an omnipotent Supreme Being who was closely related to the Sun: in fact, he created the Sun, also a superior being. When praying, Sheep Eaters faced the Sun, although their prayers were actually addressed to Our Father. …[T]he "Our Father" figure predated any contact with the white man's religion, [which] is supported by…an ancient Father Dance in their ritual life. Sheep Eaters believed that lightning and thunder were emanations from equally important, powerful spirits. Lightning was closely associated with thunderbirds,

spirits that could be represented by eagles, although they more often assumed the form of a hummingbird.[100]

While Aggretta prayed at the Wheel, a sudden storm approached. Out of concern for her safety, her yet-to-be husband tracked her high onto the mountainside and upon finding her tracks, found the tracks of a Grizzly bear overlapping Aggretta's.

At this time, the yet-to-be husband did not have a name, as he had done nothing to earn one. 'Child of Red Eagle' was his only title. In Aggretta's story, the yet-to-be husband earned his name on that fateful day when Aggretta's life was saved by his skill with bow and arrow. The Child of Red Eagle found the grizzly had Aggretta prisoner in a tree. He was able to kill the Grizzly and as he pulled the bloody arrow from the heart of the Grizzly, Aggretta named him, "Red Arrow."

The Wheel's connection to the tribe and the sky comes out again in her story when Red Eagle, the father of Red Arrow, and chief of the twenty-eight bands of Sheepeaters, sent runners to call all the bands to a feast at the "Sun Dial" the next spring in honor of the marriage of Aggretta and Red Arrow.[101]

Coordinating dates using a Sundial is a straightforward endeavor for a society that still sees the stars, the seasonal movement of the Sun along the horizon, and the phases of the Moon. The Sheepeaters likely held their ceremony at the summer solstice rather than the 'spring' as Allen states. The summer solstice on this mountain at 10,000 feet finds the snow drifts still melting and the earliest flowers just beginning to show color. Allen most likely based his translation of 'spring' on Aggretta's description of the environment.

Aggretta's people could coordinate this 'spring' celebration within a day or two by attention to celestial signs of the approaching summer solstice.

The easiest visual celestial movement to coordinate between distant people is the summer solstice. Harder is the first day of spring because for any specific location it falls on different days at different latitudes. This latitude specific "first day of spring" is the equal day/equal night. Equal day/equal night is not synonymous with 'equinox' as is often assumed. [102] Tracking the solstice would have been the easier astronomical calendar to synchronize as people traveled.

Tracking the equinox and equal day/equal night are not beyond the ability of the Big Horn Medicine Wheel to decipher, but it makes sense that the Sheepeaters would celebrate at the solstice instead of the equinox at this latitude and altitude. It is the summer solstice when the Sun affords longer days: warming the earth and lighting the journey for traveling. The Sheepeaters would have been able to travel long distances and find plenty of food en route to a celebration at the Big Horn Medicine Wheel.

The solstice is the time when the Sun reaches its northernmost position along the eastern horizon at dawn. The strongest archaeological evidence of astronomical use of the Big Horn Medicine Wheel is its alignment of the outlying southwest cairn with the central cairn to the rise of Sun at the summer solstice.

It is the most distinguishable and uncontested alignment feature of the wheel. If an observer stands in the southwest cairn (or behind it) and looks toward the center cairn, the view of the horizon in that direction points to the Sunrise position of the Sun at

summer solstice.[103] As the Sun approached this position, Aggretta's people would know the time for celebration was approaching.

It is interesting to note that according to Allen, the number of Sheepeater bands that met at the wheel purportedly match the number of the Medicine Wheel's twenty-eight spokes.

David Dominick, foremost among Allen's critics, reminds us that "last of the tribe" narratives were quite popular at the time of Allen's book, *Sheepeaters*.[104] On the Wind River Shoshoni web site, Lawrence Loendorf argues that Aggretta was not a Sheepeater at all. He bases this on a report from the photographer who took the image of Aggretta used by Allen in his book. The photographer says the woman in his photograph was a Crow woman. Aggretta did live among the Crow so she may have appeared as such to the photographer. There is no evidence in Loendorf's explanation that gives a sense of whether the photographer had any ability to judge this difference.[105] Without more evidence, Aggretta's own words of her tribal affiliation, trapper's descriptions, and the history of decimating diseases appear to be more credible.

Michael Wilson studied the wheel in 1973 and believes Aggretta's story has value and merits a deeper investigation.[106] She described the Wheel's use as a ceremonial site where the Sun played an important role. Subsequent oral histories or other evidence has not refuted this. Aggretta's story remains the oldest historical evidence of a people's use of the wheel for astronomical purposes.

The Crow

The Crow have the most stories of the Big Horn Medicine Wheel. The stories of the Crow are not creation stories but stories of their arrival in the Bighorn Mountains after years of traveling. The Crow named No Vitals or No Intestines experienced a vision of stars coming to earth and turning into the sacred tobacco plant. This convinced him that they had found their home.[107] The Crow have continued to live near the Bighorn Mountains since that time. Two versions found on the Crow Tribal History Project webpage are as follows:

No Intestines received a vision that told him to seek the seeds of Sacred Tobacco, Ihchichiaee. Once locating this tobacco, he and his followers would be in the center of the world, the best place for his people.

> ….To the Apsáalooke the highest peak on the crest of the Big Horn Mountains is called Awaxaawakússawishe, "Extended Mountain," and it is considered the center of their world. On this peak No Intestines fasted for the fourth time and received a vision telling him that he was in the right place that the tobacco seed could be found at the bottom of Awaxaawakússawishe. As he looked to the base of the mountain, he saw the seeds as "twinkling stars," ihkaxáaxaaheetak. The Apsáalooke people then made their home in Montana and Wyoming, with the Big Horn Mountains as their heartland."[108]

> [T]he migration was purposely undertaken. It was motivated by the dream of one man named No Intestines. At the Sacred Waters, First Maker promised him a good land far to the west where his people would find the good life one day. These Apsáalooke, Children of the Large Beaked Bird, brought the sacred seeds to the mountains of the west. The Beartooths, the Crazy Mountains, the Bighorns, the Wind River Mountains, the Absarokas, and even the Grand Tetons. Indeed, this is the land the great Apsáalooke chief described as "a good country because the Great Spirit had put it in exactly the right place.[109]

A list of Crow chiefs on the same tribal history project's webpage lists No Vitals' names and approximate date:

"Shíipdeetash/No Intestines or No Vitals (mid-1400's) vision of the sacred Tobacco seed led to our migration from Spirit (Devils) Lake to Crow Country."[110]

Emerson Bull Chief, the director of the Crow Historic Preservation Office related the story of Burnt Face, a crow man who had fallen into a fire when young and badly scarred his face. Embarrassed over his facial disfigurement, he left the tribe to wander alone in the Bighorn Mountains for many years. During this time, he prayed at the Big Horn Medicine Wheel and was given instructions to go back to his people and build another medicine wheel. That wheel is called the Ft. Smith Wheel and still exists. Burnt Face's scars were healed and the people rejoiced to see him again. Bull Chief said that Burnt Face built smaller medicine wheels all over the Bighorn Mountains.[111]

Tom Yellowtail told a detailed story of Burnt Face for an audio recording in June 1993. Notes from the (unknown) transcriber: "To better reflect a sense of oral nuances and dynamic rhythm of the storytelling, I have italicized Tom's voiced inflections and stresses, and added a series of dot ellipses to mark his pauses, from brief (two dot) to longer (three dot and four dot). Paragraph demarcation reflects the critical segments selected for this presentation. For a complete text vision of the original story, see Frey 1995: 108-122."[112]

Tom Yellowtail's story of Burnt Face:

> So . . they got to the mountains .. and he [Burnt Face as a young lad] bid his folks goodbye for awhile . . other friends . . . "Now you folks go on and I'll . . I'll take these mountains and I'll find a place where I'll fast . . for quite awhile . . . . so he left the camp and he took to

the mountains and went south . . . along the mountain range . . . kept on . . traveling . . into Wyoming . . . kept traveling south and finally he come to a place . ."I believe this is a good place" . . where the present Medicine Wheel is now . . ... he come to that place . . look things over the country . . "Right here is where I will . . fast!" . . . .

So he did . . he started fasting there . . right where the Medicine . . Wheel is now . . . . he fasted there and during the day . . where he fasted . . a lot of the place is just rocky . . formations of rocks . . all around him . . . . so during the day . . he would gather . . rocks . . and he started forming . . a circle . . representing the Lodge . . the Lodge you seen nowadays that comprise . . the Sundance Lodge . . . he built . . that large circle . . everyday he'd pile up rocks on top of . . to form a circle . . and a doorway toward the rising Sun to the east . . . . he made it big . . . and everyday he works . . and the spokes that lead to the center . . he piles a . . Sundance Lodge . . it is round . . with a doorway leading towards the Sun . . to the east where the Sun rises . . . . and he built that according to the . . to the form of a Sundance Lodge . . built it according to the Sundance Lodge . . . . and . . . no telling how many . . he must have stayed there a month or so . . . . and he fasted . . fasted there . . . everyday says his prayers . . he has tobacco . . with him . . and a good supply of tobacco . . . and he'd fill up his pipe and offer smokes . . to the Great Spirit . . . and he went that way on all these days of fasting . . . .

And right by are the cliffs . . caves . . where . . you hear about the Little People . . . . they are there . . and they're there yet today . . . . finally . . the Little People come out . . they'd been watching him . . . they come out . . and they . . they said "Young man . . . you have been here for awhile . . we've been watching you . . . you're fasting . . you've said your prayers . . and you've spent enough time here . . and you've built this . . . representing a Sundance Lodge . . it is good . . . now we want to adopt you . . we want to give you medicine . . . we want you to quit your fasting and you go back to your people . . . . your people are at that place . . your parents and the rest of them . . . . you get back . . back to your people . . don't stay away from them . . . . we'll take those scars away from you so you'll look . . look decent . . so you won't be ashamed to get back into your people . . . . and . . the medicine things we will give you . . you will have them . . . and . . you pray for people . . doctor people . . when you are back home you'll have the power we are giving you . . all these powers . . . . so . . you exercise . . using your medicines when you get back to your people . . . . and you will be a medicine man among your people and eventually become a chief . . of your tribe" . . . .

> [Burnt face then went back to his people and the Chief brought the people together to hear Burnt Face's story.]
>
> So the young man . . says "I am the boy . . that when . . quite awhile back . . when we were . . moving up . . from way down there . . way down the Missouri headed this way up the Bighorn . . River . . . when we got to the mountain . . where I left . . you people . . and I . . I went to the mountains . . and I went on south from there . . quite a ways down and come to a place where I fasted and stayed in one place . . . . I spent all my time there . . . and finally the Little People there around close by . . come to me.. and visit with me and talk with me . . . and they advise me to leave that place and come back to . . back to my parents and all of you . . and I'm a member of your group . . . . and according to what I received they call me Burnt Face . . and I was disfigured . . . . but those Little People took those . . . took those . . disfigurations off my face and make me look different . . . so here I am . . . I'm the boy who left your camp" . . .

In this story, Burnt Face himself does not tell his people that he built the Wheel. Perhaps, because the storyteller has already given that information. [113]

There may have been more than one large wheel in the Bighorn Mountains. In the early 1900s, Stephen C. Simms, an anthropologist from the Chicago Field Museum, traveled to Montana to visit the Crow to learn about the Big Horn Medicine Wheel. No one in the Crow camp other that a visiting trapper knew how to get to the Wheel, although they were aware of the Wheel's existence. The trapper agreed to guide Simms to the Wheel. A drawing of the Wheel published by Simms in 1905 did not match photographs of the Big Horn Wheel taken only ten years later. Either Simms came all the way across the country and did not pay attention to the actual design of the wheel (more on this later) or he studied a different wheel. In 2011, Bald Mountain and Sheep Mountain both had remnants of stone wheels.[114]

The Big Horn Medicine Wheel's design on the northern prairies is older than the Crow's time in this area, however Shane Doyle, PhD who is Crow and also an educator views Burnt Face stories as mythological stories, stating that many Plains Indians share stories about Burnt Face/Scar Face.

The Scarface of Blackfeet mythology was a child of a Blackfeet woman and the Morning Star and does not interact with the Big Horn Medicine Wheel. However, It is interesting that the Blackfeet Scarface shares elements of the Crow's Burnt Face story. The Blackfeet's Scarface also burned his face, left his people, traveled on a "Hero's Journey" and returned to his people with additional skills that would aid his people.[115]

Another Crow named Cut Ear joined expeditions with non-Indians to the Wheel around the time of Simm's expedition. In 1916, rancher H.H. Thompson took a photo of Cut Ear at the Big Horn Medicine Wheel.[116] It remains one of the very earliest photos of the Wheel. Based on Cut Ear's birth certificate, he was forty-seven in 1900, so at the time of Thompson's photo, Cut Ear would have been close to sixty-seven years old.

> An article from the *Sheridan Post* in July 1916 tells of one of the trips guided by Cut Ear:
> "It is the best mountain trip I have ever made. The scenery is second to none between the Mexican and the Canadian borders, not excepting the national parks, it is the most easy of access, the easiest traveled and the most interesting of any place I have ever been.
>
> That was the verdict of W.M. Camp of Chicago, traveler, student writer. At the close of a week spent in the Big Horn mountains with a party which included several Sheridan men. Mr Camp came down from the Big Horns last Saturday and caught the train for the east. The rest of the party returned yesterday. Those who made the trip were Mr. Camp, J.C. Shepherd, an artist from Chicago; Fred Decker and H.H. Thompson, of Sheridan: Joe Boyd, Tom LaForge and Cut Ear, a Crow scout.

Aside from the outing, the party had two objectives in visiting the medicine wheel on Medicine mountain and search for a reported second medicine wheel; and to look over the ground with a view to determining the feasibility and desirability of a national park. In both they were successful.

Going to the old medicine wheel, they spent some time studying it and recreating the scenes of the old days when the various tribes went there, leaving behind all weapons, to worship a common deity on neutral ground. They then journeyed over practically all of that country from Tongue river north to the Big Horn and fixed in their own minds, the natural boundaries of a national park. The boundaries are the Big Horn canyon, Devil's canyon and the Black Canyon. Within that section they found the finest natural scenery, the most admirable camping places, the most natural advantages for a game preserve, although the most attractive out land, that it is possible to conceive. Mr. Camp, as well as all other members of the party, was delighted with the project of converting that groups' into a national playground and gave assurance that he will do all in his power to have it brought about.

One of the best features of the section is that it is so easily reached. While the mountains raise approximately 4,000 feet above the level of the sloping country, the grade is less than three percent along the trail followed by the party and an automobile road could be constructed without the least difficulty. That was one point that appealed strongly to Mr. Camp, the accessibility of the country and the ease of the trip.

The trail which was followed has historic interest as well as practical attractions, being the old government trail used between Fort Smith and For Kearney. It was later used by loggers and mountaineers. It follows along the east side of Black canyon.

The park which the party outlined and for which they will launch a campaign is largely in Wyoming but extends into Montana.

The party was also successful in finding a new medicine wheel, it being in all respects like the one on Medicine mountain, so well known to many people and evidently by the antiquity and used by the same Indians for the same purposes. Many of the relics found about the wheel are of the same nature as those found at the better known wheel. The two are separated by 60-70 miles of mountainous country.

> A unique experience was afforded the party at the medicine wheel, they went through all the ancient rites and ceremonies of the Indians prescribe for such places. In that they were directed by Cut Ear. The ceremonies were inconceivably weird and mystical and furnished thrills which endured for days afterwards. Following the ceremonies, the party slept on the wheel as was the custom of the Indian visitors many years gone by.[117]

This information adds to the evidence that Simms may not have gone to the same Wheel that today is called the Big Horn Medicine Wheel.

Another Crow man, Creep Gall was reported to have built the Wheel. Don Grey states in his "Summary Report of the Medicine Wheel Investigation," (1962) that a Crow named Creep Gall built the wheel.[118] Grey may have been misquoting a 1896 newspaper story in the Sheridan Enterprise that told of Chief Creep Gall building an altar and later a house on Medicine Mountain.[119] Three years before Grey's report, the *Wyoming Archaeologist* contained a new article based on the Sheridan newspaper's report. However, the story did not say Creep Gall built the wheel; it said he built an altar.[120] If the story of Creep Gall building an altar is true, it could explain the wood found in the walls of one of the cairns during the 1958 excavation that Don Grey was describing in his report. A tourist document, *The Medicine Wheel*, published by the Lovell Chamber of Commerce, repeats Grey's report.[121]

George Bird Grinnell discusses the work of H.H. Thompson who lived among the Indians in 1915 and attempted to find information about the origin of the Medicine Wheel. In 1923, a manuscript by Thompson reported that his inquiries caused him to conclude the Crow, Cheyenne, Sioux, Arapaho and Shoshoni knew little information

about the origin of the wheel although they did know of its existence and held it as sacred.[122]

The Cheyenne

The Cheyenne were not ancient residents of the Plains, but respected the Big Horn Medicine Wheel as sacred and incorporated it into their lives. William Tall Bull (Northern Cheyenne) of the Big Horn Medicine Wheel Alliance worked for many years to oversee the management of the historical landmark for the protection of the site's value as a sacred destination for present and future visitors.[123]

George "Bird" Grinnell lived with the Cheyenne during the summers and was named "Bird" because he came and left with the warm seasons. He asked about the Big Horn Medicine Wheel among the Cheyenne and one man who said he had never been there said that the drawing of the Wheel looked like a Cheyenne Sundance lodge. This idea has stayed in literature and interpreter's talks about the Wheel. The Cheyenne gentleman had specifically told Grinnell that he had never been to the Wheel, but he likened the amount of spokes (28) radiating from a common center to a Cheyenne Sundance lodge. While the number twenty-eight has significance here as well as the spokes radiating from a common center, the Big Horn Medicine Wheel's spokes are not equidistant from each other like in a Sundance Lodge and the cairns around the Big Horn Medicine Wheel do not have a counterpart in the Lodge.

Grinnell thought the western, inside cairn of the Big Horn Medicine Wheel matched the placement of the altar in the Sundance Lodge, but there is no account of the Cheyenne agreeing with him on this. (More on Grinnell's research later.)

In 2011, Francine Spang-Willis, an interpreter working at the Big Horn Medicine Wheel for the summer, was bothered by the interpretive signs that called the Wheel a "mystery."[124] She stated,

> Who is the Big Horn Medicine Wheel a mystery to? The interpretive signs portray a Eurocentric perspective about the wheel. There are American Indian individuals, from different American Indian tribes, who understand its intent and purpose from their perspective.
>
> In order to have a deeper understanding of this place, American Indian knowledge holders have to be open to sharing and non-Indians have to value and be open to learning American Indian knowledge. However, it is important to understand that not all American Indian knowledge is appropriate and accessible to the general public. It is up to the American Indian knowledge holder to decide if and to whom he or she will share it with.
>
> I [became an interpreter at the Wheel] because it fit with my goal to help share American Indian knowledge about the Medicine Wheel from an American Indian perspective.
>
> The more perspectives you know about, the better your understanding is going to be.
>
> It is not just the educators' responsibility. It is all of our responsibility to value and include American Indian knowledge for a deeper understanding to take place.[125]

The A'aninin (Gros Ventres)

George Horse Capture, Sr. an anthropology graduate of the University of California-Berkeley studied stone rings larger than tipi rings in the 1960-70s across Montana and adjacent states. In a personal communication, he shared that he believed the Plains Indians were not the builders of the larger rings like the Big Horn Medicine Wheel. He felt that since the Plains Indians were not an agricultural people, they had little

need to track the seasons. He stated this was just his opinion and that he knew of no oral histories of his people that included stories of these large wheels.[126]

Terry Brockie, a Gros Ventres language specialist and language educator on the Fort Belknap reservation, has recorded audio interviews with many of the Elders to preserve the language within the context of conversation and cultural stories. Terry is familiar with the "Big Medicine Wheel" but says it plays no part in the oral histories he has heard. However, he adds that the Wheel is commonly known among his people and thought to have been built by "ancient ancestors."[127] When queried as to whether this means A'aninin ancestors, Terry said he felt "ancient ancestors" refers to an ancient people who preceded the A'aninin in this land by an unknown number of years.128

George Horse Capture, Sr. made it clear that although he had academic degrees and had spent most of his life in a formal career as an anthropologist and museum curator, it was his son who should be sought out for matters concerning Gros Ventres tradition. His admiration for his son livened his speech more than any other subject during our short conversation. George Horse Capture, Jr., usually called "Junior" is the Flat Pipe Holder for the A'aninin, a member of the school board, and beginning in 2013, the vice-president of the Fort Belknap Indian Community Council.

When asked about how the Big Horn Medicine Wheel fits into tribal culture, "Junior" replies that it fits into all cultures, not just the Native cultures of the West. The Wheel is known for its existence without any specific references to who built it or when it was built. It is a sacred site with the ability to change people's lives if they know how to

listen. “If there is one Creator, then he must have made all people--although I am sure he made the A’aninin first!” Junior laughs.” The Wheel exists for all the Creator’s children.”

The Shoshone

The Shoshone have lived in the Rocky Mountains for longer than the Crow or Blackfeet can recall. Anthropologists believe the Shoshone lived in southwestern Montana and southern Idaho for thousands of years.[129] Their connection with the ancient Uto-Aztecan living in the western mid-continent for such a long range of time makes them possible builders of the Wheel, although no stories have been found to verify this.[130]

A member of the Shoshone, currently living in Southeast Idaho, made the comment that Places such as the Big Horn Medicine Wheel exist everywhere and are quite common. He said they are found when they are needed and become lost when no longer needed. During this dissertation’s study, no members of the Shoshone tribe were willing to give information about the Wheel or introduce the author to anyone else who might. For that reason, description of the Shoshone’s interaction with the Wheel in this dissertation is limited.

The location of the Medicine Wheels along the eastern side of the Rocky Mountains set them in lands where Blackfeet, Blood, Gros Ventres, Crow, Cree, and Shoshone have all historically been present. Oral histories of the Blackfeet tell of the Shoshone being the major group present before the Blackfeet pushed them south.

The Blackfeet

Leo Bird, a Blackfeet astronomer and teacher shared Blackfeet knowledge of the Big Horn Medicine Wheel at a public talk at the Museum of the Rockies in 2005. He told the audience that the Big Horn Medicine Wheel was within the ancient territory visited by the Blackfeet. His people have always known of the Wheel and traveled to it for "scientific purposes" and to "learn of changes in the sky over time."[131]

Leo told of meeting another astronomy teacher from south of the United States' border who told of other wheels even further south. This matches Blackfeet oral history of traveling to South America to establish the differences in the skyview, from different latitudes.[132] Junior Horse Capture also recounts stories of his people traveling to the end of the Southern continent long ago when it was safe to travel far distances because tribes were not at war. "They would take care of travelers," Junior said. [133]

The Blackfeet and Shoshoni have lived along the Rocky Mountains much longer than other groups. The A'aninin's movements were more in the mid to western prairie areas. During this dissertation's study, not one person's remembrance or any documented cases were found where any of these tribes claimed the wheel as their own.

The Blackfeet have built medicine wheels, but these are not the large astronomical wheels. The Blackfeet and other groups living along the eastern Rocky Mountains and associated prairies created burial mounds for honored ancestors that take the form of wheels with rays toward notable cultural or geographical directions, but these are much smaller structures than wheels like the Big Horn Medicine Wheel.[134]

Summary

Many of the American Indian tribes and nations now living in Wyoming, Montana and Idaho did not originate from this area of the continent. Each of these nation's creation stories tell of their specific origins. What is important for this study is that none of the tribes now living in the region claim to have built the Big Horn Medicine Wheel. There is no tribal memory of a time when it was not already present.

The Wheel is a Place of ceremony for many cultures and honored as a Sacred Site by all. Ceremonies performed by American Indians at the Wheel vary; there is no one ceremony that defines the interaction between humans and the Wheel's Place.

Perhaps Aggretta's Sheepeaters were the builders and knew the original ceremonies and stories associated with the Wheel. If so, these stories died with Aggretta or are guarded by knowledge keepers and therefore not readily available for academic research.

Aggretta's people lived in the high mountains of the Bighorn Range, she prayed at the Wheel, celebrated her marriage at the Wheel and lived out her life with the Crow, not far from the Wheel. Her voice, the voice of a 115 year-old Sheepeater Elder, is the last voice to speak with perspicacious certitude respecting the Wheel's role.

CHAPTER FIVE

WESTERN SCIENCE AT THE WHEEL

Explorations and Publications

Stephen C. Simms, 1903

The first scientific paper written on the Big Horn Medicine Wheel appeared in 1903, written by S. C. Simms, an anthropologist who traveled from Chicago to the Crow encampment near the Bighorns in 1902 to study the Wheel in the "interest of the ethnological division of the Field Columbian Museum."[135] While in the Crow camp, Simms was unable to find any Crow person who had been to the Wheel, although many were aware of its existence. Two Sioux Indians at the Crow camp told Simms that they had never been to the Wheel but they also knew of it. Simms showed them a sketch of the Wheel he had made from other's descriptions and one of the Sioux marked a line down the middle of the sketch and called one side of the wheel, 'Cheyenne' and the other side, 'Arapaho.' This detail comes in again later when in 1922, George Grinnell sees a feature on the west side of the wheel that he perceives as a symbol of the altar placement inside the Cheyenne medicine lodge.[136]

In five years of research, this author has found no other information about dividing the Wheel in this manner. The Cheyenne that Grinnell spoke with did not substantiate this, so the meaning of the division remains ambiguous.

A trapper, visiting among the Crow, had been to the Wheel before and agreed to guide Simms to it. Simms describes the journey in his 1903 paper. He told of the steep

climb to the Wheel and said he knew they were high in altitude because they climbed above tree-line. He describes the travois trail traveling up and across the mountaintop and alongside the wheel, astonished at the deep cut of the trail into the mountainside, showing many years of use by many people. (See Image 5.1.)

A travois trail is much wider than a single track trail or animal trail. Simms was impressed with how established that road appeared. The Forest Service road that now goes to the Wheel is partially built right on top of the travois trail, obviously still the most efficient way to get to the Wheel. Some authors write about the difficulty of traveling to the Wheel due to its high altitude location. However, General Sherman used this same trail to cross the bighorns to get his troops to Yellowstone Park. The deep cut and width of the travois trail along with large numbers of tipi rings in the meadows just beneath the wheel, give evidence for continued use of this travois trail and area of the Bighorns.

Although Simms went to much effort to study the Wheel, when he later drew a diagram of it for his 1903 paper, his sketch had serious problems. It did not match the Big Horn Medicine Wheel's appearance as recorded in photographs only fourteen years later. This could be due to disruption of the site, but the basic drawing is different in the amount and placement of cairns and has one less spoke that the Bighorn Wheel. His direction of north is off by almost 40 degrees if he was showing true north and about 20+ degrees if he was showing magnetic (although that is hard to judge with certainty because magnetic north changes in unpredictable ways over time).

Simms' diagram shows a 'hut' on the east side. This corroborates with other physical descriptions of the cairns as "huts" having roofs. As this could be evidence of a

skywatchers' temporary shelter, it is worth noting.[137] Aggretta's story also talked of a hut for the Sun chief. The description of 'huts' or 'houses' shows up in a local resident's descriptions two decades earlier. In the late 1800s, George Griffin bemoans the fate of the huts and attributes the change in their size and shape to the miners from Bald Mountain City.[138] This mining town was six miles from the Wheel but lasted only a short time between 1887 and 1893. It could not produce enough gold to pay for its operation and the train system they built to haul out their hoped-for riches.

A resident of Bald Mountain City wrote in her journal about a night when town residents heard Indians singing in the mountains near the wheel. This caused great fear among the towns people and they hid under their floorboards in their cabins wondering if the Indians would come to their town. The Indians were many and their singing and dancing could be heard for miles. Reservations were established by this time, but these Indians were not yet forced to stay on the reservations and could still travel freely. The isolation of the mining town inhabitants made them fear the large numbers of Indians who joined in the festivities on the mountain that night.

When dawn came, the Indians were all gone and all was quiet. The author of the journal wrote that she thought it was pretty silly that they were all so afraid when obviously the Indians were just enjoying their time together.

The Indians as well as the miners could have made changes to the Wheel's spokes and cairn huts. However, some believe the Indians held sacred structures like the wheel in high regard and would not have likely tampered with them[139].

The change in shape and size of the wheel's cairns are important in research involving archaeoastronomy. Researchers use the alignment of spokes and cairns to celestial objects to understand the importance of these to the builders. If Simms had been aware of astronomy as possible evidence of culture, he would have likely used more care in noting the directions of spokes and cairns.

Simms numbered the spokes at twenty-seven, not twenty-eight as every other observer except Jay Ellis Ransom had counted.[140] Ransom purports that the forest service added a spoke after 1924. It fits Ransom's cultural symbolism argument to have twenty-seven instead of twenty-eight spokes, but it is interesting that Simms also counted twenty-seven. This author is not certain that Simms actually studied the same wheel we now call the big Horn medicine Wheel. However, either number of spokes has astronomical significance for the counting of Moon days and the division of the sky into calendric sections.

Simms lack of exact measurements does not take away the importance of his research. His original files at the Chicago Field Museum have not yet been reviewed and these may help clear up the question as to whether he studied the Wheel we now call the Big Horn Wheel or whether he studied on Bald Mountain, Sheep mountain, or an entirely different mountain in the Bighorns. He did make mention of a buffalo skull resting on the central cairn and as the buffalo is symbolic of the Sun in some cultures, this may be relevant to skywatching. The addition of a Bison or Elk skull to the central "hut" at the Wheel has been maintained over time, although it is unknown to the Forest Service who is responsible for replacing the old skulls with new ones.[141]

George Bird Grinnell, 1922

The first periodical to present a description of the Big Horn Medicine Wheel for the public was the magazine, *Forest and Stream*—the precursor to today's *Field and Stream*. In the 1895 article, the author likened the medicine wheel to the Aztec Calendar Stone in Mexico. This allusion brought many speculations on the use of the wheel and the people who designed it. Many years later, possibly inspired by this article, an editor of this magazine named George Byrd Grinnell decided to formally study the wheel and in 1922 published his results. Grinnell's emphasis focused on the wheel's likeness to the Cheyenne medicine lodge. (See Image 5.2.) Future histories carried this idea forward with little consultation with the Cheyenne for confirmation of this idea. However, in 1981 Michael Wilson, a Wyoming archaeologist, studied the Wheel during his graduate study and concluded that the thirst-dance may be a better candidate for connecting the Wheel to Native American culture.[142]

In 2002, Karl H. Schlesier attempted to show that the Sundance was not a cultural aspect of the Plains Indians' use of the wheel for he concluded the Sundance based on the time of the Sun's solstice was not even important to most Plains peoples.[143]

Regardless of this controversy over possible cultural uses, Grinnell's attention to detail was helpful for later astronomy research. His work in 1922 recorded rock groups at a distance from the Wheel proper. These groups are termed "outliers" or "outlying cairns." (See Image 5.3.) Outliers are important when investigating a long baseline between a large cairn and a distant, discrete point.

During this dissertation study, one of the outliers Grinnell recorded in 1922 was found to align with the middle and easternmost cairns of the wheel proper and with the sharp edge of a ridge to the west, 180 degrees in the opposite direction.[144]

Grinnell did not designate any astronomical significance to these outliers. There is no evidence that he had the background to understand their importance in baseline astronomical alignments. However, because he was a careful observer, his research helps our astronomical research almost a hundred years later.

These outliers are no longer present. Only a few years after Grinnell's visit to the Wheel, a stone wall was built around the Wheel to protect it from large animals. The rock wall may have included the outlying cairns' stones in its construction. In this dissertation's study of the Wheel, we found the location of Grinnell's northwest cairn may have rested where the Forest Service road now resides.

Wyoming Archaeology Society (WAS) and Don Grey 1958

In 1958, Don Grey reported on the excavation of the Big Horn Medicine Wheel performed by the Wyoming Archaeological Society (WAS), a group of enthusiastic amateurs that included Joe Medicine Crow in its membership. In their excavation, a piece of wood from the wall of a cairn was carbon dated to between 1500 and 1700.[145] Joe Medicine Crow was out of town during the excavation but was very interested in the findings. He did not believe the carbon dates were accurate for the Wheel's origin because the wood had not been found at a foundational depth but instead was found in a wall of one of the built-up cairn huts.[146]

Few artifacts were found on the WAS excavation in 1958. The central cairn appeared to have been previously dug up, possibly by treasure seekers. Unlike the Majorville Medicine Wheel in Alberta, the Big Horn Wheel did not have an undisturbed stratigraphic record of artifacts. The Majorville Wheel was dated through its layering of known types of artifacts, to 3200 BC. The Big Horn Wheel has not been dated this accurately due to the disturbed nature of its cairn huts.[147]

Dating of charcoal recovered from a hearth about twenty feet from the rim of the wheel did not occur until early in the 1990s, long after the 1958 excavation. This charcoal turned out to be much older than the wood left inside the cairns. It was dated at around 4350 BP.[148] Without additional association to the wheel, however, this charcoal remains an anomaly as does the arrowhead found in the central cairn that also dates to around 4400 BC. Later investigations of the wheel continued to use the surface diagram and site survey made by the Wyoming Archaeology Association in this 1958 excavation.

Jay Ellis Ransom, 1971

Jay Ellis Ransom grew up in the small town of Lovell in the Bighorn basin of Wyoming. Medicine Mountain, where the Big Horn Medicine Wheel resides, lies to the east, hovering 6000 feet above Lovell. As a child, Jay visited the Wheel often with his father, a geologist. Jay later became an anthropologist and wrote the only popular book available on the Big Horn Medicine Wheel. “Popular” in its definition meaning, “for the public” not in its definition, “well known and liked.”

Ransom had an entirely different idea than any other researcher about the Wheel’s origins and purpose.

His writings on the Big Horn Wheel are the most extensive and to some, the most fanciful! Ransom based his hypothesis about the origin and purpose of the Big Horn Medicine Wheel on evidence of linguistics and the study of symbology. He cites anthropologists such as Lowie to back up his methods. He believed linguistics were based on building language from smaller blocks of word meanings and that this caused a culture's linguistics to belie their symbolism. He believes the Wheel to be of Uto-Aztecan origin because the number of cairn huts were a sacred number to the Uto-Aztecans and used in their symbolism. Ransom determined the Sheepeaters to be remnants of the Uto-Aztecan makers of the wheel based on their similar symbolism-language.

Ransom's research supports the Sheepeater Elder Aggretta's story. She did say her people built the Wheel. [149] His work was not critically examined by other researchers and in 1990, the Forest Service announced that studies on the ethnological importance of the wheel area had never been done.[150] This lack of attention to his research infuriated Ransom and he sent the Forest Service a letter to make them aware of his many decades of research. He sent them newspaper clippings about his research along with his entire 15,000 word document on the ethnological and cosmological significance of the site.[151]

Ransom was opposed to designating the Wheel as a Native American Sacred Site because the builders of the site, by his determination, were ancient Uto-Aztecans. He believed the current Indian nations had no special claim to the Wheel. In contrast to this, the Big Horn Medicine Wheel Alliance reminded those attending meetings about the management of the Wheel area that Native Peoples have historically used the site for vision quests and other rituals even if they did not claim to have built it. The Alliance

made it clear that native people considered the Wheel a Sacred Site and respected it as such. Their lack of recent use in the early 20th Century was due to restrictions in travel based on poverty, vehicle availability, and the danger of off-reservation interactions with non-Indians or Indians of different tribes.

Ransom's writing style in his early research was coherent and scholarly. One archaeologist thought that Ransom may not have gained attention of his peers because his ideas encompassed too broad of a topic. He was making a case for cultural ties of humans across thousands of years. Archaeologists at that time were still focusing on artifact remains to determine cultural groups. When the artifacts changed, the cultural group was given a new name. Ransom flew in the face of this by connecting cultures across millennia due to their symbolism and linguistic "artifacts."

In Ransom' letters to the Forest Service, concerned that the Forest Service was giving current Plain's Indians a preferential treatment in their access to the Wheel, his writing style decayed into incoherent ranting. However, regardless of his obvious angst over being ignored , he was correct and remains correct that his ideas have not been critically analyzed by his scholarly peers. His belligerent attitude discredited his real scientific work. When interviewing anthropologists and archaeologists about Ransom, the only comments were that "the man is crazy." When asked about his work specifically, not one person had actually read his scientific work on the Wheel.[152]

Ransom modified his scientific treatise into the book, *The Big Horn Medicine Wheel, the Birth and Death of Humanity, and its Successor the Aztec Calendar Stone.* He published this book hoping to generate popular interest after the science community

ignored him. He had sent his treatise off to many university libraries, yet never gained a response. It is unclear why he did not publish his ideas in a peer-reviewed journal.

Ransom's book implies that the ancient Uto-Aztecans moved from the far north to Mexico and became the Aztecs.[153] He goes to great length to describe the symbolism of the Aztec Calendar Stone as it relates to the metaphysics of the original builders of the Big Horn Medicine Wheel. (Recall that more than two decades before Ransom was born, the 1895 issue of *Field and Forest* contained an article whose author mentioned the likeness of the Wheel to the Aztec calendar stone). Ransom noted the ancient age of salvage artifacts from a site now under water due to the construction of the Yellowtail Dam. He dates the age of the Wheel circa 4000 BC. This date coincides with the carbon dating of some wood found during the 1958 excavation but not dated until the 1990s. Ransom's hypothesis preceded the dating of this remnant of the 1858 excavation. That detail has never been brought to scholarly attention and discussed. The dating of that remnant was found by Ivy Merriot while researching artifact reports in the Wyoming's State Historical Preservation Office (SHPO) documents, unattached to any excavation findings.

Ransom came from within the anthropological tradition, tied his ideas about cosmology to the culture--as anthropologists prefer yet was ignored. Could no one critique him, so they just ignored him? Over-arching theories connecting thousands of years and widely separated cultures were not in vogue in the late 20th century.

The cosmological hypothesis proposed by Ransom was not connected to the real sky, but to a symbolic sky. Ransom saw the wheel as a representative symbol of Uto-

Aztecan metaphysical beliefs. For Ransom, the central cairn represents the emergence place of the Uto-Aztecan people from the underworld. Two spokes of the wheel that connect from the center cairn to the eastern cairn were drivelines for emerging souls: the path they must follow to emerge properly into this world. Ancestors who have died but lost their way and so have not yet entered the spirit world can get there by using the cairn to the southwest. He proposed the wheel is a two dimensional representation of a three dimensional cosmological concept. He believes the southwest cairn rests outside the wheel's rim because in the Wheel's two-dimensional 'cosmogram' this cairn is signifying the path for the spirits of the dead to travel the Milky Way.[154] To do this, in the three dimensional structure, the line of rocks would lift above the center of the wheel, straight up to the zenith position overhead.[155]

During this dissertation's study, it was found that the Wheel does have a prominent zenith star: Capella, one of the very brightest stars in the sky, so bright that it is often mistaken for a UFO as it strobes multiple colors when it rises.[156] Zenith stars are *the* important stars for north-south celestial navigation across distant lands. The astronomical connection to Capella as a zenith star would have strengthened Ransom's theory of both the Uto-Aztecan zenith star symbology and the migration of these people to Mexico. Even so, Ransom did not relate the symbol of the wheel to the star Capella or the actual night sky other than in a general, symbolic way, for Ransom was not a skywatcher and did not believe the real sky played an actual role in the cosmogram's importance to the Uto-Aztecans.[157]

A little astronomical background on Ransom's cosmology: In 4400 BC, the brightest star to cross the zenith at the Big Horn Medicine Wheel was Alderamin. The name of this star gives away its celebrity status in antiquity. Brighter stars near Alderamin are not named. Alderamin has an Arabic name meaning "blaze" such as the white blaze on a horse's nose. The asterism that holds Alderamin appears like a horse's head. Alderamin is among the few stars in the sky that will be (and has been) a pole star sometime during the precessional cycle of the Earth's north pole. Other ancient cultures have tracked this star. Ransom's Uto-Aztecan designers of the wheel may have been among them.[158]

Ransom clearly remembers that when he was a boy, the rim of the wheel was decorated with crystal quartzite. No other person has ever mentioned this. Quartzite does not come from Medicine Mountain and is quite a different looking rock than the white limestone that makes up the rest of the Medicine Wheel. Ransom's father was a geologist who later authored (with his son Jay) *Gems and Minerals of America*.[159] Both men would have understood the difference in these rock types. Ransom was only nine or ten when he first visited the wheel in 1924. When Ransom returned a decade later, he reported the quartz rock had been stolen for gardens in Lovell, Wyoming--and even admits he took a piece himself. [160]

While Ransom knew about geology, he did not seem to know the night sky. This is unfortunate because it hindered his ability to make use of objective physical evidence (patterns of stars in the sky) to support his association of the Wheel with ancient Uto-Aztecan's symbolistic cosmology.

Michael Wilson, 1978

Due to the Wheel's designation as a Sacred Site and National Historic Landmark, any proposed archaeological excavation must describe how the recovery of artifacts would increase understanding of this site. Only one other excavation after the 1958 WAS excavation was approved. Michael Wilson, then a graduate student of the University of Wyoming, spent part of the summer in 1978 in the area of the Wheel and excavated spokes that had not been excavated in the earlier WAS excavation. Wilson was not able to verify any connection of the Wheel with the sky. He reported that the Wheel was in the fog every time he was on site.[161]

John "Jack" Eddy, 1974

NASA's current acceptance of the wheel's astronomy began with one researcher: Dr. John Eddy, a solar astronomer. [162] In 1974, Eddy found evidence that the wheel might be a remnant of an ancient solar and stellar observatory. He discovered an alignment between two rock cairns and the Sun at summer solstice Sunrise. (See Image 5.4.) He also found that additional cairns aligned with 'warning stars' giving pre- and post-solstice dates. Analyzing the change in the stars' positions along the horizon over time allowed Eddy to date the wheel according to the astronomy he found there. Eddy's findings and quick success energized the century-old controversy between the sciences of astronomy and archaeology over the origin and use of ancient, rock wheels. While Eddy obtained the support for this astronomical interpretation from NASA, the American Association for the Advancement of Science, the American Astronomical Society, and the National Geographic Society, the archaeologists were not as quick to concur.

The complex irregularities and non-symmetries of the Big Horn Medicine Wheel speak more of astronomical connections than a simple symmetry could. The wheel is not a perfect circle and its rays are not evenly spaced nor are they straight. Its cairns, large enough for a person to hide from the high-altitude wind, are not symmetric to each other. The specifics of the interaction between the rock design and the sky are imbedded in the irregularities. Irregular, yet specific angles are the normal everyday tools of the skywatcher.

For Eddy to notice these irregularities would be as obvious as a carpenter recognizing a carpenter's hammer lying in a window display of high-fashion dresses --out of context perhaps, but still quite recognizable by the craftsperson as to its potential utility. While the archaeologist is cautious not to project present conditions on the past, the astronomer has not had this training. To Eddy—a tool was a tool. "It looked very astronomical," Eddy told Spencer Weart, in a 1999 interview when describing why he decided to visit the wheel.[163]

There was no background training to restrain him from relating everything he knew in the present to past sky observational conditions. He fully engaged his knowledge and astronomical skills in an attempt to understand the wheel's purpose as a scientific instrument. The fact that the stone configurations aligned with celestial movements was an exciting find on its own, offering the possibly of a new knowledge of the capabilities of the people who built the wheel.

An understanding of how past peoples would incorporate this astronomical information into their daily lives was not a limiting consideration for Eddy. He found that

the outlying cairn that Ransom described as a two dimensional symbol of a three-dimensional zenith marker (and hallway for the ancestors to travel to the Milky Way) was closely aligned through the central cairn to the rising of the Sun on the summer solstice. He also found alignments with other cairns and the stars Rigel, Aldeberan, and Sirius. When Eddy dated the wheel according to star alignments, his dates correlated well with the date of ca 1760 tree-ring date determined by the 1958 excavation.

This brought acceptance of his conclusions with little criticism from his astronomy colleagues. Eddy's methods appeared scientific enough. He showed graphs of star movements over time, heliacal extinction angles, and hypothesized on methods to make the alignments more exact by showing the use of a gnomon held in the center cairn.

The excavation in 1958 showed the central cairn was indeed deep enough to hold a pole. In the 1958 excavation, there was evidence that the center cairn had been hollowed a few feet into the original limestone bedding, large and deep enough to support a pole. However, using a long baseline view from a distant outlying cairn would turn a large messy cairn into a discrete, singular, distant point without need for a center pole to mark a location against the horizon.

Eddy failed to see the importance of the outliers that Grinnell had mapped fifty-two years before. Grinnell's paper shows no comprehension of the astronomical value of these outliers, but he did note their presence.

The two observations together (Eddy's alignments of the wheel proper and Grinnell's observation of the outliers' existence) give more possible astronomical validity to the wheel's use than either investigation does separately. Neither investigator was

skilled, however, in long baseline skywatching.

Nonetheless, few astronomers questioned Eddy, perhaps assuming he'd done all the necessary steps, the same steps they themselves would have executed. Eddy's academic training was in solar astronomy, however, not in direct, naked-eye, observational astronomy. This means that although he could recognize an astronomical tool used in skywatching, he might not possess advanced skills in wielding that tool. Nonetheless, Eddy and his family began the application of Western science methods at the Wheel, bringing its astronomy connections into the public consciousness.

John Brumley, a consultant with expertise in medicine wheels, had another criticism of Eddy's work. He believed Eddy's error margin for the stars' alignment to stones to be so large as to be statistically irrelevant.[164] Allan Fries and Jack Robinson both believed the refraction of light at the horizon would altar the visible angle of the observed stars to a different degree than Eddy had proposed, making the alignments to a specific direction in need of more rigorous analysis of refraction angles. [165]

Eddy used formulas for the light extinction of stars during their heliacal rise based on Sir J. Norman Lockyer's 1894 book rather than having his own knowledge of light extinction at the wheel site. He used Gerald Hawkins' star chart made for Stonehenge and did not understand that the star Capella was not always circumpolar at the Big Horn Medicine Wheel due to height of the landforms to the north. This caused him to miss the potential for alignments to Capella. This is an important zenith star because it 'maps' the wheel navigationally for its latitude on the surface of the earth. If one was to use the stars

to navigate to the wheel from Canada or from Mexico, Capella is the star they would aim toward.

Capella is the *only bright star directly overhead* of the Big Horn Medicine Wheel. Eddy didn't notice either of these details (that would be foundational knowledge to a skywatcher) and therefore had no reason not to go with published tables of light refraction for heliacal stars based on other locations. Eddy was following the established norms in physics research.

Eddy, however, was, in general, well aware of his paucity of skills,

> Entering a new field with a degree in another [field] is not unlike Lewis and Clark walking into the camp of the Mandans. You are not one of them. They distrust you. Your degree means nothing and your name is not recognized. You have to learn it all from scratch, earn their respect, and learn a lot on your own. But I also think that many of the most significant discoveries in science will be found not in *but between* the rigid boundaries of the disciplines: the terra incognita where much remains to be learned."[166] *[Emphasis added.]*

Eddy was not an archaeologist nor trained in skywatching, but he had an intense interest in how people of the past viewed the Sun. Eddy's willingness to go beyond his own academic field enabled him to connect a historical set of Sunspot observations to more recent observations, thus becoming famous in the late '70s when he discovered the correlation between Sunspots (dark-appearing magnetic surface eruptions on the Sun) and the mini-ice age in latter 17th Century Europe. He coined this cold period of low Sunspot numbers the 'Maunder Minimum' after an English observer E.W. Maunder, who along with G. Sporer, a German, pointed out this Sunspot behavior in 1890.[167] In the 20th century people desired to believe the Sun was a stable, unchanging star just as they had once desired the earth to be a non-moving center of their universe. Even with his death in

2009, Eddy's work on the Maunder Minimum and the Sun's variability over time continues to influence computer modeling of global warming by introducing the added variable of a cyclic Sun.

Eddy learned of the Big Horn Medicine Wheel when he saw a short article in the Denver Post Sunday magazine. He thought he recognized an east-west symmetry in the design that caused him to think about Sunrise/Sunset positions. "…as soon as I asked the archaeologists about it, and the anthropologists, they would tell me right away that there's absolutely no point in looking at it. That it had been there too long, and too many people had looked at it already and learned all there was to know. And this notion of astronomy and sky-oriented alignment wasn't going to work out anyway."[168]

Having a good mind and being skilled in using mathematical calculations and multi-wavelength solar images in research does not alone give one a background and skill-set for research methods in direct observational astronomy. Eddy's actions again epitomized another concern of archaeologists; research methods for the field of archaeoastronomy should establish common standards for evaluating the claims of their cross-disciplinary research.[169]

Eddy's work on the wheel epitomized archaeoastronomy from the archaeologists' point of view. The quickness of his perception of the astronomy at the wheel contrasted to years of archaeologists' thoughtful research, making Eddy's work seem too quick to be true. There was also the problem with little to no connection with the culture of those who built the wheel. Keith Kintigh points out, " In social science, the generation of facts—astronomical observation and identification of alignments—is easy…however, it

is my suspicion that it will be difficult to make rigorous and testable arguments linking archaeoastronomical observations with serious anthropological questions."[170] These 'easy' alignments *would be* easy if the sky repeated its patterns in simple ways, but it does not. Creating (or recognizing) an accurate calendar would only be 'easy' if one had the skills of a master skywatcher. Eddy did not show he was this adept, yet he had sufficient skill to see and propose what archaeologists had not.[171]

Jack H. Robinson, 1980s-90s

Others stepped in to continue the rigor where Eddy left off. When Allen Fries adjusted for refraction inaccuracies, he derived a date of 1270 AD that he believed was more accurate astronomically and a bit closer to the oral histories of the people who now lived near the wheel.[172]

Two decades after Eddy, a careful skywatcher, Jack Robinson, proposed the most accurate calendric scheme. Robinson was an astronomy professor from the University of South Florida who taught archaeoastronomy physics. The rigor of his techniques exceeded those of previous researchers. Robinson discerned appurtenant star alignments by constricting the timeline of possible dates of skywatching at the wheel to only those years when *all the wheel's cairns* line up with major bright stars.[173] He found that if all the cairns of the wheel and all of the chosen bright stars were *required* to align within the same year and within the same warm season when the wheel would be in use, then the times in history when this could happen would diminish the uncertainty significantly. This new method increased the statistical validity of the cairns' association with stellar

alignments and increased the likelihood that the builders designed these large, spoked wheels in Canada and Wyoming for astronomical purposes.

To the non-adept skywatcher, alignments with astronomical objects may seem haphazard due to the common misconception that a homogenous plethora of celestial objects exist in all directions from the observer. David Kelley and Eugene Milone, state, "All wheels that show characteristics that suggest astronomical intent also have cairns or alignments that are still unexplained archaeoastronomically. This weakens the case for accepting astronomical purposes underlying these monuments. If *anyone could offer* probable astronomical explanations for any of these unexplained alignments, the case for accepting the interpretations of Eddy and others would be correspondingly strengthened."[174] *[Emphasis added.]* Strangely, these are the same authors who wrote the only encyclopedia of archaeoastronomy, referenced Robinson's article in their bibliography, and yet still failed to realize their desire had been satisfied by Robinson's conclusions.

The encyclopedia's bibliography lists the abstract of Robinsons' 1986 paper as included in Aveni's collection of papers from the 2nd Oxford Conference on Archaeoastronomy, but Kelley and Milone must not have seen Robinson's full article nor soaked in the astronomical rigor of Robinsons' investigation. Robinson indeed addresses the unexplained cairns, but even Aveni seems to have forgotten Robinson's contribution. When in 2008, Aveni publishes a textbook on New World Cultural Astronomy, his first chapter is Eddy's 1974 paper with the reprint of the question marks listed in the columns concerning the cairn alignments that Robinson later deduced. Two decades later, the very

archaeologists who once cited Robinson forgot that this astronomer, not Eddy, had the last uncontested version of the astronomical alignments at the Big Horn Medicine Wheel.

Summary

Western science publications are the keepers of Western science research history at the Big Horn Medicine Wheel. Those who have studied the Wheel using Western science methods include the anthropologists Stephen C. Simms and George Bird Grinnell. Their research attempted to find connections between Plains Indian cultures and the Wheel. Two archaeological excavations have taken place at the Wheel. The Wyoming Archaeological Society in the mid 1950s and in the late 1970s, Michael Wilson. Neither excavation found enough artifacts to reach conclusions about why or when the Wheel was built.

The solar astronomer John Eddy published the first paper with detailed Western science methodology about the solstice Sunrise at the Wheel. Both Eddy and the astronomy educator Jack Robinson published research on heliacal star alignments. Robinson also published on a similar wheel called the “Fort Smith” Wheel, showing the relation of the Fort Smith Wheel to the Big Horn Medicine Wheel. This is the Wheel built by Scarface, described in Crow histories.

The most recent publication was Robinson’s 1986 paper. Twenty-three years later in 2009, Western science research for my study began. That research is the subject of the next chapter.

Images



Image 5.1 Forest Service Road: showing old travois trail just to the right, near the top.

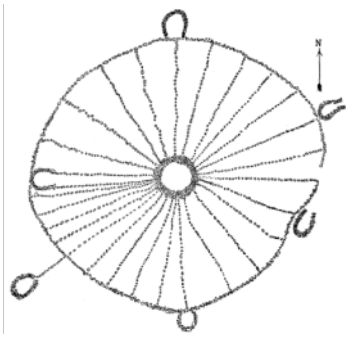


Image 5.2 Grinnell's 1922 Drawing of the Wheel.

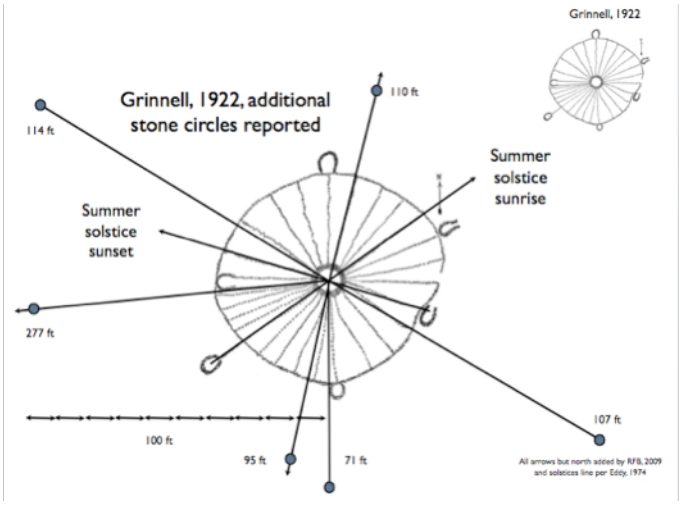


Image 5.3 Outlier Cairns.

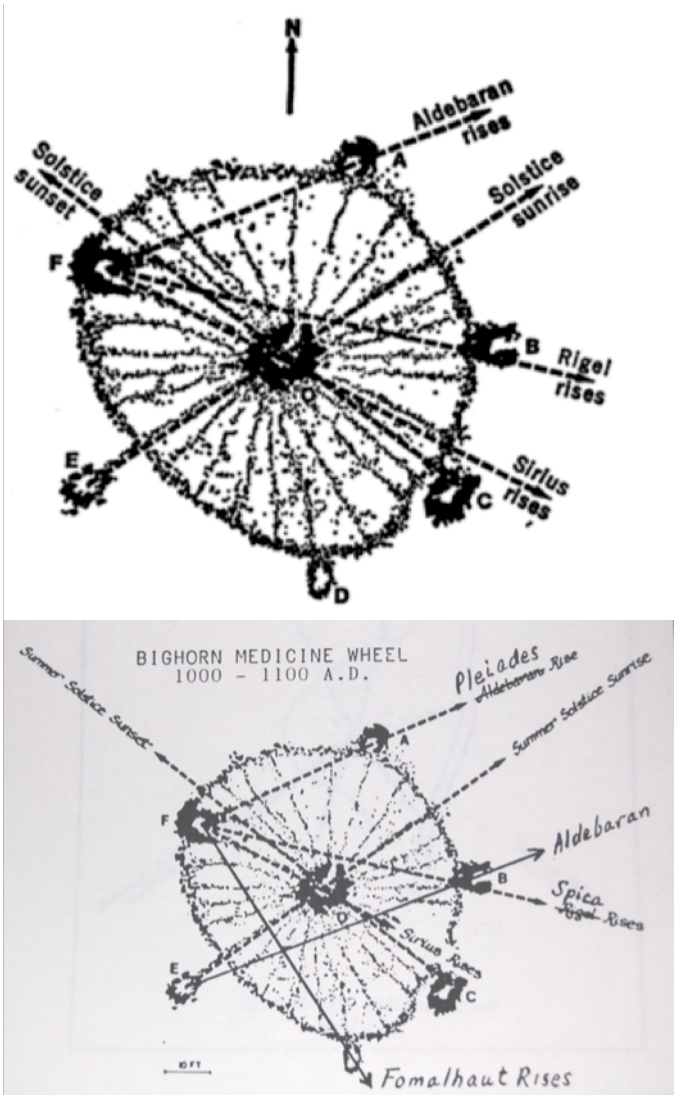


Image 5.4 Top: Eddy Alignments from *Science*, 1974;
Bottom: Robinson's Modification of Alignments.

CHAPTER SIX

INVESTIGATING PLACE-BASED SKYWATCHING PEDAGOGIES AT THE BIG HORN MEDICINE WHEEL

The investigation of place-based pedagogies at the Big Horn Medicine Wheel described in this dissertation began with Western science methods and moved into a broader Native Science approach as the five-year study proceeded. Before visiting the Wheel, I familiarized myself with diagrams, photos, and maps. After scrutinizing the astronomy, geometry, and archaeology of peer-reviewed journal articles, forest service files, and Wyoming State Historic Preservation Office archives, further references were located in papers found in museums in Canada, Wyoming, Montana, and Illinois.

For the most part, popular websites were avoided except for web-accessible tribal oral histories, such as those on the Bighorn Tribal College Tribal Histories Project website. Conversations with Native Peoples of Montana, Wyoming and Idaho afforded the opportunity to be responsive to body language and tonal nuances when listening to verbal accounts that would not be recognizable when reading written accounts.[175]

My investigation is best identified as "exploratory research." Gary Theisen and Don Adams explain the difference between four types of educational research, describing exploratory research in the following manner:

> The purpose of exploratory research is to generate hypotheses or research questions rather than to test propositions or find "answers." In their exploratory efforts, researchers examine the utility of new paradigms for organizing or studying data that describe a process or product. Exploratory studies may synthesize or extrapolate data to define issues that need further analytical, evaluative, or exploratory research. "In contrast to searching for cause-and-effect or functional,

> dependency relations, exploratory researchers try to identify, for example, ***associations that have not yet been recognized or understood*** among educational actors, relationships between educational interventions and the educational system, or ones between the educational system and its environment."[Emphasis is my own.][176]

Exploratory research is primarily qualitative, however, this research includes a quantitative component in that it provides numerical results from Western science experiments in archaeoastronomy. These results support the main question of this dissertation that asks whether the Wheel can act as a pedagogical instrument. To answer this question, experiments were created to bring to light whether the Wheel could instigate knowledge generation about the sky-earth relationship, primarily by its placement in context with the landscape. That is, could it act as a place-based pedagogical instrument for learning about the sky?

Those interested in how the Wheel's pedagogy would work on an un-schooled mind will have to look elsewhere. All of the researchers working on this dissertation's study had previous knowledge of celestial mechanics.[177] Textbook knowledge in astronomy helped plan the viewing of specific celestial events and helped with creating hypotheses to test. However, the Wheel provided its own pedagogy, unplanned by the research team. I found that my past knowledge gained from textbooks was *inadequate for making sense of new knowledge* gained by experiencing the sky at the Wheel. The following is my account of the making of new--and the breaking of old--skywatching concepts.

My background in teaching astronomy and operating a telescope gave a framework for analyzing skywatching details in written records. This is important. I did

not approach the Wheel with an un-schooled mind in celestial mechanics. One might think that a schooled mind would see things more quickly. Instead, the Wheel demonstrated the incompleteness of astronomy concepts found in textbooks. The real world, such as the Wheel, has its own lessons and we were fortunate to be hit hard with the reality of these differences. The Wheel in its contextual Place provided the desired end products of exploratory research, in that

- It generated new hypotheses and research questions
- It showed its utility to inspire new paradigms for organizing and studying data when describing the process of place-based learning
- It helped us synthesize and extrapolate data to define issues that need further analytical, evaluative, or exploratory research
- It helped, "identify…*associations that have not yet been recognized or understood* among educational actors, relationships between educational interventions and the educational system…[and] ones between the educational system and its environment."[178]

Previous Astronomical Research at the Wheel

John Eddy, a solar physicist interested in the history of astronomy, was the first scientist to approach the Wheel with all the tools of Western science in the early 1970s.[179] He measured the wheel, the angle of alignments between cairns, and used astronomical tables to determine the height of stars over time. He confirmed the stories and legends that the Wheel points to the solstice Sun on the longest day of the year.

The Big Horn Medicine Wheel's most characteristic element is its smaller circle of stones lying at a distance from the main Wheel, connected to the main Wheel by a line of stones. Standing in the smaller circle of stones and facing the center of the Wheel on the longest days of summer, the Sun can be seen to rise in alignment with the center of the Wheel.

It was already a popular belief that the Wheel was associated with the solstice Sun, but John Eddy was the first person to use Western science methods to secure objective data in evidence for this belief. He analyzed whether the popular beliefs held objective reality and concluded they did. In 1974, his peer-reviewed article in the journal Science gave the details of his rigorous approach. He took measurements, created data tables, compared his data to well established astronomical data, and analyzed his results. These steps were necessary to convince other scientists that hard evidence supported the Wheel's use as a solstice marker. Eddy dated the Wheel by heliacal stars and concluded the alignments favored a date similar to the carbon dating of a piece of wood found in the wall of a cairn during the Wyoming Archaeological Society's excavations of 1958. Eddy found heliacal stars aligned with some of the cairns and proposed they may be "warning" stars for the approaching summer solstice and the approaching autumn.[180]

Jack Robinson, an astronomy professor from Florida looked at Eddy's angles of alignment. In Robinson's classes at the university, he taught his students how to determine where stars would be located during past ages. His students used globes that showed not the earth, but the sphere of stars overhead. These star globes could be set for

any year, past or future, by changing the angle of the polar axis. The students could then "read off" the new star position as it appeared for any period in history. [181]

Using his globes, Robinson realized that Eddy's star alignments could be improved. Without ever visiting the Big Horn Medicine Wheel in person, Robinson executed admirable Western science research and carefully developed rigorous star alignments that stand undisputed today, thirty-five years after his report. And in fact, when I re-investigated Robinson's alignments at the Wheel, his star alignments held true when corrected for the passing of time.[182]

Eddy was present at the Wheel during the day, but we do not know if he watched the stars rise at the Wheel. When he was in military service, he was known to climb on top of the barracks and watch the stars at night, but whether he enjoyed the night drama at the Wheel is unknown. If Eddy would have watched the stars move over any entire night at the Wheel, he may have noticed the interesting behavior of one very bright star, Capella. Eddy had not considered Capella as an actor at the Wheel noting that it was not a possible heliacal star because it was a circumpolar star at this latitude.

The Capella Problem

Eddy died in 2010 and so I was not able to interview him directly but I was fortunate to share many ideas with Jack Robinson. One "problem" we were both interested in early in this investigation was the role the star Capella plays at the Big Horn Medicine Wheel. In my Masters paper, I stated that Capella, although it is circumpolar, might still play a part at the Wheel because of its interaction with the horizon. I knew this

from watching Capella from our Montana cabin only a few degrees of latitude north of the Big Horn Medicine Wheel. Capella is so bright that it often looked like a UFO hovering above the horizon, flashing a sequence of colors, looking very un-star like. Many people notice Capella, Deneb and Sirius playing these color-flashing games when they are near the horizon causing concern about their identity. Calls about UFOs come in when these three stars are near the horizon.

Robinson relates a story of a time when he took calls about strange objects in the sky. He is a member of the Skeptics Club in Tampa, Florida. They analyze information about celestial sightings and when Robinson took the call one night about a UFO that was throwing colors and hovering above the ground, Robinson answered, "Oh, that is Sirius." The caller thought he said, "Oh, that is serious" so she exclaimed, "I thought so too! That's why I called." Robinson chuckled to himself, but as a patient and practiced educator, he described to her the refraction of light in the atmosphere near the horizon. He explained how light traveling through moist air will separate into its constituent colors like light does when coming through a prism or a crystal hanging in the window on a Sunny day. We see separate colors rather than a rainbow because the temperature of air is not constant and therefore air molecules stay in motion. As the air moves, the part of the rainbow refracted towards the observer moves, sometimes only the blue is seen, then only the red. We see one color and then another instead of a blend of colors. Later at night the air temperature becomes more stable, and as the star rises higher into the sky, its angle to the observer is more direct, causing the starlight to travel through less atmosphere to reach the observer's eye.

The stunning show made by the flashing of separate colors cause people to stop and take pictures when they realize the “object” is not moving and it is not a plane. Even physicists, who know about refraction of light through the atmosphere if asked on a test, may forget to apply it when they see this star show event near the horizon. A photograph traveled the university email system several years ago while students and professors alike tried to discern what the object that “hovered above the horizon flashing colors” might be. None of the students learning the astronomy in textbooks had an answer. None of the professors were able to help them.

Three stars: Capella, Deneb, and Sirius do the flashy-color dance when they are near the horizon. Capella seemed too “wonderful” to be left out of the Wheel’s design. Although Eddy thought Capella was not involved in the Wheel’s alignments, Jack Robinson and I disagreed. Neither Jack nor I had yet been physically to the Wheel, but we had our suspicions that if the Wheel conversed about the sky at this latitude, Capella somehow had to be included in the conversation.

A year later, after three trips to the Wheel to survey the landscape and the starfield above the Wheel, Rob Bargatze and I flew to visit Jack in Florida and together, we three devised a research plan. Rob worked through topographical maps to analyze the northern landscape view from the position of the Wheel and Jack worked out the spherical geometry to analyze the altitude and azimuth of the mountain tops and ridges to the north of the Wheel. Jack made a side sketch of what he termed, “Capella Mountain” for us to use in our field research. The sketch showed us the angular height above the horizon for the mountain's ridge so we could compare it to the actual movements of Capella in the

sky above the real ridgeline. We were all certain our hypothesis that Capella would roll through the northern gap in mountains and interact with “Capella Mountain” was worth testing.

Our first official Western science research began in the summer of 2011. Rob made use of his electronic 8” Meade Cassegrain telescope to make measurements of the altitude and azimuth of stars as seen from the Wheel. The most interesting thing we found was that the horizon from the Wheel is much lower than we had thought it would be. It was under “zero” altitude. This meant the dip in the landscape to the north was deeper than we thought. Capella does not roll down into the dip, but it does hit the lowest point of its circumpolar path right above the center of the dip. If the Wheel was placed to the left or right by too many feet, this alignment would not happen. If this was a coincidence, it was also worthy of a hypothesis of its own to be tested further. Capella does interact with the ridge of “Capella Mountain” and would have interacted with this mountain for over a thousand years. This was worthy of more study as well. The details of this will be sent to a peer-reviewed science journal and brought before the international archaeoastronomy association for review in a future conference.

This dissertation is primarily concerned with the possibility of the Wheel acting as a pedagogical instrument in learning about the sky. Our Western science field research results showed that the placement and design of the Wheel could instigate learning about the sky. The Western science experiments done during this study led into Native science explorations. The Wheel as a pedagogical instrument was not limited to only Western science or Native Science methods.

Near the end of the first night of telescope use, the electronics in the telescope experienced a surge in voltage resulting in an arcing light between the ground and the telescope rendering the electronic part of the telescope useless. On later trips, non-electronic instruments were used.

The star Capella is the brightest circumpolar star at the latitude of the Wheel. After the Sun goes down, Capella is the first of these to "pop" out. As previously stated, a traveler using the stars for guidance would make use of Capella. It can be seen at night even under a full Moon when other stars are lost in the glow of Moonlight. It can be seen when the sky is foggy or slightly overcast and it can be seen all night long--it never sets. Capella is on all the northern hemisphere star charts of the ancient and modern world. It has played important roles in many cultural star stories. [183]

Scholars do not know the stories that connect the star Capella to the Big Horn Medicine Wheel. However, the geometry of the Wheel's geographical location, surface design, and correspondence with celestial patterns, suggest a part for Capella to play. Capella makes one circle in the sky each day. If the Sun did not blind us from seeing the stars, Capella could be seen to circle low on the horizon above the dip in the landscape to the north of the Wheel and then ride high in the sky through the point straight above the central cairn of the Wheel. This position straight above a location on earth is called the "zenith."

Capella's movement from the northern horizon (near zero degrees altitude) to the zenith (near 90 degrees altitude) traces out a circle in the sky that mirrors the circle of the

Wheel on Earth. Capella's mirroring of the Wheel would not occur if the Wheel was placed at a different latitude. (See Image 6.1.)

While other stars shift in position in relation to cairn and spoke alignments over the 24,000-year precessional cycle, Capella remains remarkably stable, hovering over the Big Horn Medicine Wheel's zenith for over four thousand years, changing less than three degrees in zenith altitude for years between AD 500 and AD 4500. Compare this to the majority of stars that are not circumpolar and move by a degree every seventy years.[184] Relative to the quick shift of other stars, Capella plays the role of the watchful guardian, staying in step with its earthly counterpart, the Big Horn Medicine Wheel. There are no mythologies known to describe Capella's relationship to the Big Horn Medicine Wheel, but with this mathematical, factual information, a story could be told, keeping all the scientific data exact while weaving a story of heroism and loyalty that would help each generation remember the relationship of this star to the Wheel.

Table 6.1 shows the changes in the highest and the lowest points Capella reaches in the sky for different eras.[185] Note the period between AD 500 and 4,500 shows a small <3-degree difference in Capella's zenith altitude position with Capella remaining near 2.5 degree in horizon altitude position. Capella has a proper motion of 0.0752 arc-sec per year in Right Ascension and 0.4268 arc-sec per year in declination. However, the reason it stays a zenith-horizon star for so many millennia is due to its angular separation from the center of the precessional circle of polar stars. This distance is termed, "ecliptic latitude" and for Capella this angular separation is 22.53 degrees. Other stars that share this ecliptic latitude will also remain a zenith star for longer periods of time than stars

with greater or lesser ecliptic latitudes. Stars within a couple degrees of Capella's ecliptic latitude include Epsilon Serpens (Serpens Caput), Algol (Perseus), Alpheratz (Andromeda) and Enif (Pegasus). However, none of these stars have Capella's brilliance in the pre-dawn, post-Sunset or night sky. Capella draws attention as soon as the Sun fades in the evening and is one of only four stars visible in the pre-dawn glow after the Sun whitewashes the remaining stars from the sky.[186]

Capella and Vega

The history of astronomy is full of predictions. For example Thales predicted a solar eclipse that ended a six-year war, Haley predicted the return of a comet that now bears his name, etc. Predictions are made possible by knowing the repeating patterns in the movements of celestial objects, making it possible to predict when an object will return and where it will be seen. The federal designation of the Big Horn Medicine Wheel labels it as a *Historical* Landmark and Sacred Site. However, the astronomy capability at the Wheel suggests a prerogative for adding the label that designates the Place for the *future* as well. The alignment for future celestial events can be found in the design of the Wheel. I am not proposing this was the original builders' purpose, but I am saying that the Wheel's design is able to predict future astronomical events.

One of these events is the northern alignment in c AD 4000 of two of the brightest stars in the sky that are also stars particularly associated with the Wheel: Capella, for reasons already discussed, and Vega for its importance in the precessional cycle. (See Image 6.1.)

The "Sweet Spot" Near 45 Degrees Latitude

The latitude of the Big Horn Medicine Wheel on the surface of the Earth at 44 degrees 49' 32" N makes this long zenith event for the star Capella possible. If the Wheel was placed at a lower or higher north latitude location, a zenith star would shift away from the zenith much more quickly. The sweetness of 45 degrees also bears the best latitude for the stretching of star angles over the precessional cycle, giving the skywatcher the widest angles for measuring the change in stars over the change in years. For example, at 45 degrees latitude the distance between a star rising in 1000 BC and AD 1000 would show a larger measurable change along the horizon than the same two stars when viewed from the equator. Forty-five degrees (north or south) latitude is ideal for skywatching if the skywatcher is interested in tracking the long cycles of 24,000 years that affect the seasonal shifts in the precession of the equinoxes

Star Group Paths

While exploring a pedagogical approach to help those new to skywatching determine where stars may rise in their own backyard, I discovered that the Big Horn Medicine Wheel provided the template. Conversations had started about building an astronomical wheel at the Headwaters of the Missouri State Park near Three Forks, Montana. Anne Ore, a park interpreter asked me to share ideas about the workings of an astronomical wheel with the public during a weekly interpretive program at the park. During my efforts to create a pedagogy that would help the transfer of sky knowledge and wheel design, I found the Big Horn Wheel's design was the pedagogy. I needed the

people who would participate in finding the location for a new wheel to know what to look for when stars became visible after dark. I would have them spread out all over the bluff in an attempt to catch the right angle for stars aligning with prominent landscape features.

It is windy up there and I knew whatever pedagogy I used it would have to do its own work after a brief introduction. I decided they needed a map to orient themselves, so I drew a circle to mimic the horizon around them. Then I wanted them to have an idea where to look for major stars at the latitude of the park. After a bit of work with software that shows the path of stars for any latitude, I drew the possible locations of the brightest or most important stars for their latitude.[187]

To my surprise my map looked like the design of the Big Horn Medicine Wheel. The eastern rising of bright stars at both locations happened exclusively in two paths that matched the angular dimensions of the two eastern cairns of the Big Horn Wheel. When learning astronomy from textbooks, a student does not learn the path of stars based on a specific latitude or place but in a Gods-eye view as if the student could see all the stars at once from the center of the earth, without the earth being in your way or the Sun blocking your view. While I built the map based on Western science information about the path of stars at the park's location, I found that the finished product was an instrument bearing the same design as the Big Horn Medicine Wheel.

Some aspects of the Big Horn Medicine Wheel's design are extremely specific to its location on Medicine Mountain, such as Capella's rotation through the northern horizon's dip. However, other features, such as the star bands are more broadly

applicable to latitudes near 45 degrees north, depending on the horizon view, anywhere on earth.

This, in part, supports my dissertation assertion that the Wheel acts as a pedagogical instrument for learning sky-earth relationships. The position and size of cairns along the perimeter rim of these wheels are useful in helping novitiates learn where stars will likely come up in the east.

Long Baseline Sighting of Cairns

Critics of Eddy's solar and stellar alignments considered the angular variation too wide to be considered useful for astronomical purposes. Eddy thought that perhaps a pole could be set in the center of the center cairn to narrow the angle and make it accurate to the position of the Sun or stars. I found this argument to be unnecessary. The center cairn is quite large and the critics are correct that the angle is wide if you are standing in another cairn or along the rim. However, this is a spatial problem, not easily understood on paper but quite easy to see when you are standing at the Wheel. All that needs to be done to decrease the possible angle to a tighter accuracy for tracking star positions, is to step back.

Place your finger in front of your eye and use the tip of your finger to block out an object at the other side of the room. Slowly push your finger away from your eye until your arm is fully extended. Notice how the finger takes up less and less space and covers less and less of objects at a distance? This is how long baseline sighting techniques work.

You can take a messy tumble of stones and if you retreat far enough from it, that messy group of stones will become a small, specific point in front of you.

The Big Horn Medicine Wheel has cairns at a distance from the main Wheel. Grinnell reported these "outliers" in 1922 and approximate measurements to them were listed.[188] Rob Bargatze made a diagram showing as much detail as Grinnell had afforded and these cairns were found to be in significant directions for tracking star positions. (See Image 5.3)

My own concern was that this site was used for vision quests in historical times and that perhaps cairns that were made originally for star-tracking were changed for vision quests. The more time I spent at the Wheel, I realized this would not matter. The major paths for stars are easy to determine and long baseline site lines could be adjusted during a single skywatching period. Multi-use of the Big Horn Medicine Wheel would not altar its usefulness in tracking stars. It is primarily the position on the landscape, as we will soon see, that carries the burden of correspondence to the celestial sphere as seen from the Wheel's location.

The Wheel as a Calendar

Twenty-Eight Segments –Stellar Stations

The Big Horn Medicine Wheel currently has twenty-eight spokes made of stones radiating out from the central shelter, culminating at the rim. Only one spoke goes beyond the rim and that one connects to the small circle of stones that is the "feather" end of the arrow that points at the rising Sun on the summer solstice.

The Wheel was reported to have twenty-seven spokes in the early 1900s by both Simms (1903) and Ransom (circa 1924). For use as a calendar, either number of spokes works well. The number of spokes may relate to the days of the Moon through its phases as seen from earth.

The Moon takes 27.3 days to orbit Earth, but the lunar phase cycle (from new Moon to new Moon) is 29.5 days. The Moon spends the extra 2.2 days "catching up" because Earth travels about 45 million miles around the Sun during the time the Moon completes one orbit around Earth.[189]

Either twenty-eight or twenty-seven would still represent the Moon's actions. However, the change in width between the spokes speaks of something more rigorous in the Moon's actions. The irregularity of width between spokes triggered, for me, a visual correspondence to the irregular separation between star groups in the night skies.

I decided to look up the separation between constellations to determine if what I was noticing at the Wheel under the starry dome in fact had a Western science component already mapped out by hundreds of years of astronomers with their measuring tools. I assumed the separations did not relate to the zodiacal stars that lie on the path of the Sun because there are only twelve of them. I was surprised to find that in the most ancient of calendars, the sky was separated into twenty-seven or twenty-eight sections. I found images of these calendars from India, Korea, and China and information about the width of the separation between these segments.[190]

I created a model with transparent paper that showed the ancient Indian "Nakasutras" and laid this on top of a diagram of the Wheel, knowing that a flat diagram

of the Wheel would not be totally accurate as the spokes really lay on a curved surface and also reminding myself that I did not know the latitude where the Indian map was created. The latitude would altar the angle of the spokes. Understanding these limits, I still assumed major aspects could be similar because the width between sections may still have a recognizable pattern.

And it did. Large sections between spokes of the Wheel aligned with large sections of the ancient calendar; two small sections of the Wheel fell on top of two small sections of the calendar. This is a hopeful discovery that needs the angular mathematical details carefully studied. This quick jaunt into calendric history based on twenty-eight sections, showed a way to track time with the Wheel. The twenty-eight sections of this type of calendar are historically called “houses” or “stations” of the Moon. This is because the Moon abides in each station during its monthly trip around the earth. Because the Moon’s monthly trip around the earth cannot be counted in whole days (there is always a fraction of a day before its trip is complete), trying to count days with the Moon is always bothersome. However, defining where the Moon is according to the stars can be straightforward.

The full cycle for the phases of the Moon do not take the same time as the Moon’s orbital cycle through the stars (as seen from earth). By dividing the sky into twenty-eight segments, the Moon can be tracked for both phase cycle and for orbital cycle. Its orbital cycle can be compared to its location to the background of stars and its phase can be seen visually by watching which segment of the sky the Moon is stationed as it changes

through its phases. By watching where in each segment of sky the Moon's phase cycle and orbit cycle are stationed, patterns for eclipses can be determined.

The Moon's path in the sky is near the Sun's path but not identical with it. It has nodes where its path and the Sun's path cross. If the Moon hits one of these crossings on the Sun's path while the Sun is present at that same location, then an eclipse will occur. The Moon and Sun are not actually at the same place but appear to be in the same place. The Sun is much farther away than the Moon. This description builds the picture of the Sun and Moon's movement as seen from Earth. An eclipse on Earth would not make an eclipse on another planet. The Moon only blocks out the Sun from an Earth surface point of view.[191]

The Korean calendar with its twenty-eight segments was overlaid with the Big Horn Medicine Wheel's spoke arrangement. Many segments of the Wheel coincide with this type of segmented calendar. (See Image 6.2)

The Moon is not the only celestial object to be tracked with a twenty-eight-section calendar/star chart of the sky. These sections are useful in tracking the Sun and the planets and the angle of comets and asteroids. Dividing the sky into twenty-eight sections corresponds to the actual sky as viewed from this area of our Galaxy.

The system used by Western science today, approved by the International Astronomical Union (IAU), divides the sky into segments that have no correspondence to the actual sky. It would not be an overstatement to say that the older calendar based on twenty-eight sections took the larger solar system view rather than the view only from Earth. Crazy as it sounds, the twenty-eight sectioned star chart could be used without

alteration for any planet, Moon, or asteroid. The twenty-eight sectioned star chart does not have to be updated for tens of thousands of years while the one we use today needs to be updated continually.

The twenty-eight sectioned star chart divides the sky into *varying* width sections based on visible, easily observed asterisms. The IAU divides the sky into non-varying width sections based on a mathematical grid imposed on the sky, ignoring visible asterisms.

Dividing the Sky

There are four systems for dividing the sky:

- You-based (altitude--azimuth)
- Earth-based (declination—right ascension)
- Sun-based (ecliptic latitude—ecliptic longitude)
- Star-based (28 segmented asterisms)

When a novice learns the sky, it is easier to find objects if given "you-based" system of coordinates because the directions for finding a planet or star would simply be, "look along the horizon until you get to a certain point and then look up a certain distance. Finding a star this way is a two-step process. You move along the horizon a certain number of degrees (this is called the azimuth) and then look up perpendicular from that azimuth a certain number of degrees (this is called altitude). You go along a horizon and then you go up into the sky. This type of coordinate system is called the azimuth-altitude (Alt-Az) "you-based" system. The problem with the Alt-Az system is

that the star will only be located in its Alt-Az coordinates for a brief time because of the spin of the Earth. An hour later, these Alt-Az directions no longer align with the object.

The system most used today for computerized telescopes uses a database of coordinates called declination (Dec) and right ascension (RA). This type of coordinate system is called the declination-right ascension (Dec-RA) "Earth-based" system. These coordinates are measured relative to the Earth's equator projected into space. This "Earth-based" system remains accurate much longer than the "you-based" (Alt-Az) system, but does lose accuracy over a few decades. Celestial objects slide away from their RA and Dec coordinates before an object's path in the sky can be closely studied. However, computer software adjusts for this "slide" and can calculate the present Dec-RA coordinates.

In this system, it is mathematically difficult to discern which stars are moving faster or slower or in different directions without computer assistance. This "Earth-based" (Dec-RA) system is used by computer-controlled telescopes.

The ecliptic, "Sun-based" system assigns coordinates relative to the Sun and the plane of the Solar system. This "Sun-based" system would be the system of choice for telescopes mounted on any of the planets, Moons and asteroids in the solar system.

The "you-based" system works well over minutes; the "Earth-based" system works well over decades; the "Sun-based" system works well over centuries; the "star-based" system works well over *tens of thousands* of years.

In the "star-based" system, any faster moving stars or a change in their direction of an object (proper motion) would be readily apparent without needing a computer to

calculate the coordinates. The star-based system is the one used by ancient skywatchers who kept track of thousands of years worth of time and knew their society's place in those long cycles.[192]

If the "star-based" system would be the superior system to use over long periods of time, why then do we use inferior systems today? When telescopes first looked at the sky, the Western world assumed they were the first people to use this technology and created systems that worked with their new technology, unconcerned with the usefulness of ancient systems that they assumed were not applicable to their "advanced" technology.

Later, with computers to do the work directing their telescopes, astronomers were more interested in what they could "see" and analyzing the light from these objects to determine the physics at work. The compelling questions were related to light years, not Earth years.

Those who rarely look at the real sky may not notice the comparative effectiveness of these four systems. The TLRBSE (Teacher Leaders in Research Based Science Education) astronomers at Kitt Peak in 2003 are an example of this.[193] The objects they studied were located by using computer-controlled telescopes and RA-Dec coordinates, adjusted for the exact night of the observation. Once the computer accepted the RA-Dec coordinates and changes were made for the date and time of viewing, the computer sent the telescope a message to begin to move toward the target. Gigantic gears moved the entire roof of the observatory to point it toward the object under study.

The astronomer and science teachers present that night had a few minutes while the telescope's camera took a long exposure of the object. They left the telescope control

room to view Arizona's dark skies on the top of Kitt Peak. While standing around, looking at the star-studded inky blackness, one teacher asked the astronomer, "Where is the object you are studying?" The teacher wondered where in the real sky, the object, whose coordinates were just plugged into the computer, might lie. The astronomer looked left, then right then behind himself. He finally said, "I don't think its up yet." Among the teachers were a few who knew their way around the real sky.

After exchanging covert glances of our incredulity and wonderment of how to best approach the astronomer, one finally said, "Didn't we just point the telescope to it? Doesn't it have to be above the horizon for the telescope to take a picture of it?" A short, uncomfortable silence ensued while the astronomer, caught in his ignorance about the real sky--but worse yet exposed for his inability to find the location in the sky above his head of the object he had spent his career studying. The story ends well. The astronomer, being quite clever, said, "Well, in that case, let's look where the telescope is pointing!" Everyone laughed and everyone realized this was the most profound learning moment of their trip to Kitt Peak's observatories. The science teachers found that astronomers do not necessarily know anything about the sky above us—even when it pertains to the location of their own object of study.

In our study of the Big Horn Medicine Wheel, the twenty-eight divisions stimulated a deeper consideration of the "star-based" view of the universe.

We wondered why one system might be preferred over another with the resulting answer being that for skywatchers who look at the real sky and desire to track changes in

position of celestial objects, the "star-based" system using twenty-eight segments makes for easier star tracking.

Organizing Sky Information

The Big Horn Medicine Wheel is able to organize information about the sky by using a common method of grouping stars. The night sky is not a homogenous scattering of celestial objects with all the same color and brightness, all spaced evenly apart. If this were the case, a simple circle with evenly spaced radiating lines would suffice for star tracking. The stars in the real sky are found in clumps and groups, in varying colors and brightness, and in patterns that resemble creatures of the earth.

The star fields shown in Image 6.3 show the stars that reside above the north pole axis of the solar system. Notice that the night sky does not have a homogenous scattering of stars in all directions. It has specific brightness and colors and groupings of stars. These groupings have been visualized as characters in mythologies as a way to keep track of celestial "plots," i.e., the movements of celestial bodies. Individual stars in the character groups can be connected to make asterisms, easy to pick out in the sky. Placing a grid on these characters allows the detailed precision for investigating small movements over large amounts of time, aiding the tracking of celestial bodies: Sun, Moon, planets, comets, asteroids, and stars that move faster than the rest.

Stars are grouped into sets we now call asterisms.[194] Stars grouped together are visible on the earliest recorded star charts, in the first writings, and in mythologies concerning stars. The method of grouping stars into familiar patterns predates the grid of Western science. Other stars are harder to distinguish and harder to track unless some

sense is made of their connection to the asterisms. Adding a grid allows us to give each star a position on the grid and attempt to track them by their relative position to this grid over time. The grid has little to do with the actual stars and is an abstraction of reality created using Western science methods. (See Image 6.3 and 6.4.)

There is little about the grid that coincides with the stars' grouping patterns. The Big Horn Medicine Wheel's "grid" gives a better fit to the northern stars than the current Western science grid. (See Image 6.7.)

Northern Stars and the Ecliptic

Northern Precessional Circle

The ability to easily track stars and other celestial objects over long periods of time is not limited to just the twenty-eight spokes. The spokes work in coordination with the dimensions of the rim and the placement of the cairns of the wheel to produce a pattern that is reproduced from a pattern seen in the sky. Any culture living or traveling above 30 degrees south latitude (mid Africa) would have this celestial pattern available to them.

This change in orientation in the sky is due to the Earth's spin axis pointing in different directions, rolling as though drawing a circle in the sky over a period of 24,000 years. As the axis rotates, the crossing point of the ecliptic with the celestial equator moves clockwise as seen from this vantage point. The place where the ecliptic and the celestial equator cross, is termed the equinox. There is a fall equinox and a spring equinox. The constant movement of the equinoctial crossing is termed, "the precession of the equinoxes." (See Image 6.5) Today, our calendars shift our days so that we do not see

the drift of our equinoxes. This is not just a mathematical abstract notion. The shift of the equinoxes is important over time for the shifting of habitats and species on the earth for in 12,000 years, summer will be winter and spring will be fall. The seasons add a day forward every 66.6 years. Currently, our environmental researchers include this shift of seasons in their models for global weather and habitat changes.[195]

The importance of this circle is that the stars found on or near this circle will be the pole star at some time during a 24,000-year repeating cycle. This precessional circle is based on the stars, the plane of the solar system, and the path of the Sun through the star field over thousands of years. [196]

The Big Horn Wheel replicates this stellar pattern with white stones on the ground. This coincidence of design is curious in that even the flattened side of the Wheel is necessary for the stone pattern to match the star pattern. [197] (See Image 6.6.)

The stars along the rim of the Wheel show the most exact north pole stars or the brightest ones closest to the north pole at any one time in the precessional cycle. The few stars that become pole stars during a 24,000-year cycle are shown in the following image of the Big Horn Medicine Wheel. (See Image 6.7.)

The stars are in their correct angular measurement proportions from each other as they coincide with the shape of the rim of the Wheel. Deneb is the star that sits in the small circle of stones at a distance from the main Wheel just as it sits at this same proportional difference from the precession circle of north pole stars up in the sky.

There may be two reasons why astronomers looking at the Wheel did not notice this earlier. One reason is that the image is a mirror image of the sky, unlike the images

of the stars on modern star charts. Star charts are made to look like the star field when we look up at the sky. The Wheel's pattern is the mirror image. This is the pattern you would get if you were creating a reflection of the starfield with stones on the earth. Each piece of the pattern would directly correspond to its counterpart in the heavens. The Wheel is a mirror of the sky above, so that when you stand in the Wheel and look down, you are looking into a mirror of the sky above. This could have deep parallels in cultural ceremonies, as the people who placed themselves inside the cairn enclosures would be in direct correspondence with their celestial counterpart. Our current paper and computer star charts are not mirrors of the sky. They represent the view if you are looking up. Because I was used to thinking of the stars in the way they appear on modern star charts, it took me years to realize the Wheel was a mirror image of the sky, an exact one-to one correspondence of star light toughing the ground.

The second reason this may not have been noticed prior to this dissertation's research is that today astronomers, science teachers, media and others who share the natural world with the public rarely if ever give an account of the sky using the "star-based" system for tracking stars. Too caught up in our own era, few remember that Polaris is "the" pole star for only a few hundred years. Because Polaris is such a good pole star, in that it is so close to the place in the sky where the Earth's North Pole points, it was used effectively for navigation in the era of big ships and colonial powers. Tables were created to keep track of the shifting of stars for purposes of navigation and mathematicians were employed to keep these up to date and accurate with the real sky. There was no reason to change star charts and tables from an "Earth-based" (Dec-RA)

view because it was from that view that navigators saw their world. By the time telescopes became computer-controlled, the labor was given to computers to determine the change in star positions and so there was no reason to alter the method used for finding stars to a simpler method. Computer software makes quick work of adjusting the coordinates of a celestial object from any time and place on Earth.

In short, the precessional circle is not easy to pick out using the "Earth-based" system which is the one learned from textbooks. The "star-based" system makes the circle more obvious. People who wanted to create a calendar that would track celestial movements over thousands of years, would more likely pick the pattern the Wheel reflects. The Wheel's "star-based" system is the simpler system that needs no adjustment for latitude or time and would work over multiple precessional cycles.[198]

Design Elements of the Big Horn Medicine Wheel

Wheels made with the design elements of the Big Horn Medicine Wheel could be used as "signs" to share this information anywhere in the solar system without need for a common spoken or written language. The language of the sky is common across our solar system and across millennia, regardless of cultural differences. Wheels with the design elements found in the Big Horn Wheel are beneficial for use as a calendar and as a map, for locating one's position in time (minutes, hours, days, months years), for locating one's position on Earth or another celestial body (geo-latitude and longitude), and for locating one's position in space (celestial latitude and longitude).

Table 6.3 shows the many ways in which the Big Horn Medicine Wheel is able to act as a pedagogical instrument in learning about the sky. Astronomical functionalities expressible through specific design elements are listed along with other contextual aspects of the Wheel's Place that are needed for the design element to perform an astronomical function.

Discussion of the Design Element Table

Latitude and longitude in the headings refers to the *geographical* latitude and longitude of the Wheel's location on Earth. An "X" in a box refers to "yes." The x's represent the design elements researched in my study. A "P" in the box, means, "it is considered possible." The "P" represents hypotheses that are in the process of being researched. Empty boxes under the heading, "Longitude matters?" means that the design element would function regardless of the geographical longitude of the Wheel. The preponderance of empty boxes under the longitude heading show the Wheel could be moved to different longitudes and only the horizon and landscapes of the new location would alter the functionality of the design element. For example, if a new Wheel was created on a floating platform on the ocean, where the horizon was water in every direction, all the design elements that show a blank in the "Longitude matters?" column, would continue to work regardless of which longitude the boat found itself. However, if the boat moved north or south and changed its latitude, many of the design elements would no longer be trustworthy. Most of the Big Horn Medicine Wheel's design elements are latitude specific.

The abundant astronomical functionality of the design elements shown in this table satisfies my question as to whether the Big Horn Medicine Wheel could act as a pedagogical instrument for learning about sky-earth relations. Whether it was built originally for this purpose, I cannot say. I do find it interesting that the Wheel does a more thorough job of teaching about the fundamentals of celestial mechanics than any textbook I have ever used (or as yet seen) in college classes.

Summary

The sky at the Big Horn Medicine Wheel is visually more than half of one's total environment. The horizon creating the thin separation between land and space is literally under one's feet. Standing at the Wheel, one's whole body is immersed in sky. When looking across the Wheel, a fellow researcher is outlined in "sky." In the daytime, this equates to deep blue littered with fluffy white, at night this means black speckled with all colors of glittering stars. The sky and one's relationship to that Place on the mountain creates an immersive environment, day or night. When looking around at a star-studded night, it is impossible not to be struck with awe. Stars play a mystical role in people's lives. They even call their favorite celebrities and musicians "stars" due to both their inaccessibility and their ability to inspire.

Before the internet held human knowledge in the spatial arrangement of electrons and before libraries held knowledge with abstract symbols written in books, people held knowledge within stories. In the case of the Blackfeet Indians of Montana, these stories were kept in the library of the sky, in a vault organized by the seasons. In this way,

stories could not be forgotten for each was “seen” in the sky. Specific stories were meant to be told at specific times of years. The time of the telling would not be lost for as a group of stars came into view, the time to tell its story would occur. The organization of the sky kept the order of the stories.

To many cultures, the stars are magical, beyond our reach, where the gods live, where souls go, where we came from.

The Wheel as a Calendar

The Big Horn Medicine Wheel as a circular calendar keeps track of stars as they move across the horizon. The pace of stars’ movement along the horizon is different from the pace of the Sun, planets or Moon. The Moon tracks days and months, the Sun tracks seasons and the ending/beginning of year, planets track years and decades. Only stars track thousands of years. The twenty-eight segments of the Wheel are able to track the precession of the equinoxes.

The twenty-eight segments of the circular Wheel closely match the twenty-eight asterism sections of the real cyclical sky. This system reveals distinct changes in the movements of celestial objects through time and therefore is a more accurate skywatching calendrical device than the square, twelve sectioned, computer-created calendar that hang on our walls today.

The Wheel in its contextual Place includes the following calendric design elements:

- 28 spokes = sky grid
- central cairn = alignment center

- circumference cairns = watch points
- outliers = connect other watch points to landscape and sky for precision
- landscape + humans + sky = one system

Learning about the sky-earth relationship from the Wheel is not merely an action for tracking time, but tracking what changes in time means for humans living on this planet. A Wheel built on another planet could give information about living on that particular planet and so I make this distinction here. The Wheel is able to give information about changes over time that when connected to the current landscape and environment gives clues about where the future will take the environment. This concerns climactic changes and with it the movement of plant and animal species. Although humans now seem to think they are free from worrying about these changes because they can always import what they need, this is a modern fallacy of thought. The plant and animal world is interdependent right down to the micro world of algae and bacteria. The Wheel narrates the interconnectedness of plants and animals with the movement of our planet through space and time. This sounds like a grand idea, but in practice it is a fact of the geometry of the Wheel within its landscape. This is Western science, not poetic hyperbole. The Wheel is both beauty in symmetry and scientifically complex.

Reaching into Native Science, the view becomes more meaningful. Native Science involves human consciousness whereas Western science attempts to limit this involvement. Empirical experiences repeatedly show that human consciousness is able to take in more of the real environment than scientific instruments. For example, pilots crash planes due to their reliance on autopilots.[199]

Humans, as microcosms of the larger universe, possess an ability "to know." Descartes and Plato devoted much of their intellect to describing this attribute. As long as this is the case, we would be ignorant to disavow our own awareness and give our intellectual conclusions over to only those found through our machines, measurements, and instruments. The Wheel repeats themes seen in ancient cosmology all over the globe. These themes have been stored not only in its Western science geometry but also in oral histories and mythologies.

Humans' use of calendars tag tribal, national, and personal history to time. The Wheel is a simple and complex calendar, still capable of carrying on a time-history-future instrumentation helpful to human consciousness and survival. Alice Kehoe tells the story of when a Blackfeet man was asked if the tribe still had shamans who kept track of time. The man laughed, "Not since the bank started giving away free calendars!"[200].

Images

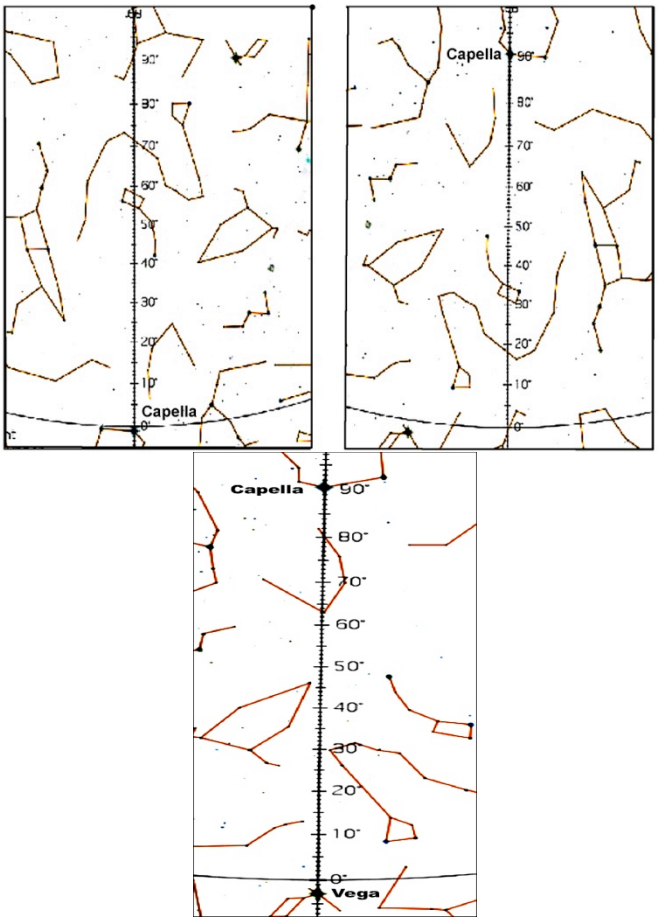


Image 6.1 Star Charts of Capella and Vega. Above: Capella makes a complete circle in the sky above the Big Horn Medicine Wheel. On the lower left, Capella is near the horizon at zero degrees and moving toward the right (east); on the lower right, Capella has just moved into the zenith position above the Wheel (90 degrees altitude) Below: Capella and Vega at circa AD 4000. Both stars circle above the Wheel, balancing a perfect 90 degrees between them.

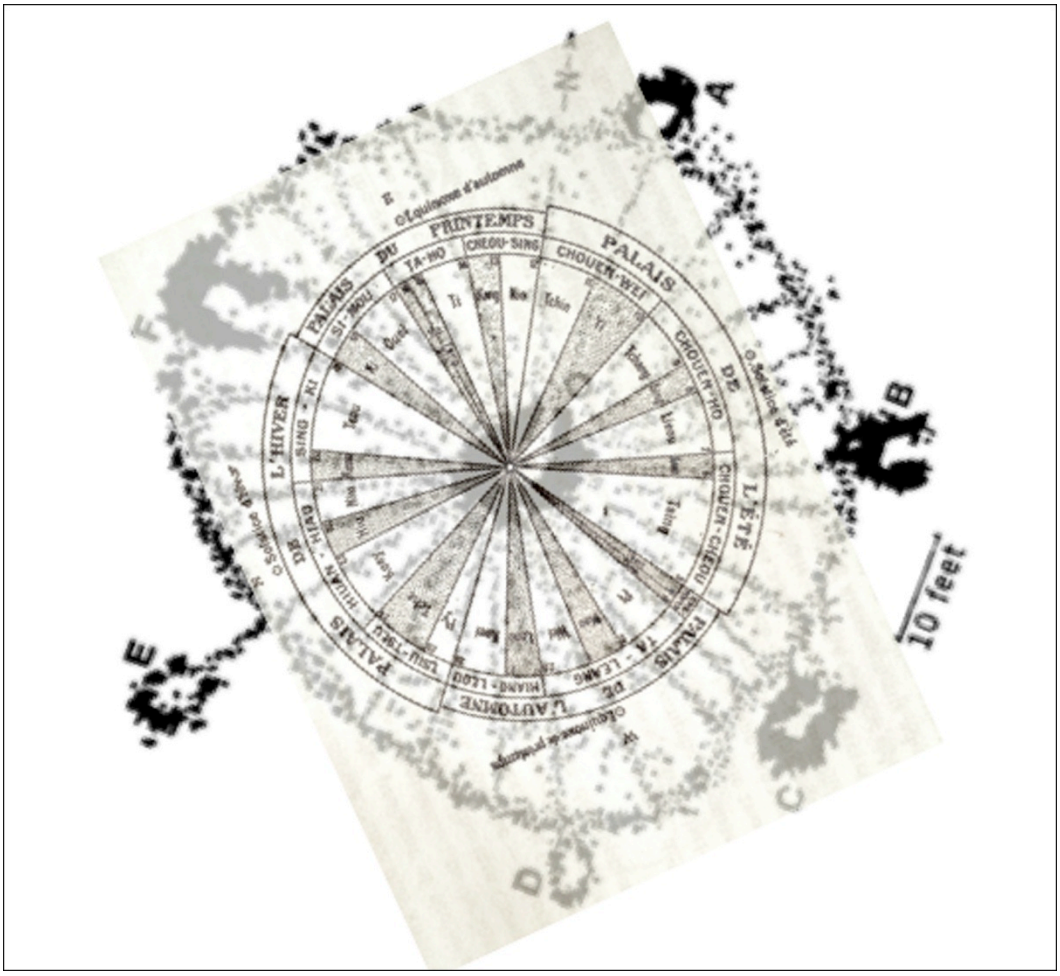


Image 6.2 Overlay of Twenty-Eight Segment Calendar Over the Big Horn Medicine Wheel.

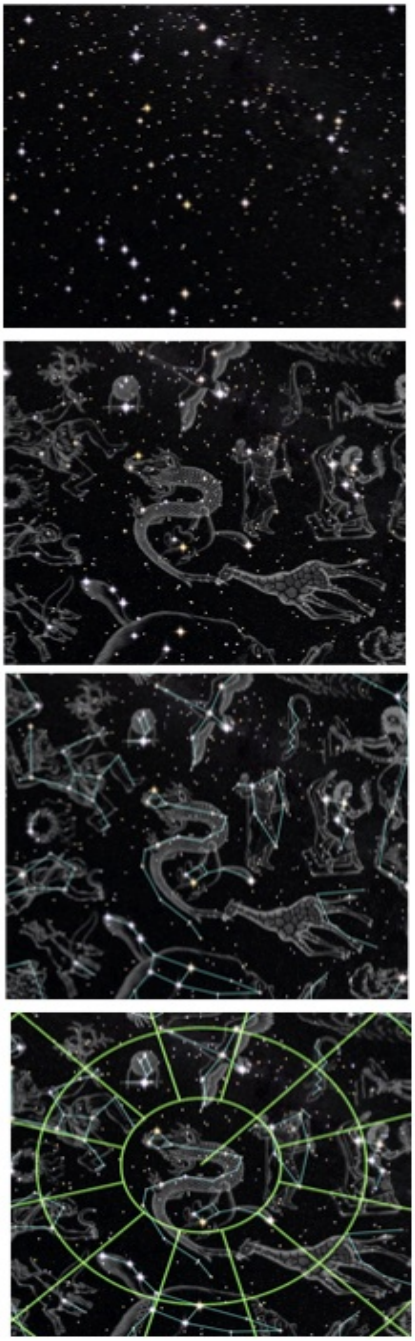


Image 6.3 Organization of the Sky Based on Images from Starry Night Software.

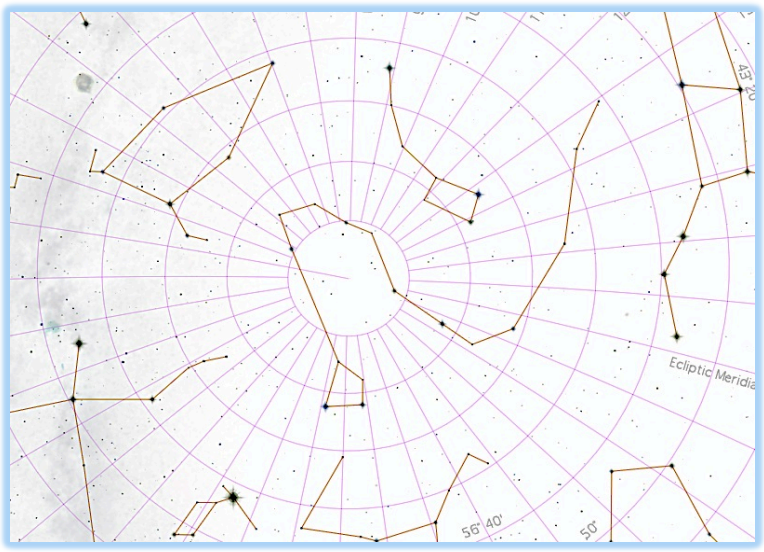


Image 6.4 Ecliptic Northern Circle Star Grid: Evenly spaced grid does not align with stars in the sky.

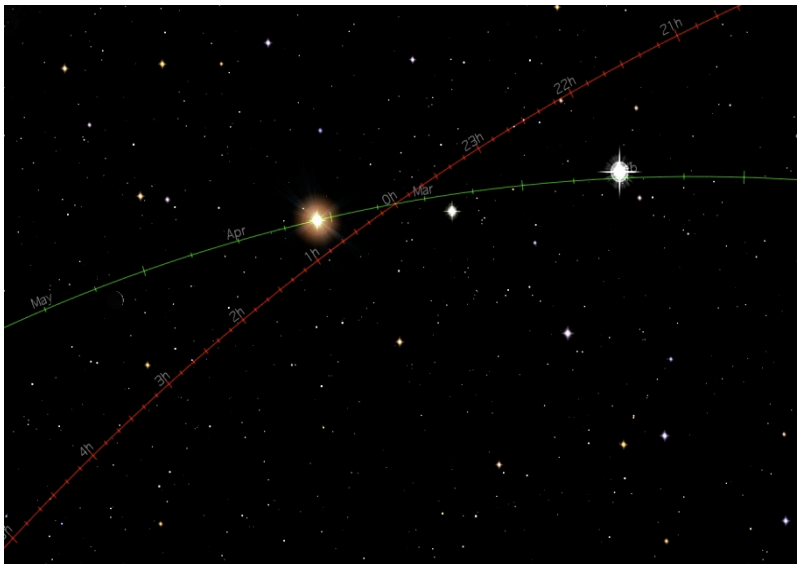


Image 6.5 Ecliptic Crossing Celestial Equator: the Sun is bright yellow on left of equinoctial point, Mercury is Star-like just right of the crossing, Venus is Star-like and bright further to the right. Pleiades and Taurus are to the far left.

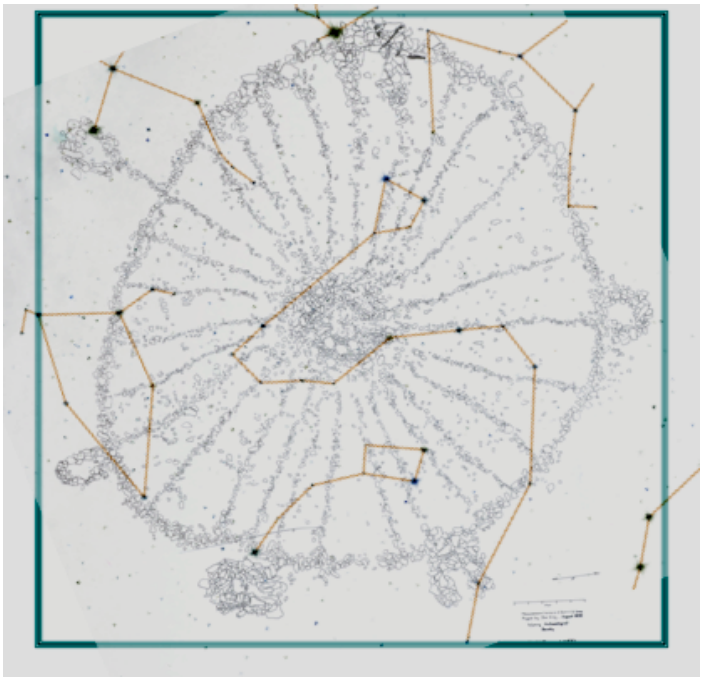


Image 6.6 The Overlay of the Ecliptic Northern Stars with the Wheel: created using the 1958 survey of the Wheel by the Wyoming Archaeology Society and a starfield created in Starry Night Pro 6 software.

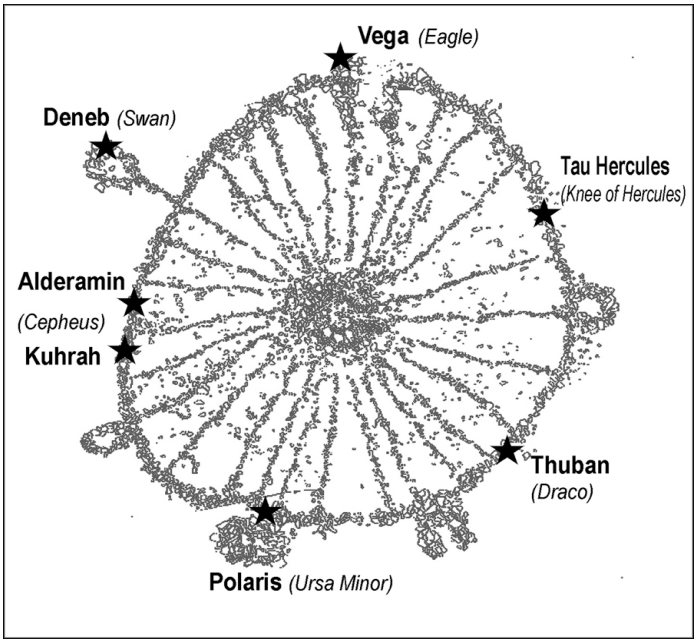


Image 6.7 Stars That Will Be North Pole Stars: The stars shown here will be north pole stars sometime over the precessional 24,000 year cycle.

Tables

Table 6.1: The Zenith Position of The Star Capella from 3000 BC to 6000 AD

Capella (Alpha Auriga)	**Date**	**Zenith** Above the Wheel	**Altitude** Above N horizon
	3000 BC	70* 06'	-19* 15'
	2000 BC	75* 31.5'	-13* 45.5'
	1000 BC	80* 34.5'	-08* 38'
	AD 1	84* 55'	-04* 14'
	AD 500	86* 04.5'	-02* 26'
	AD 1000	87* 59'	-00* 57'
	AD 2000	87* 35.5'	01* 11'
	AD 3000	87* 31'	01* 12.5'
Closest to zenith	AD 3800	88* 41'	00* 08'
Vega-Capella align on meridian: AD 4000	AD 4000	88* 12.5'	00* 52.5'
	AD 4500	86* 48'	-02* 20'
	AD 5000	85*	-04* 07'
	AD 6000	80* 04'	-08* 3.5'

Table 6.2 Astronomical Functionality Expressed
In the Design Elements Of The Big Horn Medicine Wheel

Astronomical Functionality Expressed	Design Elements Present?	Design Elements	Latitude matters?	Longitude matters?	Horizon/ Landscape matters?
Cardinal directions					
• Zenith star at zenith	X	central cairn, entire Wheel	X		
• Zenith star makes full visible circle horizon to zenith	X	central cairn, northern landscape	X		X
• True north	X	spoke			X
• Magnetic north	P				X
• East/West	X	cairn, spoke			X
• Solstice (time of the longest period of light)	X	SW cairn, central cairn, spoke	X		X
• Solstice (time of the longest period of dark)	X	outlier cairns, central cairn, spoke	X		X
• Equal day/equal night (time of equal day/equal night)	P				X
• Time passed since last time the wheel was used for astro	X	curvature of east and west spokes	X		X
Sun					
• Path of the Sun along the horizon (annual motion)	X	East and west spokes and cairns	X		X
• Path of the Sun among the stars (precessional motion)	X	outlier cairn, central cairn	X		X
• Crossing of ecliptic and celestial equator	P				X
• Equation of time (sundial)	X	rim, change in diameter, spokes	X		
Stars					
• Stellar tracking	X	cairns, spokes	X		X
• Astronomical horizon below zero	X	altitude of Wheel			X
• Star group paths	X	cairns, rim	X		X
• Precession north pole star positioning	X	cairns, rim			
• Milky Way positioning	X	spoke segments, SW cairn			
Moon					
• Eclipse	P		?	?	X
• Phases (rising and setting positions)	X	Spokes, cairns	X	?	X
• Moon stations	X	spoke segment angular spacing	?		?
Visible planets					
• Mercury, Venus	P		X		X
• Mars, Saturn, Jupiter	P		X		X
Precession of the Equinoxes					
• A star's change in angle along the horizon over the precessional cycle	X	spoke curvature	X		X
Geography					
• Direction to other wheels used for astronomical purposes	P		X	X	X
• Latitude of the Wheel's location on the celestial body's surface	X	Solstice cairn alignments	X		X

KEY: x = Yes, P= Possible, ? = Unknown

CHAPTER SEVEN

CONCLUSION

The Stars Still Talk to Us

This chapter concludes my dissertation and summarizes the research accomplished between September 2008 and January 2014. I began this journey by questioning the possibility that the Big Horn Medicine Wheel could act as a pedagogical instrument for learning about the sky in relation to the earth. I have concluded that it can act in this manner and summarize the evidence for this conclusion below.

The stars still talk to us. To get our attention, they glitter and glow, mysteriously peak through our windows in the dark of night, and gently lift us from deep dreams. However, we mostly ignore their requests for conversation because their messages come from outside our daily sphere of activity. Even for those who desire to listen, it is difficult, for the voices of thirteen billion years of celestial choir are easily muted by city lights. The ever-changing oscillations of light from variable stars and the sounds of meteors pummeling the atmosphere, smother under civilization's industrial roar.

Knowledge of the Sky is Power

Knowledge of the sky has historically been synonymous with power. Skywatchers of many types found that awareness of the changing sky affected the way they practiced their profession. Shamans, court astronomers, medicine herbalists, midwifes, agriculturists, and navigators were among those professions. The staffs held by those in ancient images of "kings" and "rulers" are often sky staffs, useful for measuring changes

in the sky. The disc worn around the necks of Chinese emperors is a replica of an ancient star chart.

In 1957, Americans experienced fear when they saw the first satellite, launched by Russia, pass over their heads. Sputnik was a tangible bone-chilling acknowledgement of another country's power. Both countries went on to create many more man-made satellites--meant to intimidate. Passing overhead beyond reach, these satellites could collect data on the people below.

During the space "race" in the last half of the 20th century, mainframe computers with their blood quanta of impersonal bytes, captured the sky and held it without ransom because no one noticed it was missing. Astronomers had already left their night watch of the real sky to go indoors and "see" the stars through photographic imaging and spectral analysis. Obsessed, astronomers focused on star composition obtainable through the stars' light emitting and absorbing spectra. Research methods moved toward computer imaging and away from the interaction between the researchers' own eyes and celestial borne photons. The position of stars and planets were found through the interaction of photons hitting photographic film, while locating celestial objects via direct interaction with human eyes and minds became increasingly rare.

The Moon landings stretched our physical existence beyond the egg of Earth. By using millennia of sky knowledge, our species walked "among the stars."

Indigenous Ways of Knowing

Beginning at least as far back as the 1960s with Civil Rights and the American Indian Movement (AIM), Americans have been paying more attention to indigenous ways of knowing. With the current concern in climate change, indigenous Elders' voices are coming to the table to help Western science "pick up the pieces of the past."[201]

The Milankovitch Cycles used in Western science environmental change predictions, use the same cycles tracked by indigenous skywatchers for thousands of years.[202] These cycles include the 24,000-year precessional cycle that pushes each season into the following season by one day every 66.6 years.

Mythologies around the world and through the ages have embedded stories of environmental changes over time. Western academia began to understand this in 1969 with the startling research by Giorgio de Santillana and Hertha von Dechend of MIT. As a global society, we have yet to combine the oldest stories with the oldest astronomies to gain a predictive power concerning our species' future. The Sahara Desert and the Peruvian coast, once vibrant with human life, now know the weight of bone dust added to their drifting sands. Humans have witnessed environmental changes before and left stories for the future—stories connected to time by their connection to the sky. The scholarly deciphering of these stories is still before us.

Sky as Story, Calendar, and Culture Keeper

The sky is the foundation upon which cultures have based their ideas of time. Sky is the universal time keeper, holding knowledge of culturally significant events. The

repeating patterns of the sky give a backdrop for the non-repeating patterns, allowing all events to be placed in time. When ancient stories of environmental change are tied to a sky calendar then those stories have predictive power, able to be read far into the future and useful in determining patterns of environmental change.

Stories are the ultimate technology for the storage of human knowledge. It does not matter if civilizations collapse, if people move, if volcanic ash buries our books and computers. If any people who know the stories survive, then knowledge survives. The plots of ancient stories may give detailed information about the sky that in turn give detailed information about *time*.

I am convinced we do not give enough credit to the stories that have followed us through the deep lengths of time. This, I believe, is mostly due to our conquerors' heritage in America. We are trained to disregard old stories that come from our ancestors and instead are asked to take up new stories that support the current power structure.

Stars are the one constant in generations of humans on this planet. Although some stars are moving at a pace recognizable to us, the majority move at speeds and directions that make slight difference over many ages of men. Like the bacteria that grow five generations in our water glass before we are finished with our evening meal, our lives come and go quickly compared to the lives and motions of most stars.[203] Stars give us a constant reference system over the eons. When we connect this reference system to stories, and we have an accurate and enduring encyclopedia of human events.

John Eddy scientifically studied the Big Horn Medicine Wheel in 1974 and determined that this artifact of unknown origin demonstrated the ability to track our

closest star, the Sun, over thousands of years of human generations. The people who built this wheel appear to be gone or perhaps their genetics are among us but they have forgotten their skywatching heritage through the genocide of their Elders and the mistreatment of their youth over the last 150 years.[204]

We are left with a complex ideogram embedded in a landscape, possibly portraying the major plotlines of oral histories and mythologies. What will it take to translate the ideogram back into the cultural ways that gave it life?[205]

Learning the Sky from the Wheel

The sky at the Big Horn Medicine Wheel is more than half of one's total environment. The horizon creating the thin separation between land and space is literally under one's feet. The whole body is immersed in sky. When looking across the Wheel, a fellow researcher is outlined in "sky." In the day, this equates to deep blue littered with fluffy white, and at night this means deep black speckled with all colors of glittering stars. The sky makes up the major part of the environment, day or night.

Before the internet held human's knowledge in the spatial arrangement of electrons and before libraries held knowledge within inked symbols written in books, people held knowledge within stories. In the case of the Blackfeet Indians of Montana, these stories were kept in the library of the sky, in a vault organized by the seasons. In this way, no stories could be forgot for each was "seen" in the sky. Specific stories were to be told at specific times of years. The time of the telling remained consistent; as a

group of stars came into view, the time to tell its story would occur. The organization of the sky kept the order of the stories.

To many cultures, the stars are magical, beyond our reach, where the gods live, where souls go, where we came from.

Indigenous Sky Pedagogies

What makes indigenous sky pedagogies different from conquerors' sky pedagogies? Indigenous sky pedagogies include a relationship between the learner and the sky. A conquerors' sky pedagogy does not require the learner to ever interact with the real sky. For example, universities allow very brilliant people to earn degrees in many specialty areas of astronomy without ever requiring them to be knowledgeable about naked-eye observations under the real sky.

Indigenous sky pedagogies are present inside a classroom when local resources are a part of the lesson. For example, a local storyteller sharing stories about an interaction that happened at a local site where local people and the real sky were part of the story would be a way to bring indigenous sky pedagogies into the classroom, keeping the interaction with the sky as little removed from the student's own experience as possible. In contrast a conqueror's sky pedagogy would use images of distant galaxies taken by the satellite telescope Hubble. The images are astounding, but they are removed from our personal lives.

Direct interaction with the sky sends information [data] straight to the human brain through the nervous system. The data is complex and integrated with emotion, such

as the feeling of comfort if the observing environment was satisfying to the senses or discomfort if the environment was cold or wet. Human to human interaction also plays a part in indigenous sky pedagogies. The excitement of one person's interaction with the sky can heighten another's experience. These are indigenous experiences because they arise locally and are experienced first-hand.

In contrast, a main goal of conquerors' sky pedagogies is to gather objective data, devoid of emotion. The concept that this is possible comes from the metaphysical belief that the physical forces that create and maintain the universe do not need emotion to function. [206]There is no evidence of this, but the concept endures.

Indigenous sky pedagogies may include data collection, but the data comes from a wider set of methods without the restrictions held by Western science to limit and discount the roles of emotion and human involvement with the object of study. Western science data collecting methods are a subset of the kinds of data collecting that is included in Native Science research where methods do not stop with the reduction of an observation but instead includes methods for complex re-integration.

The largest difference in sky pedagogies is the degree of distance between the learner (observer) and the sky (observed). The following table offers examples of indigenous and conquerors' sky pedagogies. The table does not include other types of sky pedagogies such as art, dance, singing, stories, craft-making, etc. These are important pedagogies but regretfully were not included in my study due to time restrictions. (See Table 7.1.)

The Wheel as a Calendar

The Big Horn Medicine Wheel is able to act as a pedagogical instrument for learning sky-earth relationships, skywatching fundamentals, and celestial mechanics. In this way, it functions as a calendar, tracking time based on celestial movements. In chapter six, I explained how the Wheel's design elements play a role in tracking celestial dynamics and offered a table based on the astronomical functionality expressed through the Wheel's specific design elements. Here, I turn that around to focus the attention of the reader on the calendric aptitude of the Wheel by placing the more familiar units of time as the focus of the table's organization.

The table below describes how the following uses of the Wheel can create a calendar-like pedagogical instrument for learning sky-earth relationships:

- Wheel's rim= precessional ecliptic north circle
- Wheel's spokes= segmented star chart
- Wheel's cairns= precessional star positions
- Wheel's outlier cairns= long baseline sighting watch posts

In addition to its calendar-like characteristics that set humans within the context of *time*, the Wheel is specifically situated to set humans within the context of *Place*. The following characteristics are dependent on the landscape and latitude of the Wheel's setting.

- Wheel's northern landscape horizon=circumpolar star rotation
- Wheel's latitude = 45 degree "sweet" spot for precessional changes
- Capella's path mirrored in the Wheel's latitude and landscape

- Wheel's flattened side = Sundial's equation of time

The results of my study are gathered in Table 7.2. From a skywatching perspective, the evidence is overwhelming. Every element of the Wheel's design and every characteristic of the landscape have a celestial counterpart.

However, there is little ethnographic and no archaeological evidence (other than the arrangement of the stones themselves within the contextual landscape) that the original construction was designed for teaching about the sky.

Predicting the Future

The Wheel is able to do more than track time. It is also a spatial locator. A Wheel with the same design elements as the Big Horn Medicine Wheel could be built elsewhere on Earth or on another planet and hold information about the Place←→Sky interaction at any specific site. It would do this through the skywatching toolset I described in chapter six.

In this dissertation, I have directed the reader to the astronomy aspects of my study, but as I close this discussion, it is important to prepare the reader for the larger role the Big Horn Medicine Wheel is able to play. The Wheel is a circle. Whether a person has sky knowledge or not, a circle represents a continuum, a repetition of processes. The Big Horn Medicine Wheel both symbolizes this repetition and gives exact astronomical information about when and how changes in the Earth's orientation to the Sun will take place.

The Wheel communicates in factual, objective terms that humans are engaged in a continuously dynamic environment. The Big Horn Medicine Wheel tells us how the

Earth's angle to the Sun changes over time. The angle of the Earth's axis to the Sun is the basis for every weather system on Earth. Our current calendars do not give us long-range information about the continual shift of our seasons. The calendars hanging on our walls and digitized in our computers hold us in an illusion that spring always falls on the same day when in actuality, in 6000 years, spring will not begin until late June.

The Wheel appears to rest quietly, while to the skywatcher, it roars with knowledge of approaching change. Knowledge built into its symmetry—a symmetry we can read.

I assume the long roll of seasons must affect the movement of plant and animal species. The plant and animal world is interdependent right down to the micro world of bacteria and the photosynthesis mechanism in the cells of plants. The Wheel is able to act as a measuring gauge for collocating the change in habitat of plants and animals with the movement of our planet through space and time. It is a fact of the geometry of the Wheel within its landscape; able to be analyzed objectively by Western science.

Nonetheless, I am convinced there is more to learn at the Big Horn Medicine Wheel than celestial mechanics and its resulting ramifications for human survival. For my dissertation, I have limited the discussion to this astronomical activity of the Wheel, but I acknowledge that this role is simply a role I studied, not "The Role." I make no claims about "The Role" of the Big Horn Medicine Wheel.

Conclusion

In the 1970s, the Big Horn Medicine Wheel gained federal recognition as a National Historical Landmark. In 2013, America's leading media continue to report on the Wheel's "mysteries" and categorize the Big Horn Medicine Wheel among the mysteries of America's past.[207]

The Wheel gained status as a National Sacred Site without any specific indigenous nation claiming ownership. It is truly an *American* Sacred Site, preserved for and maintained *by the people, for the people*. Federal law protects it as a place for *all people*.

I believe the Big Horn Medicine Wheel has been worthy of scholarly attention in its role in astronomy place-based education. I hope that this study will be an addition to scholarly knowledge about indigenous place-based pedagogies and inspire a deepening appreciation for the knowledge of our ancestors, still existing in the remains of their cultures. In the words of the eloquent speaker and educator, Nate St. Pierre (Chippewa Cree from the Rocky Boy "Stone Child' Reservation in central Montana),

> Rather than using technologies to document or record culture and heritage, I hope we use them to *perpetuate* it, taking our cultures into the future.[208]

I hope that by documenting the possible astronomical uses of the Big Horn Medicine Wheel, I fulfill St. Pierre's hopes for the continued, perpetual interaction of American pluralistic culture and the Place of the Big Horn Medicine Wheel within American thought and practice.

Tables

Table 7.1 Sky Pedagogies Compared: Indigenous and Conquerors'

SKY PEDAGOGIES	
Indigenous	**Conquerors'**
Learn from the real sky	Learn from other's documentation
Use of human five senses interacting directly with the sky	Use of technology as an intermediary giving the learner secondary information
Use of technologies that allow learner to interact first-hand with the sky	Use of telescopes inside observatories where learner cannot see the real sky
Use of binoculars that focuses the light from the sky into the observer's eyes	Use of computers to record the light from the sky in digital photographs or in spectral analysis
Observing the sky from the same place where the Sky is seen	Observing the sky from a distant location using remote-controlled telescopes

Table 7.2 Pedagogical Acts of The Big Horn Medicine Wheel

PEDAGOGICAL ACTS OF BIG HORN MEDICINE WHEEL FOR SKY-EARTH RELATIONSHIPS					
CALENDAR	**SKY OBJECT**	**WHEEL ARCHITECTURE**	**LANDSCAPE**	**MODE OF USE**	**TIME TO COMPREHEND**
Seconds	Stars, Moon, Sun	Any cairn	Horizon	Sky staff, shadow	Seconds
Minutes	Stars, Moon, Sun	Any cairn	Horizon	Sky staff, shadow	Minutes
Hours	Stars, Moon, Sun	Central cairn	Horizon	Sky staff, shadow	Hours
Days	Moon	Spokes	Horizon	Counting	Days
Weeks	Moon	Placement of Wheel	Horizon	Moon phase	Weeks
Months	Stars, Moon	Cairns	Horizon	Moon Synodic: phase; Siderial: spokes Heliacal stars	Months
Year	Sun	Central cairn, spoke	Horizon	Horizon position	Year
Centuries	Stars	Cairns, spokes, outliers	Horizon	Heliacal stars	Decades
Millenium	Sun, stars,	Cairns, spokes, outliers	Horizon topography	Heliacal stars Sun horizon position	Decades
Millennia	Sun, stars, Moon	Cairns, spokes, outliers	Horizon topography	Moon conjunction with Solstice Sun	Decades
24 Millennia precession	Sun, stars	Cairns, spokes, outliers	Northern dip	Full cycle of cairn position as compared to no star	Decades
Repeats of 24 Millennia Precession	Sun, stars	Rim. spoke segment size	Northern dip	Full cycle of cairn position as compared to polar stars, counting	Decades

APPENDIX A

A SHORT HISTORY OF PLACE-BASED AND INDIGENOUS EDUCATION PHILOSOPHY AND PRACTICE IN AMERICA

Early Place-Based Philosophies

Francis Bacon (1561-1626) and John Amos Comenius (1592-1670) were early philosophers concerned with educational practices. Comenius' ideas are quite indigenous even thought he was not indigenous to America. Education history is full of indigenous ideas supporting indigenous pedagogies that did not originate in indigenous America.[209]

As the Western world became enlightened with the use of rationality and the scientific method, the threads of indigeneity struggled to survive--often as an anti-thesis to rational theories. The individual's relation to their environment was never without a champion. However, as free public education became a reality in America, many indigenous pedagogies smothered under the building of institutions capable of educating the mass of America's children.[210]

The European model was still in effect in the early 1800s; tutors, academies and boarding schools for children of the rich gave competition to the free public schools. "Public schools were charity schools, serving a limited segment of those unwilling...or unable to pay."[211] For public schools to survive and offer instruction free to all children, they had to, "justify [their] claims on the public purse."[212]

By 1814, the soldier-like pedagogical practices of the Lancaster schools were springing up in Europe, Australia, and the eastern US. In these schools, older students "monitored" younger students. Joseph Lancaster (1778-1838) claimed that 1000 students could be taught effectively by only one teacher using this pedagogy. To achieve this, discipline was strict and focused on bringing "shame rather than pain."[213]. Children were hung in baskets above the other students so they could be ridiculed. They were yoked at

the neck and walked around by other students who would shout out their misdeeds. Positive reinforcement came through winning prizes, such as tickets that could buy paper kites, balls, and wooden horses. Lancaster's pedagogy had a combination of industrial and military character.

> The system was certainly economical, but it required careful organization, systematic procedures, and strict regimentation. A monitor was in charge of ten children and each child, like a member of a military squad, was expected to respond immediately as the monitor called the order to take off hats, trace a letter in the sand tray, spell a word, show slates, turn around.[214]

Although by today's standards, we would be concerned about this method of teaching, it did allow a greater number of children to receive an education. In the early 1800s, knowing how to read was a marketable skill.

Johann Heinrich Pestalozzi (1746-1827) in Switzerland believed children could learn from their natural environment. He trained teachers to be active participants in a child's learning. Pestalozzi combined the psychological development of the learner with--what we now call--a constructivist approach where the student builds new knowledge upon existing knowledge. Pestalozzi agreed with Jean-Jacques Rousseau's (1712-1778) ideas of pedagogical concepts of place-based learning in nature. Pestalozzi's pedagogy was indigenous because it was personal, connected to the environment, and entrusted local teachers to actively take part in the students' learning. This human-centered pedagogy challenged the conforming industrial models of education, giving education practitioners new energy. "Pestalozzianism stimulated industrial education….It contributed to improvement in methods by bringing reality to the classroom through the

intelligent use of the object lesson and, finally, it introduced psychology to formal education."[215]

Pestalozzi came to these pedagogical understandings while educating "vagrant boys and girls" on his farm.[216] Pestalozzi allowed the children to learn through experiencing the cause and effects of life on a farm, letting nature do the teaching. In this way Pestalozzi contributed an indigenous type of pedagogy to public schools across America and Europe. These pedagogies were not called "indigenous" at the time, but we can now see the difference between pedagogies born of a conquerors' industrial role on a new land and pedagogies coming from those whose lives are connected to sustaining the land.

I use the term "conquerors" to imply a type of thinking about education. See chapter two and three in the main text for more on this. The possessive apostrophe will come after the entire word "conquerors" when I am not talking about one or many conquerors, but instead am speaking of the term as a possessive adjective.

Heavily influenced by Pestalozzi's pedagogies, Johann Herbart (1776-1841), focused his attention on the secondary school. Herbart was a philosopher, succeeding Immanuel Kant in his university position at Königsberg. Like Kant, he believed in the training of moral character, however, he felt that students only learn if learning connects to their interests, therefore, teachers must find what interests their students and build upon this. Margaret Gillette tells us that Herbart believed that interest is,

> …a pleasurable feeling which accompanies the reception of an idea in the mind. Its presence may be gauged by the amount of energy a student puts forward to act upon any idea. If interest is present, attention will be freely given and the need for external discipline

> will be removed. Interest may have an emotional element, but it does not interfere with reason; on the contrary, it aids reason because without it no real learning can take place.[217]

Like Pestalozzi, Herbart felt that new knowledge must build on what the student already knows. Followers of Herbart's methods later formalized his plan into steps, commonly in use today:

- Preparation: set the mood for learning, rouse interest, recall previous material or past experience,
- Presentation: explain new material,
- Association: combine old and new,
- Generalization: make comparisons, formulate general principals, definitions, or rules, and
- Application: test the rules by applying the solving of problems, performance of relevant tasks, or completion of homework.

Although Herbart believed in the necessity of learning from the natural world and the students' environment, he formalized the procedure for doing so. *This formalization put pedagogy in the hands of a human hierarchy of authority external to the student, their local community, local Elders and local culture.* By attempting to codify a natural process, Herbert's followers continued the formalization that pushed it away from an indigenous pedagogy. Herbert's system organizes a teaching scheme for curriculum writers and teachers. Herbert's pedagogy is "subject-centered," the student is not included in the design of the lessons, unless the instructor takes the time to make the steps personal to each student.

Friedrich Froebel (1782-1852) broke with the tradition of subject-centered pedagogy and held a God-centered and triune mystical approach. He is known for establishing the theoretical framework for kindergarten. Because student's nature was a flow of the Divine nature, he believed teachers should guide students but never force or restrict the Divine flowing through them. Education developed from inside the student, subject to the laws of opposites and that these opposites needed reconciling, for then they would become a third entity and complete their likeness to the Creator. He saw education as making "inner outer" and "outer inner." He made use of the circle to symbolically emulate this unity and completion of the inner and outer.

Froebel noticed that children love to move and this motion was fundamental in their learning process. He felt their motion should have no separation from their thinking. For this reason, his curriculum supported self-development through self-expression through games, songs, and the creation of things. Frobel's pedagogy focused on what originates from within the child, not what originates with the teacher or the lesson.

In the history of pedagogy, "play could be seen afresh as a legitimate creative, intellectual and moral force."[218] This gave the world a theoretical basis for the kindergarten movement. The first German speaking kindergarten opened in the US in 1855 and the first English speaking kindergarten opened in Boston by Elizabeth Peabody in 1860. However, Francis W. Parker thought Froebel's principles were worthy of any grade level and if used could cause a needed revolution in learning.

Froebel's pedagogy is highly indigenous with its ideas of completion, coming back to the whole understanding by "reconciling" opposites and by his pedagogy of

allowing the student to learn from self-expression instead of from outside interference with that inner flowing process. The child's dance, song, and use of hands in the creations of things, all express learning arising from the inside, and flowing toward the outside.

What Knowledge Is of the Most Worth?

Herbert Spencer (1820-1903) questioned, "What Knowledge Is of the Most Worth" in an essay in the *Westminster Review* in 1859. Spenser had run away from school as a child but held on to his inquisitive energy. He believed that studying the classics (England was behind the US in adding more practical courses to their curriculum), was merely an ornamental show for the elite and did little to help students with their lives outside of the "ornament" of high speech among peers. He believed that English society's real consideration was, "not what knowledge is of most worth…but what will bring most applause, honour, and respect—what will most conduce to social position and influence—what will be most imposing."[219]

Spencer saw this type of learning as only an ornament, not very useful for most people. He proposed adding, "the knowledge underlying the processes which make civilized life possible" to the curriculum. This meant the sciences, physiology and hygiene, chemistry, physics, geology, biology, plus child-care, social history (not just names and dates), psychology, and "the morals, theoretical and practical of all classes; as indicated in their laws, habits, proverbs, deeds." He felt the sciences, unlike the classics, would prepare students for direct self-preservation (health), indirect self-preservation (a livelihood), parenthood, citizenship and leisure. These ideas did not catch on in England

as quickly as in America and the Spencer phrase, “education for complete living” was picked up by Americans and adopted as their own.

Spencer’s ideas were indigenous in that they turned the focus away from a student’s place in a social hierarchy and toward the students’ place in a work environment, recommending school courses useful to the student’s practical survival. However, Spencer, like those before him, supported formal learning and believed formal learning was useful in disciplining the mind. He contributed to the change from learning classics to learning sciences, thus giving the learning a pragmatic application in an increasingly industrialized world.

The Beginnings of Formal Control in America’s Public Education

Education became increasingly formulated from “above” In the 1800s. Massachusetts had the first State Board of Education in 1837 with Horace Mann as the first secretary.[220Á] Horace Mann's concept of common schooling was not an effort to "bring school to the masses," but was an effort to make public school attractive to middle-class parents. As the states developed their own boards of education, they had the freedom to create the types of schools their populace demanded. The federal government had little influence. However, the influence on educational institutions by the social classes in America weighed heavy at this time in America. “White Anglo-Saxon Protestant middle class did especially well.”[221]

In 1855, Henry Barnard created the American Journal of Education, bringing new pedagogical philosophies from Europe into the American educator's awareness and helped create a Bureau of Education in Washington, DC.[222]

Most states had laws allowing local taxation to support schools, however this money often went to private organizations that were offering schools, not to a public school system. After the civil war, public schools had slowly gained momentum and began establishing themselves as the dominant form of education in the United States. In 1865, San Francisco had 138 teachers in 29 schools. Chicago had provided schooling in the 1830s but did not create an office of the superintendent until 1853. However, the state laws providing free public education did not occur in Illinois until 1865. Atlanta established its public school in 1872.[223]

By the end of the 1800s, churches had less control of local education. Compulsory education became law. The states required free local schooling at the elementary level with the curriculum for these left up to the local school community. Free public high schools were yet to come. More children attended school and among these, wider social classes were present. The curriculum included courses beyond the classics: geography, history, nature study, and manual and industrial skills. Physical education was given time in the school day and training of teachers became specialized. With the formal training of teachers in pedagogical practices, the teachers gained status as professionals.

Industry and Education

The 1893 World's Fair in Chicago exhibited new science and technology. These exhibitions were designed to give Americans a trust in industry's ability to guard our

future welfare. Industrial entrepreneurs, scientists, and engineers were energized by the possibilities of the near future. In contrast, education practices and subjects available to students dragged behind, not as quick to absorb new ideas as the entrepreneurs of industry.

The industrial era in America had its effects in the classroom. Conformity was the ideal. Efficiency in creating educational products out of students worked against earlier indigenous ideas of personalized instruction as set out in Rousseau's *Emile* in the preceding century. Immanuel Kant's concept of moral duty, with conformity of rules for all people, laid a deep foundation for pedagogy that has continued into the 21st century.

Approaches to the Acquisition of Knowledge: What is Knowledge For?

William James (1842-1910) and his work on pragmatism countered this formal approach to acquiring knowledge. With his students at Harvard, he ran experiments to determine if memorizing the classics really transferred to gaining knowledge in other areas. Edward Thorndike (1874-1949), professor of psychology at Teachers College, Columbia University, tested the long-held concept that learning Latin and mathematics would increase one's reasoning ability under other circumstances.

The James-Thorndike experiments showed little difference in a student's ability to reason through studying the classics compared to studying anything else.[224225]

Centuries earlier, Francis Bacon had made the case for experimentation and the scientific method to observe the real world rather than a theoretical one. Comenius had brought the idea of sense-realism where "truth may be arrived at through the senses, that

education could conform to nature, that natural objects and a natural order should be used in teaching, that knowledge is of utmost value, and that, "man is naturally capable of acquiring a knowledge of all things."[226] These ideas found a stronger hold in education theory in the 20th and 21st centuries. Bacon's scientific method continues to be used in science lab courses and Comenius' ideas continue to align with the environmental education movement.

Comenius thought that learning should begin with concrete objects and then move to the abstract and generalized. He prioritized the indigenous pedagogy of interaction with the real object above the theoretical and abstract as a starting point in acquiring knowledge. He advised to start with what is right in front of the student, available to the five senses. This describes an indigenous pedagogy because it keeps the student's practical circumstances an integral part of the lesson.

Limits in Pedagogy: Time and Quantifiable Learning in Public School Practices

Educating masses of students instead of educating individual students creates limits to the pedagogies that can be employed. One limit is in the way time is structured. In mass education institutions, school clocks and bells designate the amount of time for teaching and learning. This means the clock defines the learning time, rather than engagement in the process of learning defining the time spent in learning. Limiting time for learning activities interrupts personal learning. Time becomes a higher priority than learning. Control of time becomes a construct forced on top of learning, for the ease of managing learners, not for managing learning. Although many ways of working with

time limits have been successfully negotiated by educators and teachers, this limit in mass education stands as a barrier between what pedagogies are used and which are abandoned in mass education institutions.[227]

The "need" for quantifiable learning outcomes creates another limit in mass education. Administrators use learning outcomes to create cost-benefit ratios for educational funding. Teachers quantify learning outcomes by percentage grading to show student "progress." The pedagogical limit in this is that quantifying the outcomes of learning presupposes that all people learn alike and that testing can objectively measure that learning, which research shows is not true.[228]

These constraining limits block indigenous pedagogies from being used effectively in mass education institutions. Indigenous pedagogies require a lower student-teacher ratio along with flexible time periods for learning engagement. Pedagogies that do not rely on quantifiable results require a higher teacher/student ratio than states or the federal government has yet been willing to fund.[229]

However, private and charter schools have used indigenous-like pedagogies with success. In 1998, Ted and Nancy Sizer, founders and co-principals of Francis W. Parker Charter Essential School use a pedagogy where students created their own learning, guided by teachers. The students produced portfolios showing not only their knowledge gained, but also their ability to write and speak confidently about their topics.

> The governing practical metaphor of the school…[is the] student-as worker, rather than the more familiar metaphor of teacher-as-deliverer-of-instructional-services. Accordingly, a prominent pedagogy…[is] coaching [by the teachers], to provoke students to learn how to learn and thus to teach themselves.[230]

Freedom in Alternative Pedagogies

There have been many attempts to change the public school pedagogies from their industrial-military model to more modernly useful pedagogies. Mindful teamwork models are taking the place of the military teamwork models that focused on a team working under a hierarchy of authority. The new teamwork models attempt to give each member of the team their own authority over a specific talent set and then encourage the team to work together with equal voices.

Some of the new pedagogies can work within the public schools, others cannot. Alternative schools arise when a group of parents and educators desire to use pedagogies that are incompatible with public school. Such is the case with adventure schools that take their students on traveling adventures, sometimes around the world. Public schools simply do not have the budget to consider adding this type of pedagogy.

Public schools, with their management of mass education, cannot fund a home-school pedagogy that gives careful and loving attention to each student. At present, the public system considers funding for thirty students to one teacher as acceptable.

Charter schools are able to use public monies as they work within the local school board's rules yet are allowed to test pedagogies that the public school is not prepared to attempt. If these pedagogies show success, public school may adopt them. Charter schools are a way for the public school to try out an idea without forcing the new methods on any students whose families are not ready for the change.

Nature schools work for the benefit of the nature-deficit populace. They hope to connect normal learning with a real environment and thereby increase students'

awareness of the connections of learning in the classroom to the real life of the planet around them. An appreciation for the complexity, diversity, and fragile nature of species' interactions with each other and their environment is the focus of nature schools. These schools help students gain first-hand experiences of the workings of nature and connect these experiences to the normal courses taught within public schools, such as reading, writing, biology, art, Earth science and others.

Free schools work under the auspice that all we need to know, we already do know and it is the uncovering of inner knowledge, not the stuffing in of knowledge, that is the aim of education. These schools allow the student freedom to explore, letting nature remind the student of knowledge already known to their inner self.

Formal and Informal Learning

Formal learning occurs in institutions that require a specific set of tasks accomplished in exchange for a grade, certificate, or degree. With formal learning, the student is required to show their level of understanding, usually through written tests or presentations, and thereby earn a grade and/or credits or credentials based on their level of knowledge gained.

Informal learning occurs in museums, after school programs, gifted programs, camps, and places where the student is not motivated by the earning of grades or credit. Instead, the knowledge gained is entirely dependent on the learners desire to understand. Grades or credits are usually not of interest in informal learning experiences.

Homeschools may seem 'informal' but because the student, by law, has to gain as much knowledge as a median-scoring student in their local district as determined by standardized tests, even a homeschool is under the auspices of learning toward a defined credit or grade level.

Both informal and formal learning have goals, assessments, and standards. Formal learning has a wider agreement at state and federal level as to what the goals, assessments and standards should look like, whereas informal learning is able to create these independently of any state or federal department of education. A museum board may set standards for informal learning through its own mission statement. Camps and afterschool programs may or may not set standards.

It is very difficult for formal educators to agree on the purpose of education or what a quality education looks like. This is not the case with informal educators. They all know that their purpose when creating a learning experience is to spark a desire to look beyond the obvious, to go deeper, and to enjoy the journey.

Why does formal learning have such trouble defining its objectives? Unlike informal learning, formal learning is under the gun to perform a miracle with each student. To create a gateway to any future possibility the student may desire. It also has to show that it treats all students alike, making sure all have access to every learning experience.

The hardest part of formal learning is that the student is required to show up and required to perform--not so with many informal learning activities. There may be no requirement to show up or to perform. The students themselves decide if they are

interested in attending and once they attend, such as in a museum activity, they are always free to choose to leave if the activity disinterests them.

This step of self-choice is crucial. When the student decides to join an informal learning activity, they have set their will into motion.[231] They know that they can leave at any time and that they can be asked to leave at any time. This active participation readies the learner to accept new knowledge, without the motivations of grades or credits. If there are no grades or credits to be gained, then the only thing of interest to the student is the subject matter and the experience itself.

The learners place themselves in the path of knowledge generation and by their continued attention, use their will to take into consideration all that they experience. In this way, *informal learning is much closer to indigenous pedagogies than is formal learning*.

This willingness to learn and use one's own volition to accept instruction is crucial. Learners who can learn effectively within formal learning structures may make use of this skill, realizing that it is easier to learn when they become self-motivated. In this way, indigenous learning pedagogies can take place inside of formal learning, but formal learning is rarely set up consciously to support indigenous pedagogies, due to the overriding need to be efficient with large numbers of students.

For the most part, however, it is the informal learning that is able to make use of indigenous pedagogies most effectively due to the fact that it isn't required to show learning outcomes. The learners are not expected to display a pre-designed level of knowledge. Knowledge gained by participants is more likely to stretch beyond any box

that the curriculum writers could have imagined. The learning is personal and constructed within each student's hierarchy of thinking, according to their personal priorities--not those of a distant board of education.

Where informal learning is usually of the student's own free choice (with possible parental encouragement), the activities may still be highly structured.

Informal learning is often personal and includes the student's own community and local resources; formal learning is impersonal and relies on abstracted and reconstituted information. Informal learning tends to be more indigenous, whereas formal learning tends to be more conqueror-like.

A fundamental characteristic of indigenous pedagogies is the preponderance of personal reflections and resulting decisions that are built into the teaching process, whereas the fundamental characteristic of conquerors' pedagogies is the preponderance of reflections and decisions that are made by "authorities" outside of the learner's family, community and local culture.

The United States is a large land mass. Public schools sacrifice the individual's familial, geographical, and cultural identity in an attempt to give equal opportunities to all learners across our nation's diverse populations and living conditions.

Current Trends in Place-Based and Indigenous Pedagogies

Educational reforms throughout American history have swung between humanism efforts (closer to indigenous) and scientific efforts (closer to conquerors'). When parents became dissatisfied or psychologists suggested alternate theories of human development,

school boards attempted different pedagogies. However, even with the best-case scenario, strategies needed to manage large student populations restrict the types of pedagogies that are utilized, regardless of the desires of parents, psychologists, philosophers, teachers, or administrators. Although American schools aspire to provide every youth with an education, they do not fund education to a level that can access successful pedagogies.

Public schools accept a dropout rate as high as 50%, which is puzzling for a nation whose education goal is "No Child Left Behind." To leave no child behind, each child's education needs attention. Each student's perception, learning style, and personality must find engagement. If schools use pedagogies that allow for only a segment of students to engage, then unacceptable drop out rates will continue to rise. This should not be a shock after years of educational research. The shock is that as a nation we ignore the need to change the system.

Students who succeed in the system are the ones who control the system. Dropouts rarely get the chance to design the next public school. And so recapitulation of the mass educational phenotype continues.

Pedagogies available for use are limited because pedagogies in the public schools have to coexist with strategies for the management of large groups, such as fifty-minute classes, credits based on hours spent--not mastery of subject, and students sitting neatly in rows facing the teacher as authority. Indigenous pedagogies that could be successful with individuals cannot be employed if our public school system is set up to manage mass education, not individual students.[232]

Individuals engage when the pedagogy matches their learning style. Indigenous pedagogies allow personal engagement through the openness to make use of their personal perceptions during instruction. For example, the place-based indigenous pedagogy that allows students to enter a natural environment and observe using all their senses offers individual students an opportunity for a personal experience even if the pedagogy requires students to describe common objects, such as the invertebrates in a creek. Instead of learning about invertebrates through a written description and images in a book, the students activate multiple sensory pathways to their brain to comprehend the lesson's goal to observe invertebrates.

"How" students perceive is the filter for "what" they perceive. Students construct their understanding of the world through the filter of their perceptions. If pedagogies do not allow students to construct knowledge based on their own perceptions, the learning is abstract and non-engaging. A pedagogy that ignores students' individual learning styles also ignores students' personalities with their own metaphysics and view of the world. This begs the question, how can any pedagogy work if the teaching is not relevant to the student's worldview? Indigenous pedagogies depend on the relevance of the teaching to the student's worldview. Conquerors' pedagogies presuppose that the individual worldview of the student is irrelevant. Conquerors desire that all learners recognize one "objective" reality—the conquerors' reality. These two opposing pedagogies represent two philosophical theories of knowledge generation described earlier: is reality one or many? Is it personal or objective? If there is one, objective reality, then conquerors' pedagogies should work for all learners.

Students who do not benefit from conquerors' pedagogies are often considered either belligerent or low in intelligence. To help these belligerent students learn, stringent rules are enforced with negative consequences for not following them. The motivation to learn comes from fear of consequences, not from the richness and joy of the learning experience. Remedial courses are added for the "less" intelligent, in the hope that more time on a subject will allow the student to catch on.

These variations aimed to manage the education of the belligerent and less intelligent learner, reinforce the conquerors' hierarchical structure; they do not empower the individual and may greatly hinder the expression of the learner's talents within society.

This is not new information, it is added here to reinforce the need for incorporating indigenous pedagogies in the education practices for our nation's youth. The United States has more people per capita locked in prisons than any other country on Earth[233Á]. The cost of imprisoning Americans is much higher than the price of educating them.[234Á] Foresight is needed to reverse this trend and help youth become engaged in society. The benefits of funding education may take two generations before any difference is noticed in prison funding. The conquerors' attitude is one of greed in gaining the most for the present without concern beyond one's family and business partners' future. The foresight to see into the health of the future (seven generations) is an indigenous trait.

Long-lasting Effects of Past Educational Practices

America's public schools are presently informed by a conquerors' system. Research on educational pedagogies supports the effectiveness of indigenous pedagogies, but changing the current conquerors' system would require an increase in funding and community involvement to counteract the limits imposed upon any pedagogies advocated within a mass education system.

In the 21st century, with environmental issues constantly in front of us, a place-based model connects students directly to the complexity of their authentic environment. America is beginning to incorporate Native Science to help probe questions concerning sustained survival for humans on this planet.[235Á] In an article in the 2013, *Contemporary Studies in Environmental and Indigenous Pedagogies: A Curricula of Stories and Place,* Dan Roronhiakewen Longboat, Andrejs Kulknieks and Kelly Young review the history of environmental education and its indigenous pedagogical possibilities:

> Environmental education curricula in North America is primarily based upon a scientific model of inquiry. Clearly in an age where environmental degradation, loss of biodiversity, population growth, issues of sustainability, and global climate change continues to soar to daunting heights, environmental education is failing to interrupt the status quo and requires a model that integrates both scientific understandings within themselves, and Indigenous knowledge systems (IK) cross-culturally….Historically, during the latter half of the twentieth century, there was a concern about nature that grew into environmental sciences based upon a scientific model "about nature" rather than a naturalist and experiential model "in nature." Environmental studies moved into books and field courses." At this time, there was a kinesthetic loss of learning whereby humans no longer fully experienced nature and moved toward "text based knowledge" as a dominant method of learning about the environment in systems of education. The methods involved a shift

> from experiential learning in nature to learning about the environment in a library.[236]

The systems we ask our students (and teachers) to study are too complex for Western science alone. When Western science dating methods fall short of confirming long range patterns for climate changes, Indigenous records of the movement of animals and the extent of ice sheets dating back thousands of years are of great value.

This recognition of the value of Native Science methods has a counterpart in education. Science education research shows that using indigenous methods in the classroom helps children learn science. Hands-on activities where the student experiences learning with their own hands is widely accepted as a "best practice," although it is time consuming and many teachers cannot make use of it regularly.

A hands-on pedagogy combined with experience in nature requires more interaction between the learner and the subject. The learner gives more attention to the subject through multiple senses, not just the eyes and ears. The learning is active, not passive. While America looks for holistic solutions to environmental problems, education looks for holistic pedagogies to better understand environmental issues.

The long-lasting effects of past educational practices can be viewed inside a college classroom. College students have had an average of twelve years to learn how to learn within public and private schools, mostly under western education military-industrial conquerors' pedagogies. In 2013, while guest lecturing in a course titled *Current Issues in Native American Studies at Montana State University*, I witnessed fifty-six students from freshmen through junior year who were unable to speak out and critique new information readily. This is not uncommon in undergraduate courses. These students

were trained to be anonymous, trained to think there was only one right answer, and trained to think that the person standing in front of them with the title of "instructor" was the only one in the room who knew the "correct" answer for certain. The conquerors' pedagogy is easy to maintain at this level, for the students are well trained in its methods.

When students are trained to think that they are not unique, that their perception is rarely more prescient than their teacher's, and that their contribution (if it does not align with the correct answer) is without value, then they will act accordingly. Where are the "belligerent" kids who dropped out of school? The ones who could not blindly follow guided instruction from a human they personally never accepted as an authority. Where are they?

Asking a doctoral student in computer science, "How would students act if they had no fear of appearing more intelligent than their teacher or their peers?" The answer came back quickly, "They'd act like a homeschooler!" Laughter ensued. "Homeschoolers don't know the proper etiquette of hiding their way of thinking and so they are very clumsy in social settings."[237]

I have taught homeschoolers who came to a private school to gain this social etiquette. Their thoughts flowed too quickly for them to fit in with the other students. They did not realize their quick, expansive thinking seemed rude to the other students. As an educator, this is puzzling. Do Western education pedagogies press our youth to fit in by hiding their intelligence?

"Fitting in" means more than intelligence to many students, but why do our youth have to choose? Is there a pedagogy that supports both happiness and intelligence? The

answer is a resounding yes. Indigenous pedagogies allow the expression of many types of intelligence profiting all students. However, this means all students engage and succeed and this works against a conquerors' hierarchical structure.

Howard Gardner is the Hobbs Professor of Education and Cognition at Harvard Graduate School of Education. He has studied the variety of intelligences that students exhibit and found more than seven specific types of intelligences. It is unfair, in his experience, to use pedagogies that support one kind of intelligence but create barriers to other types of intelligences, thereby branding some students as "excellent" and others as "unsatisfactory." Either label is damaging to the psyche, separating them in an unnatural and unhelpful way from their peers, pointing out differences that may have very little meaning in real life (outside the classroom) setting. Howard Gardner's past and current research on the multiple intelligences supports the heart of all indigenous pedagogies.

> Along with this one-dimensional view of how to assess people's minds comes a corresponding view of school, which I will call the 'uniform view.' A uniform school features a core curriculum, a set of facts that everybody should know, and very few electives. The better students, perhaps those with higher IQs, are allowed to take courses that call upon critical reading, calculation, and thinking skills. In the "uniform school," there are regular assessments, using paper and pencil instruments, of the IQ or SAT variety. These assessments yield reliable rankings of people; the best and the brightest get into the better colleges, and perhaps—but only perhaps—they will also get better rankings in life. There is no question but that this approach works well for certain people—schools such as Harvard and Stanford are eloquent testimony to that. Since this measurement and selection system is clearly meritocratic in certain respects, it has something to recommend it. The uniform school sounds fair—after all, everyone is treated in the same away. But some years ago it occurred to me that this supposed rationale was completely unfair. The uniform school picks out and is addressed to a certain kind of mind—we might call it provisionally the IQ or SAT mind. I sometimes call it "the mind of the future law

professor." The more that your mind resembles that of the legendary law professor, Dr. Charles W. Kingsfield, Jr., played on-screen by John Houseman in The Paper Chase, the better that you will do in school and the more readily you will handle IQ-SAT type measures. But to the extent that your mind works differently—and not that many of us are cut out to be law professors—school is certainly not fair to you.

There is an alternative vision that I would like to present—one based on a radically different view of the mind, and one that yields a very different view of school. It is a pluralistic view of mind, recognizing many different and discrete facets of cognition, acknowledging that people have different cognitive strengths and contrasting cognitive styles. I introduce the concept of an "individual-centered school" that takes this multifaceted view of intelligence seriously. This model for a school is based in part on findings from sciences that did not even exist in Binet's time: cognitive science (the study of the mind) and neuroscience (the study of the brain). One such approach I have called 'the theory of multiple intelligences.' Let me tell you something about its sources and claims, and lay the ground work for the educational discussions in the chapters that follow.

To introduce this new point of view, let us undertake the following 'thought experiment.' Suspend the usual judgment of what constitutes intelligence, and let your thoughts run freely over the capabilities of humans—perhaps those that would be picked out by the proverbial visitor from Mars. In this exercise, you are drawn to the brilliant chess player, the world-class violinist, and the champion athlete; such outstanding performers deserve special consideration. Following through on this experiment, a quite different view of intelligence emerges. Are the chess player, violinist, and athlete 'intelligent' in these pursuits? If they are, then why do our tests of 'intelligence' fail to identify them? If they are not "intelligent," what allows them to achieve such astounding feats? In general, why does the contemporary construct 'intelligence' fail to take into account large areas of human endeavor?

To approach these questions I introduced the theory of multiple intelligences (MI) in the early 1980s. As the name indicates, I believe that human cognitive competence is better described in terms of a set of abilities, talents, or mental skills, which I call 'intelligences.' All normal individuals possess each of these skills to some extent; individuals differ in the degree of skill and in the nature of their combination. I believe this theory of intelligence may

> be more humane and more veridical than alternative views of intelligence and that it more adequately reflects the data of human 'intelligent' behavior. Such a theory has important educational implications.[238]

Conquerors' pedagogies cause the student to be anonymous, accepting of their instruction and the instructor, and very seldom ask them to apply their learning to the world outside the classroom. Learning remains abstract in a conquerors' system. Yet, for learning to be meaningful, the individual has to be involved. They *cannot* be like the college classroom students described. They *cannot* be anonymous, they *cannot* be unaffected by experience.

ENDNOTES

[1] Robert B. Strassler, *The Landmark Herodotus: the Histories,* trans by Andrea L. Purvis (Anchor Books, 2009), 42-43. Herodotus tells us that Thales of Miletus predicted the eclipse that occurred when the Medes and Lydians were in the sixth year of continued war. When day became night, both sides stopped fighting and worked for peace, intermarrying to give their treaties the "force of strong obligations." The date of this eclipse was May 28, 585 BC according to Herodotus' editor Robert B. Strassler.

[2] David E. Stuart, *Anasazi America* (University of New Mexico, 2000), 107-124.

[3] Ramon A. Gutierrez, *When Jesus Came, the Corn Mothers Went Away: Marriages, Sexuality, and Power in New Mexico, 1500-1846* (Stanford Press, 1991), 15.

[4] Anna Sofaer, *Chaco Astronomy: An Ancient American Cosmology* (Sante Fe, NM: Ocean Tree Books, 2008).

[5] From my (Ivy Merriot) journal notes from spending the night at the Wheel, September, 2011.

[6] Wyoming State Historical Preservation Office archives.

[7] William Mc. Matthews, West Zone Archaeologist, Bighorn National Forest, Lovell WY.

[8]John Eddy, "Astronomical Alignment of the Big Horn Medicine Wheel," *Science*, 184 (4141) (1974): 1035-1043; Jack H. Robinson, "Medicine Wheels: Testing the Astronomical Theory" (a paper given at the 2nd Oxford International Conference on Archaeoastronomy, Merida, Yucatan, Mexico, 1986).

[9] The concept of "Place" is more than a location or an environment. It has no limits or parameters. It is capitalized here to call attention to the concept of Place as having a "being" with agency. It is not only a backdrop for action, but an instigator, designer, and collaborator in action.

[10] Carol Delaney, *Investigating Culture: An Experiential Introduction to Anthropology* (Wiley-Blackwell, 2011), 9. Delaney points out that the needs of a group (food, shelter, weapons, tools, ceremonies) create the culture of the group, not the other way around.

[11] Robinson, J. H. "Astronomical Alignments at the Fort-Smith Medicine-Wheel," *Archaeoastronomy,* Bulletin Center Arch. 4, no. 3 (1981).

[12] This dissertation describes an interdisciplinary investigation. The immediate problem with interdisciplinary research is that each discipline has a particular style for reporting

research. Within American Studies, a literary or historical style is often preferred. In this dissertation, an American Studies' literary style will be slightly altered to include the hard science writing and vocabulary of astronomy. I apply philosophy's deductive reasoning to express the usefulness of my research in indigenous educational practices. I utilize an emerging writing style recognized in Native American Studies for its indigenous honesty--a style that accepts the use of first person "I" and "my" to more accurately discuss the relationships recounted in this study.

[13] Lucy Maddox, ed., *Locating American Studies: The Evolution of a Discipline* (John Hopkins, 1999). Many good essays in this volume on what it means to be an American.

[14] Facebook did not invent the term, "meme." When the British scientist Richard Dawkins coined the word, "meme" in his 1976 book The Selfish Gene, he wanted a word like "gene**"** that conveyed the way in which ideas and behavior spread within society by nongenetic means. Since then, the word has been used to describe a piece of information spread by e-mail or blogs and social networking sites. A meme can be almost anything—a joke, a video clip, a cartoon, a news story—and can also evolve as it spreads, with users editing the content or adding comments. Common collocates in the Oxford English Corpus include *spread*, *pass*, and *transmit*. Like the term, "viral" used for ideas spreading on the Internet, meme uses the metaphor of disease and infection.

[15] Henry Nash Smith, "American Emotional and Imaginative Attitudes Toward the Great Plains and the Rocky Mountains, 1803-1850," (PhD diss. Harvard c. 1950). Nash's dissertation was Harvard's first PhD in American Studies. He began the "myth and symbol" school of thought in American Studies. Nash's myth and symbol translate to my use of meme and icon. I use the words, "myth" and "symbol" in this dissertation to mean something quite different than Smith's meaning and therefore do not want to confuse the reader. "Myth" will be used in its definition as an instructive cultural story, not as a fabricated story as Smith implies in his use. Symbols, such as the Medicine Wheel itself, have scientific and mathematical uses. Smith does not give much attention to this aspect. He is more interested in the social creation of myth and symbol, not necessarily tied to reality, whereas when this dissertation speaks of these words, it is in direct relationship to reality.

[16] Chadwick Allen, "Unspeaking the Settler: 'The Indian Today' in International Perspective," *American Studies*, vol. 46, no. ¾, "Indigeneity at the Crossroads of American Studies," *Indigenous Studies Today,* Issue 1 (Fall 2005/Spring 2006) (Fall/Winter 2005): 55.

[17] Russell Thornton, "Native American Demographic and Tribal Survival into the Twenty-first Century," *American Studies,"* vol. 46, no. ¾, "Indigeneity at the Crossroads of American Studies," *Indigenous Studies Today*, Issue 1 (Fall 2005/Spring 2006) (Fall/Winter 2005): 23-38.

[18] The other 33% may have listed a tribal affiliation, without being officially enrolled in a recognized tribe.

[19] Vine Deloria and Daniel Wildcat, *Power and Place* (Fulcrum, 2001).

[20] Stan Juneau, *History and Foundation of American Indian Policy* (Montana Office of Public Instruction, 2001), 23.

[21] Sherrie L. Smith, *Hippies, Indians, and the Fight for Red Power* (Oxford, 2012).

[22] Eddy, Astronomical Alignments; Jack H. Robinson, "Medicine Wheels: Testing the Astronomical Theory," 2nd Oxford International Conference on Archaeoastronomy (Merida, Yucatan, Mexico: 1986).

[23] Thomas Kuhn, *The Structure of Scientific Revolutions* (University of Chicago, 1962).

[24] Robin Wall Kimmerer "The Fortress, the River and the Garden: A New Metaphor for Cultivating Relationship Between Scientific and Traditional Ecological Knowledge," *Contemporary Studies in Environmental and Indigenous Pedagogies, A Curricula of Stories and Place*, ed. Andrejs Kulnieks, Dan Roronhiakewen, Longboat, Kelly Young (Rotterdam Netherlands: Sense Publishers, 2013), 49-76.

[25] Devon Abbott Mihesuah and Angela Cavendar Wilson, *Indigenizing the Academy* (University of Nebraska, 2004).

[26] Native Science is capitalized differently than Western science. This is due to Native Science being one concept, whereas Western science is a type of science. Native Science and Western science are not polarized opposites; Western science is a subset of Native Science.

[27] Nicolaus Copernicus, *On the Revolution of Heavenly Spheres* (Prometheus, 1995), 6-7. Originally published in 1543 as *De Revolutionibus Orbium Coelestium*.

[28] James M. Calder, *The Majorville Cairn and Medicine Wheel Site*, *Alberta*, National Museum of Man Series (Archaeological Survey of Canada, Paper 62, 1977), 202-203.

[29] I find this fascinating that for 800 years, the Wheel in Canada shows no archaeological signs of use between 1000 BC and 200 BC.

[30] This number is estimated from the talks I have given on this topic and the answers I have received when asking the audience to pick out which structures (Stonehenge, Jantar

Mantar, and the Apollo 1 launch pad) that show the culture who built these was engaged in any skywatching or astronomy activities.

[31] Carroll Wegemann, *Report on the Medicine Wheel of Wyoming* (United States Department of the Interior, 1941), 3; Bill Barnhart, "Medicine Wheel," 2. Barnhart adds to his nomination form, " The Crow Indians say it was there when they arrived and this is reinforced by similar statements from members of the Blackfeet, Shoshoni, and Arapaho tribes;" George Bird Grinnell, "The Medicine Wheel," 28. Grinnell discusses the work of H.H. Thompson who lived among the Indians in 1915 and attempted to find information about the origin of the Medicine Wheel. In 1923, a manuscript by Thompson reported that his inquiries caused him to conclude the Crow, Cheyenne, Sioux, Arapaho and Shoshoni knew little information about the origin of the wheel although they did know of its existence and held it as sacred; Don Grey, "Summary Report of the Medicine Wheel Investigation," *Seventh Annual field Conference* (1962), 317. Don states that there are stories that a Crow named Creep Gall built the wheel. Grey may have been repeating this story from a January 25, 1896 newspaper story in the Sheridan Enterprise that told of Chief Creep Gull building an alter and later a house on Medicine Mountain near 1845. The *Wyoming Archaeologist* vol. 2, no. 9, (1959) contained a brief article on the Sheridan newspaper article just three years before Don Grey's 1962 report. The story did not say Creep Gall built the wheel; it said he built an alter. If the Gall story is true, it could explain the wood from 1760 found in the walls of one of the cairns; The environment on top of Medicine Mountain is known to be austere and preserves hearth carbon over long time frames. Steve Platt, Archaeologist, Montana Department of Transportation, Personal communications, 2010; *The Medicine Wheel*, 4th ed. (Lovell, WY: Chamber of Commerce, 1955).

[32] Rick Laurent, Cultural Resource Survey of the Medicine Wheel National Historic Landmark Protection and Interpretation Project (Sheridan, WY: The Bighorn National Forest, March 20, 1989).

[33] The Royal Alberta Museum, Canada, Website:
http://www.royalalbertamuseum.ca/human/archaeo/faq/medwhls.htm
John H. Brumley, *Medicine Wheels on the Northern Plains: a Summary and Appraisal*, Archaeological Survey of Alberta Manuscript Series, no. 12 (Archaeological Survey of Alberta 1988): 6.

[34] Thinkquest, http://library.thinkquest.org/C0118421/wheel.html

[35] Brumley, *Medicine Wheels*, 1-7. Brumley defines medicine wheel categories and explains that the Big Horn Medicine Wheel was the first wheel to be termed, 'medicine wheel.' Other smaller rings later used the same term even though their features and sizes varied greatly.

[36] Brumley, *Medicine Wheel*, 67-81. Brumley gives a detailed overview of "Subgroup 6 Medicine Wheels." He adds diagrams of each wheel and descriptive quotes from major research publications concerning each wheel. Three wheels fit into subgroup 6 when Brumley published this summary: the Big Horn Medicine Wheel, the Majorville Wheel, and the Jennings Wheel. In 2008, Jack Brink found another large wheel in the Acadia Valley in Alberta but categorized it in Subgroup 1 rather than Subgroup 6, due to its lack of recognizable spokes. It has similarities to the other large wheels spoke system in that it has debris between the central cairn and outer rim that may have been spokes at one time. This wheel has a distinctive group of rocks eleven meters from the central cairn to the northeast that hints of astronomy-solstice importance. However, No one has yet researched the astronomy of this wheel. Future astronomical verification may alter Brumley's categories.

[37] Alice B. Kehoe, *Controversies in Archaeology* (Walnut Creek, CA: Left Coast Press, 2008).

[38] It is a strong urban legend in Lovell, Wyoming that Boy Scouts "cleaned up" the Wheel. However, I could not find anyone to verify this statement. If it is true, it must have happened before the oldest living memory, perhaps before the 1930s. Jay Ellis Ransom was of the age to partake in this and mentions it once in his book: Jay Ellis Ransom, *The Big Horn Medicine Wheel The Birth and Death of Humanity And its Successor the Aztec Calendar Stone* (Cody, WY: Yellowstone Printing and Publishing, 1922).

[39] W. Mc. Matthews, West Zone Archaeologist, Medicine Wheel & Paintrock Ranger District, Bighorn National Forest, personal communication, 2009. Looking at the pictures from early in the 20th Century until later, the wheel's spokes look quite similar, however, the cairns along the rim have changed noticeably. The common thought among archaeologists is that the wheel is now too messy to determine astronomical purpose, but the height of the cairns or their shape is not the only features to be considered. The spokes are buried deeply enough that they are not just a surface feature. If the Boy Scouts replaced rocks, it appears they replaced them to sit a-top these subsurface spoke features. Eddy reviewed the displacement of the cairns since a 1917 Stockwell diagram and found that the center of each cairn had changed little while the outside area of the cairn and its height had been slightly modified.

[40] George Grinnell, "The Medicine Wheel," *American Anthropologist*, 24 (1922), 299-310.

[41]The Mill Inn, National Register of Historic Places http://www.sheridanmillinn.com/wp-content/uploads/4_b.pdf accessed November 12, 2013.

[42] Image of Jessamine Leading Pack Horses, used by permission of the Johnson family and X4 Ranch, LLC. @ X4, LLC, all rights reserved.

[43] S.C. Simms, "A Wheel-Shaped Stone Monument in Wyoming," *American Anthropologist* 5 (1903): 107-110.

[44] Grinnell, 1922.

[45] Eddy, "Astronomical Alignments."

[46] Precession refers to the Earth's polar axis change in direction relative to the stars. Astronomy textbooks often publish the length of the cycle at 25,800, but I keep with the ancient Vedic sources that report the cycle length to be 24,000. It is possible that present estimates show a longer cycle because our current change in axis direction is slower than the centuries preceding Hipparchus, from which current calculations are based.

[47] For a quick overview of Milankovitch cycles, see http://www.sciencecourseware.org/eec/GlobalWarming/Tutorials/Milankovitch/ and http://geography.about.com/od/learnabouttheearth/a/milankovitch.htm accessed March 27, 2014.

[48] Archaeologists must assess radiocarbon dates for strong context, lack of contamination, etc. before accepting them. Calder's dates may need reappraisal since the 1977 excavation.

[49] Henry E. Stamm IV, *The Wind River People: The Eastern Shoshone 1825-1900* (University of Oklahoma, 1999), 8-9. Stamm states, "Although the Sheepeaters were Shoshone-speaking people they may have proceeded the general Shoshone-Comanche movement from the Basin by a millennium or more. Archaeological evidence suggests they had adapted to the mountains for several thousand years and were not part of the main eastern migration in the AD 1500-1700 period." See Stamm bibliography for more references on this. Along with references earlier on this same topic, George Horse Capture, Sr. studied stone rings larger than tipi rings in the 1960-70s across Montana and adjacent states. He believed the Plains Indians were not the builders of these larger rings. He felt that since the Plains Indians were not an agricultural people, they had little need to track the seasons. (Personal communication, George Horse Capture, Sr., 2009); In Allen's book about Aggretta, he speaks of a Cree man named Little Bear who spoke of the Sheepeaters as preceding his own people's arrival in the Bighorn Mountains. The Sheepeaters ancient connection to the wheel has many clues in rock art and material remains in the Bighorn and Wind River mountains.

[50] James M. Calder, *The Majorville Cairn and Medicine Wheel Site*, Alberta, National Museum of Man Series (Archaeological Survey of Canada, Paper 62, 1977), 202-203.

[51] Jay Ellis Ransom, "The Big Horn Medicine Wheel: An American Stonehenge?" *The American West* VIII, no 2 (March 1971): 63; Don Grey, "Big Horn Medicine Wheel Site, 48BH3 02" *Plains Anthropologist* 8, no 19 (1963): 32.

[52] Don Grey, "Summary Report," 317. "In the large cairn on the northwest side of the structure was found a piece of wood pinned down between the courses of stone in the wall. A sample was taken…for dating."

[53] The National Association of Interpretation (NAI) certifies informal educators for specific pedagogical skills founded on educators' effectiveness in interpreting the natural world. This is a different route than public school teachers take to learn pedagogical skills. Public school certification is based on learning from education professors inside institutions that are often devoid of the age or type of learners for whom the pedagogy is meant, and using statistics from research, rather than live interactions with real students for their guide.

[54] NONAM, Nordamerika Native Museum, Indianer und Inuit Kulturen, *Learning to Survive: Education in Native American and Inuit cultures*, May 8, 2013 through February 28, 2014.

[55] These lessons were created for use with Project Archaeology, an education project supported by the U.S. Bureau of Land Management. http://www.projectarchaeology.org

[56] David Abram, *The Spell of the Sensuous* (Vintage Books, 1996). David Abram discusses how the shift from oral culture to written culture coincides with the shift from concrete to abstract thinking.

[58] The "Sioux" was the name given through a translation of Aggretta's story. The exact tribe or mixture of groups labeled as the "Sioux" is not known.

[59] http://en.wikipedia.org/wiki/John_Marshall accessed November 27, 2013.

[60] Johnson & Graham's Lessee v. McIntosh - 21 U.S. 543 (1823) found at http://supreme.justia.com/cases/federal/us/21/543/case.html accessed November 27, 2013, page 20-21 U. S. 588.

[61] T.S. Twibell Rethinking Johnson V. M'intosh (1823): The Root Of The Continued Forced Displacement Of American Indians Despite Cobell V. Norton (2001)175.

[62] Balakrishnan Rajagopal, International Law From Below: Development, Social Movements And Third World Resistance 262 (2003).

[63] Veronique Lassailly-Jacob, "Land-Based Strategies in Dam-Related Resettlement Programmes in Africa in 2 Refugee And Forced Migration Studies," *Understanding Impoverishment: The Consequences Of Development Induced Displacement* 199, ed. Christopher McDowell, vol. 2 (1996).

[64] Walter R. Echo-Hawk, In the Courts of the Conqueror: The 10 Worst Indian Law Cases Ever Decided (Golden, CO: Fulcrum , 2010).

[65] Johnson & Graham's Lessee v. McIntosh - 21 U.S. 543 (1823) found at http://supreme.justia.com/cases/federal/us/21/543/case.html accessed November 27, 2013, Page 20-21 U. S. 590.

[66] David Sobel, (from a talk given at Seedlings Education Collaborative Workshop, New Haven, CT, April 2013); Coy A. Buxton and Eugene F. Provenzo, Jr. *Place-Based Science Teaching and Learning: 40 Activities for the Classroom* (Sage, 2012), xviii.

[67] Education about global concerns is not considered in this study. I specifically look at the educational power of local Place, however, as a child develops, their definition of "local" will hopefully expand to the entire globe.

[68] Buxton and Provenzo, *Place-Based Science,* 2.

[69] Mary Hammett Lewis, *An Adventure with Children* (Buffalo, NY: The Park School, 2011).

[70] The US Department of Education Website http://www2.ed...gov/about/overview/fed/role.html accessed February 26, 2014.

[71] Margaret Gillett**,** *History of Education: Thought and Practice* (McGraw-Hill, 1966), 4.

[72] Ken Kay, "21st Century Skills: Why They Matter, What They Are, and How We Get There," *21st Century Skills: Rethinking How Students Learn*, ed. James Bellanca and Ron Brandt (Solution Tree Press, 2010), xvii.

[73] The complexity of a Place includes its astrophysical, geological, biological and human histories.

[74] George Horse Capture, Sr. The Seven Visions of Bull Lodge as told by his Daughter, Garter Snake (University of Nebraska, 1992).

[75] http://projectarchaeology.org/

[76] Margaret Gillett, *History of Education*, 9.

[77] Arthur J. More, "Native Indian Learning Styles: A Review For Researchers And Teachers," *Journal of American Indian Education,* vol. 27 no. 1 (October 1987): 5.

[78] Spiral curriculum is one where a lesson is repeated in slightly or dramatically different ways so the student has the opportunity to continu to learn with each spiral.

[79] This thought is shared by many: Vine Deloria, Daniel Wildcat, Larry Gross, Gregory Cajete, George Horse Capture, Jr., and Shane Doyle.

[80] Arthur J. More, "Native Indian Learning Styles"; T. Tafoya, "Coyotes eyes: Native cognition styles," *Journal of American Indian Education, 21*(2)(1982), 21-33; S. Philips, "Participant structures and communicative competence: Warm Springs Children In Community and Classroom," in Cazden, C., Hymes, D., & John V. eds., *Functions of language in the classroom* (New York: Teachers College Press 1972); F. Erickson and G. Mohatt, "Cultural Organization of Participation Structures in Two Classrooms of Indian Students," *Doing the Ethnography of Schooling* (New York: Holt, Rhinehart and Winston,1982).

[81]Personal communication, Blackfeet Elder, Gros Ventres Elder, and a Crow Elder (I do not have permission to add their names to print.)

[82] Personal communications with Dr. Michael C. Wilson, chair, Department of Earth and Environmental Sciences, Douglas College, New Westminster, BC Canada; Personal communications with adjunct professor of archaeology, Simon Fraser University, Burnaby, BC

[83] Gregory Cajete, *Native Science: Natural Laws of Interdependence* (Sante Fe, NM: Clear Light Publishers, 2000). At the core of Merleau-Ponty's philosophy is a sustained argument for the foundational role perception plays in understanding the world as well as engaging with the world. See the written works of Merleau-Ponty (1908 -1961) at http://plato.stanford.edu/entries/merleau-ponty/ accessed January 28, 2014.

[84] This is a generalized statement. Writing in the form of symbolic art continues to be dynamic as does some first-hand written accounts.

[85] American Indian Science and Engineering, http://www.aises.org/ accessed April 1, 2014.

[86] Amelie Oksenberg Rorty, "The Ruling History of Education" *Philosophers on Education* (1998), 1.

[87] William Calvin, A Brief History of the Mind: From Apes to Intellect and Beyond (Oxford Press, 2004), 83-106.

[88] Oksenberg Rorty, *Ruling History,* 3.

[89] Michael Stephen Schiro, *Curriculum Theory: Conflicting Visions and Enduring Concerns* (Sage: 2013). For more on the importance of the students' concept of reality in education, see Schiro's work.

[90] Project Archaeology http://www.projectarchaeology.org

[91] The amount of shift in a star's position depends on where the star is located on the celestial sphere and the vantage point of the observer, i.e. whether the star is being measured from an eastern horizon, from the zenith, along the ecliptic, etc.

[92] Tapestry Institute, http://tapestryinstitute.org/processes-indigenous-science/ accessed January 23, 2014. "Indigenous Science is different from Western science in important ways, similar in other ways, and a valid way of knowing and learning about the natural world." Incorporating Indigenous Science can create "…increasing scientific diversity in order to increase the diversity of imagination, method, and experience available to the scientific workforce so it can find new and more powerful ways to address critical environmental, health, and energy problems that threaten the earth's communities. To the people who hold this point of view, acculturation destroys the very diversity from which new solutions can come."

[93] Keith Basso, *Wisdom Sits in Places* (University of New Mexico, 1996).

[94] W.A, Allen, *The Sheep Eaters* (New York: Shakespeare Press, 1913).

[95] Larry Loendorf and Nancy Medaris Stone, *Mountain Spirits the Sheep Eater Indians of Yellowstone Century* (University of Utah, 2006), 37-38.

[96] Gregory Smoak, Ghost Dances and Identity: Prophetic Religion and American Indian Ethnogenesis in the Nineteenth Century (University of California, 2006).

[97] David Dominick, review of *The Sheep Eaters,* by W.A. Allen, *Annals of Wyoming* (October 1964): 7.

[98] Ibid, 79.

[99] Rick Laurent, *Cultural Resource Survey,* 38. Although many mentions of fur traders are brought up in many sources, few of them give the trappers a name. Rick mentions a trapper named Andrew Henry as a trapper and partner of Ashley in the Rocky Mountain Fur Company.

[100] Loendorf and Medaris Stone, Mountain Spirits the Sheep Eater Indians.

[101] This is the name Allen gave the Big Horn Medicine Wheel. It is unknown as to whether this is his description or Aggretta's.

[102] Gordon R. Freeman, Canada's Stonehenge: asounding archaeological discoveries in Canada, England and Wales (Kingsley Publishing, 2009).
Gordon Freeman makes the distinction and altered the definition in dictionaries for the term equinox. The Equinox is a global event when the Sun's path in the sky crosses the path of the celestial equator. It does this twice a year. The celestial equator (Earth's equator projection into space) and the Sun's path (the ecliptic) act like two hoola-hoops set inside one another at a 23.5 degree angle to each other. Where the two hoola-hoops cross is the start of spring and autumn. Equal day/equal night is when, at a specific location, the length of day and night are equal. This day falls very near, or on the equinox depending on one's latitude.

[103] John Eddy, "Astronomical Alignment."

[104] Dominick, "The Sheep Eaters."http://www.windriverhistory.org/exhibits/sheepeaters/thesheepeaters.html

[105] Lawrence Loendorf, Review of *The Sheep Eaters* by David Dominick, New Mexico State University.
http://www.windriverhistory.org/exhibits/sheepeaters/thesheepeaters.html

[106] Wilson, Thirst Dances.

[107] Larry Loendorf, "River Crow or Mountain Crow?" (a keynote talk during the Montana Archaeological Society annual conference, 2010).

[108] Tribal Histories Project at the Little Big Horn College, http://lib.lbhc.edu/index.php?q=node/133 accessed December 8, 2013.

[109] Tribal Histories Project at the Little Big Horn College, http://lib.lbhc.edu/index.php?q=node/132 accessed December 8, 2013.

[110] Ibid. http://lib.lbhc.edu/index.php?q=node/67 accessed December 8, 2013.

[111] Jack Robinson, an archaeoastronomer and astronomer educator from University of South Florida in Tampa, found the solar and stellar alignments of the Ft. Smith Wheel corresponded to the Big Horn Wheel when adjusted for the change in latitude.

[112] Frey, Rodney, Lawrence Aripa, Tom Yellowtail, and other Elders, *Stories That Make the World: Oral Literature of the Indian Peoples of the Inland Northwest* (Norman: University of Oklahoma Press, 1995). The audio transcript quoted here was found at http://www.webpages.uidaho.edu/humanities/PDF/Burnt%20Face.pdf accessed December 10, 2013.

[113] Jack H. Robinson, "Astronomical Alignments," 21. Robinson speaks of the Crow legend of Burnt Face; Allan Fires, "Vision Quests at the Big Horn Medicine Wheel and its Date of Construction," *Archaeoastronomy* 3, no 4 (1980): 21-22. Fries notes in his paper that the informant who gave this common legend was not credible. I found no clear rebuttal.

[114] Rob Bargatze, research assistant in this current study, surveyed the tops of Bald Mountain and Sheep Mountain and found both to have many white stones similar to the Big Horn Wheel. Sheep Mountain's stones were still in the shape of a wheel while Bald Mountains stones had been altered to spell someone's name.

[115] Joseph Campbell showed how many culture's hero stories are similar in their common plot elements. He called the commonalities, "The Hero's Journey." See the following for a description of common plotlines: http://www.thewritersjourney.com/hero's_journey.htm accessed April 1, 2014.

[116] http://crm.cr.nps.gov/issue.cfm?volume=22&number=03 http://crm.cr.nps.gov/archive/22-3/22-03-2.pdf accessed November 2009.

[117] "Boost Park In Big Horns Party Returns From Week Of Exploration. Medicine Wheel," *Sheridan Post*, Sheridan, Wyoming, July 11, 1916, 1, Column 6. This article was found at http://www.crowreservation.com/html/medicine_wheel.htm accessed September 12, 2009. The webpage was written by the grandson of Joe Boyd, a member of the traveling group guided by Cut Ear.

[118] Don Grey's, "Summary Report of the Medicine Wheel Investigation," *Seventh Annual Field Conference* (1962), 317.

[119] *Sheridan Enterprise*, January 25, 1896 stated Chief Creep Gull built an altar and later a house about 1845 on Medicine Mountain.

[120] Wyoming Archaeologist 2, no. 9 (1959).

[121] *The Medicine Wheel*, 4th ed. (Lovell WY: Chamber of Commerce, 1955).

[122] Over the past century with many inter-tribal discussions about the Wheel, the only contradiction to come forth is Tom Yellowtail's (Crow) account of Burnt Face building

the Wheel. This post-dates the discussions over the nomination of the Wheel as a Sacred Site and National Historic Landmark. At that time, the Crow were in agreement that they did not know the Wheel's builder. This leads this author to question if Tom's story of Burnt Face was of a different wheel in the Bighorn Mountains, as noted in the text above.

[123] http://philkearny.vcn.com/fpk-tallbull.htm accessed March 2012.

[124] Francine Spang-Willis has her Masters degree in Native American Studies from Montana State University in Bozeman, MT and is former director of the American Tribal Histories project at the Western Heritage Center in Billings, MT. She is a descendent of Northern Cheyenne, Pawnee and German ancestors.

[125] Francine Spang-Willis quoted by Amy Stix, "Teaching Native American History from a Native Viewpoint," *Confluence* (College of Letters and Science, Montana State University, 2011-2012), 11. In 2012, the last two sentences were altered slightly, based on an email confirmation from Spang-Willis.

[126] Personal communication, George Horse Capture, Sr., 2009; Kevin Gover (Pawnee), director of the National Museum of the American Indian in Washington, DC., stated in George's April 2013 obituary, "He will be remembered not only as a dear friend and colleague, but as a leader in the reform of museology as it relates to Native peoples, and as one of the founding thinkers of the National Museum of the American Indian," Quoted from http://nmai.si.edu/sites/1/files/pdf/press_releases/George-Horse-Capture.pdf accessed December 10, 2013. Horse Capture earned a BA in anthropology from Berkeley and an MA in Native American Studies from Montana State University. In 1994, George was awarded an honorary PhD from Montana State University for his contributions to the field of Native American Studies.

[127] Personal communication with Terry Brockie (A'aninin/Gros Ventres),2009. Brockie is now Superintendent of Schools of Blaine County, Montana.

[128] The term, "ancestor" used in this way connects people to a Place, not necessarily a bloodline. I have found this definition of ancestor to be common among many different indigenous people of the northern Rocky Mountain region.

[129] Loendorf and Stone, *Mountain Spirit*, xi.

[130] The lack of stories about the Wheel in current Shoshone oral histories is evidence that Aggretta's Sheepeater tribe was not an offshoot of the Shoshone for in the later 1800s, she still knew her tribal stories of the Wheel. When she said her tribe all died from a disease, the lack of her tribe's stories remaining in circulation appear to give evidence that the Sheepeaters had their own oral histories apart from other Shoshone groups.

[131] Leo Bird, "Blackfeet Cultural Astronomy" (a public talk given at the Museum of the Rockies, Bozeman, MT 2005).

[132] Leo Bird, Blackfeet, personal communication, 2004.

[133] George Horse Capture, Jr., Personal communications, 2004.

[134] Alice B. Kehoe, *Controversies in Archaeology* (Walnut Creek, CA: Left Coast Press, 2008). Carroll Wegemann, *Report on the Medicine Wheel of Wyoming* (United States Department of the Interior, 1941), 3.

[135] S.C.Simms, "A Wheel-Shaped Stone Monument in Wyoming," 107.

[136] George Grinnell, "The Medicine Wheel" *American Anthropologist*, 24 (1922): 299-310. " Karl H. Schlesier, "On the Big Horn Medicine wheel: A Comment on Mathew Liebmann, *Plains Anthropologist* 47-180:61-71," *Plains Anthropologist* 47, 183 (2002): 389.

[137] Cushing, *Zuni: Selected Writings of Frank Hamilton Cushing,* ed. Jesse Green (University of Nebraska, 1979), 116-117.

[138] Allan Fries, "Vision Quests."

[139] David Hurst Thomas, "Big Horn Medicine Wheel," *Exploring Native North America* (Oxford, 2000), 66.

[140] Jay Ellis Ransom, The Big Horn Medicine Wheel The Birth and Death of Humanity And its Successor the Aztec Calendar Stone (Cody, WY: Yellowstone Printing and Publishing, 1922).

[141] According to the Bighorn District Forest Service, the skulls appear and disappear without the Forest Service's knowledge of who is taking or replacing them. Personal communications with Bill Matthews, Bighorn District Forest Service (Sept 2010).

[142] Wilson, Michael, "Sun Dances, Thirst Dances, and Medicine Wheels: A Search for Alternative Hypotheses," in *Megaliths to Medicine Wheels: Bolder Structures in Archaeology*, eds. Wilson, Road and Hardy *Proceedings of the Eleventh Annual Chacmool Conference* (Calgary: University of Calgary, 1981).

[143] Karl H. Schlesier, "On the Big Horn Medicine Wheel: A Comment on Mathew Liebmann, Plains Anthropologist 47-180:61-71," *Plains Anthropologist,* vol. 47 no.183 (2002): 387-392.

[144] Ivy Merriot and Marsha Fulton, measurements taken at the wheel, September, 21, 2009.

[145] Don Grey, *Summary Report,"* 317. "In the large cairn on the northwest side of the structure was found a piece of wood which had been pinned between courses of stone in the wall…wood…had died in 1760…likely that wheel had been built around 1800."

[146] Joe Medicine Crow (from a recorded oral history archived at the Western Heritage Museum in Billings, MT.)

[147] Don Grey, "*Big Horn Medicine Wheel Site,* 27-40.

[148] B.P. means 'before present' where 1950 is considered 'present' due to the beginning of radio carbon dating at this time.

[149] W.A, Allen, *The Sheep Eaters* (New York: Shakespeare Press, 1913).

[150] Wyoming Historical Preservation Office archives.

[151] Ransom's letter to Thomas Marceau, Deputy Director of the State Historic Preservation Office in Wyoming, July 10, 1991 and another letter to Mr. Lloyd D. Todd, Forest Supervisor on June 26, 1991. Both letters can now be found at the Wyoming State Preservation Office. Ransom's paper on the Uto-Aztecan connection to the wheel was titled, *Archaeolinguistics and Paleoethnography of Ancient Rock Structures in Western North America* (The Dalles, Oregon: Western American Institute for Exploration, Inc., 1984).

[152] Personal communications with seven anthropologist/archaeologists who will remain anonymous.

[153] Jay Ellis Ransom, *The Big Horn Medicine Wheel, the Birth and Death of Humanity, and its Successor the Aztec Calendar Stone* (Cody, WY: Yellowstone Printing and Publishing, 1992).

[154] Cosmogram is a term used by Ransom for structures like the Big Horn Medicine Wheel that symbolically represent the cosmos.

[155] Don Stier, *Big Horn Medicine Wheel: The Discovery of a Place* (Master's thesis in landscape architecture, Kansas State University, 2000), 56-62. Stier describes similar cosmogram ideas in the physical sacred space of the wheel.

[156] A Montana State University astronomy student took pictures of Capella and could not tell it was a star. When many professors looked at the image, no one was certain what this bright, colorful object might be.

[157] I attempted on many occasion to track down Jay Ellis Ransom and interview him. I finally found a letter where he stated he was leaving his home in the Dalles, OR, and driving off to travel in his RV.

[158] James Kaler, author of numerous astrophysics and layman books, professor emeritus http://stars.astro.illinois.edu/sow/Alderamin.html

[159] Jay Ellis Ransom, *Gems and Minerals of America* (Unknown publisher. ISBN: 0-06-013512-3, 1974).

[160] Jay Ellis Ransom, "The Big Horn Medicine Wheel," *American West,* 1971, 17.

[161] Michael Wilson, (from a Big Horn Medicine Wheel roundtable discussion at the Montana Archaeological Society Conference 2011).

[162] Eddy worked at the High Altitude Observatory of the National Center for Atmospheric Research in Boulder, Colorado. He was a founding member of the Historical Astronomy Division of the American Astronomical Society. http://had.aas.org/ accessed April 2, 2014.

[163] Spencer Weart, *Interview with Jack Eddy*, April 21, 1999 in Michigan by phone, conducted by, found at the website for the American Geophysical Union http://www.agu.org/history/sv/solar/eddy_int.html accessed April 4, 2014.

[164] Personal Communication, Jack Brumley, Oct. 2009.

[165] Fries, "Vision Quests," 23.

[166] Spencer Weart, *Interview.*

[167] John A. Eddy, "The Maunder Minimum," *Science*, New Series, 192 no. 4245 (Jun. 18, 1976): 1189-1202.

[168] Spencer Weart *Interview.*

[169] Elizabeth C. Baity, "Archaeoastronomy and Ethnoastronomy So Far," *Current Anthropology* 14, no. 4 (October 1973): 389-449.

[170] Keith Kintigh, "I Wasn't Going to Say Anything, but Since You Asked: Archaeoastronomy and Archaeology," ed. Aveni, *Foundations of New World Cultural Astronomy: A Reader With Commentary* (Boulder, CO: University Press of Colorado, 2008), 806.

[171]Jay Ellis Ransom, "The Big Horn Medicine Wheel: An American Stonehenge?" *The American West* III, no. 2 (March 1971): 63. In this article in *American West* Ransom proposed the idea that the Big Horn Medicine Wheel and Stonehenge could have cosmological similarities. Ransom did not investigate this idea using physical science methods of measurements. This article came out only a year before Eddy went to the wheel to investigate astronomical alignments.

[172] Allan Fries, "Vision Quests."

[173] Jack H. Robinson," Medicine Wheels*."*

[174] David Kelley and Eugene Milone, *Exploring Ancient Skies: Encyclopedic Survey of Archaeoastronomy* (Springer, 2005), 209.

[175] Non-written, oral history.

[176] Gary Theisen and Don Adams, **"**Comparative Education Research," *International Comparative Education, Practices, Issues, & Prospects,* ed. R. Murray Thomas (Oxford, 1997)**,** 282.
The four research methods described by Theisen and Adams are analytical, descriptive, evaluative, and exploratory.

[177] My research team included Jack Robinson, Bill Mackin and his daughters: Maggie and Jessie, Joel Haynes, Even Howard, Robert Bargatze, Joy-lyn and David McDonald, and Marsha Fulton. Jack Robinson has had a long career in astronomy education and has published archaeoastronomy research on the Big Horn Medicine Wheel and the Fort Smith Medicine Wheel. Robert Bargatze has been an avid amateur astronomer and telescope operator for over fifty-five years. Joel Haynes is an astro-photographer and landscape astro-photographer. Even Howard is an artist and skywatcher. The McDonalds are astronomy educators and telescope operators. Marsha Fulton is an art historian, anthropologist, and mythologist specializing in global Goddess mythologies. Marsha is also a founder of the Extreme History Project along with Crystal Alegria.

[178] These are the qualifying uses of exploratory research as listed by Theisen and Adams, *Comparative Education Research,* 282.

[179] Eddy, "Astronomical Alignments."

[180] Ibid.

[181] The types of celestial globes used by Robinson are extremely difficult to find. Today, education supply houses offer globes that are static in time and not able to alter the north

pole stars as the years go by. This means they do not show the change of stars or seasons over time. They are less complex and less accurate.

[182] Star alignments were checked by Robert Bargatze and adjusted for the date of viewing.

[183] Fred Schaaf, *The Brightest Stars: Discovering the Universe through the Sky's Most Brilliant Stars* (Wiley, 2008), 152-153. Schaaf quotes Canadians from Edmonton, Alberta who told of their fondness for the "clouds of Capella" referring to Capella's association with noctilucent clouds. Noctilucent clouds (NLC) keep a silver-blue glow after Sunset due to their location in the highest part of Earth's atmosphere. Alister Ling told Schaaf that "90% of the NLC images have Capella in them." Schaaf repeats earlier star historians in reporting other names used for Capella, such as the "Heart of Brahma," the "Charioteer," the "Shepherd," and the "Drinking Horn of Zeus." All of these stories are told in rigorous, historical depth in the following: William Tyler Olcott, , *Star Lore: Myths, Legends, and Facts* (Dover. 2004, Original edition, G.P Putnam's Sons, 1911). Richard Hinkley Allen, *Star Names: Their Lore and Meaning* (Dover,1963, original edition, G.E. Stechert 1899).

[184] Stars along the ecliptic move about a degree for every seventy years relative to the equinoctial points. The angular change in position for any given star will alter from this depending on a star's placement relative to the ecliptic and accounting for the star's proper motion.

[185] The change is Capella's position for the years 2000 and 3000 show a backing off from zenith. This is probably due to other cycles that perturb the precessional cycle.

[186] In order of brightness (apparent visual magnitude): Sirius -1.47; Arcturus -0.06; Vega 0.04; Capella 0.05. The larger the apparent visual magnitude number, the less bright the star will be as seen from Earth. Sirius, with its negative number is the brightest of these.

[187] Bright stars are easy to see and therefore can be used to locate the "important" stars that may not be as bright but may be more useful for accuracy tracking celestial events.

[188] Grinnell, 1922.

[189] http://stardate.org/nightsky/Moon accessed December 21, 2013.

[190] David H. Kelly and Eugene F. Milone, Exploring Ancient Skies: an Encyclopedic Survey of Archaeoastronomy (Springer, 2005).

[191] The Earth and Moon may occult the Sun from an outer planet's point of view. In these cases, the earth and Moon are between the outer planet and the Sun.

However, due to the distance, the Earth and Moon would appear as small dark dots against the brightness of the Sun. These occurrences are termed "occultations."

[192] See the Babylonian star chart using the "star-based" frame of reference. See image depicting the night sky in 2800 BC at 36 * north in the *Journal of British Astronomy Association* 108, (1998): 1.

[193] TLRBSE Teacher Leaders in Research Based Science Education chose teachers from around the country to learn how to do astronomical research to better inform their teaching practice. A wonderful experience for teachers.

[194] The term, "asterism" refers to a group of stars often connected by lines as seen here. The term, "constellation" is an official International Astronomical Union label given to a formally defined section of sky that may include one or more the asterisms. For example, the Big Dipper is an asterism, Ursa Major is a formal, internationally defined constellation area of the sky. There are many stars in the constellation Ursa Major that are not part of the asterism of the Big Dipper.

[195] A. Berger, "Milankovitch Theory and climate" *Reviews of Geophysics,* Article first published online: 14 JUN 2010, Volume 26, Issue 4, pages 624–657, November 1988, accessed January 13, 2014.

[196] The length of the precessional cycle is currently debated. Calculations based on Hipparchus (150 BC) may not be as accurate as ancient Vedic texts from India. See Sri Yukteswar, *The Holy Science* (Self Realization Press, 1990) for a detailed discussion on the precessional cycle and the Vedic scholars' contributions.

[197] The overlay of the ecliptic northern stars with the Wheel was created using the 1958 survey of the Wheel by the Wyoming Archaeology Society and a starfield created by Ivy Merriot using Starry Night Pro 6 software.

[198] The article: "Primeval Symbolic Ruin*s"* by Thomas Wilson Cultra (unpublished? 1932) was found among the papers of Jessamine Spear Johnson by her granddaughter Tempe Javitz. In Cultra's article in 1932, he spoke of some of these same astronomical concepts. I could not determine whether his astronomy ideas matched precisely with those in this dissertation because the article was missing the diagrams that would have originally accompanied his work. Javitz is continuing to search for the Cultra's diagrams.

[199] Asiana flight 214, July 2013.

[200] Personal communication with Alice Kehoe, 2011.

[201] Robin Kimmerer (from a talk given at Montana State University, Bozeman, MT, Feb 21, 2014).

[202] Walter Cruttenden, "History and Celestial Time," in *Lost Knowledge of the Ancients*, ed. G. Kreisberg (Rochester, Vermont: Bear and Company, 2010).

[203] The exceptions are stars with quick proper motion or transformative stars such as those becoming a black hole or in a nova.

[204] From my research, skywatchers last updated the Wheel circa AD 1000.

[205] Ideogram defined in Wikipdia, http://en.wikipedia.org/wiki/Ideogram accessed March 7, 2013. "An ideogram or ideograph (from Greek □δέα idea "idea" + γράφω grafo "to write") is a graphic symbol that represents an idea or concept. Some ideograms are comprehensible only by familiarity with prior convention; others convey their meaning through pictorial resemblance to a physical object, and thus may also be referred to as pictograms." The Wheel is an ideogram because it represents the concept of time as illustrated in the ecliptic north circle of polar stars.

[206] Monika M. Langer and Maurice Merleau-Ponty, Merleau-Ponty's Phenomenology of Perception : A Guide and Commentary (Tallahassee
Gainesville, FL: Florida State University Press, 1989).

[207] "Is the Bighorn Medicine Wheel an Astronomical Calendar?" *100 Greatest Mysteries Revealed* (National Geographic, 2013), 24.

[208] Nate St. Pierre (from his talk at the Native Nexus Indian Education For All Conference, Montana State University, 2006).

[209] John Amos Comenius, "The Universal Requirements of Teaching and Learning," *Great Didactic of Comenius,* trans. M.W. Keatinge (London: A & C Black, 1896).

[210] Darryl Kipp, (from a talk at the Blackfoot education conference, Blackfeet Community College, Browning, MT, 2005).

[211]Paul E. Peterson, *The Politics of School Reform 1870-1940* (University of Chicago, 1985), 10-11.

[212] Ibid.

[213] Margaret Gillett, *A History of Education: Thought and Practice* (McGraw-Hill, 1996), 207.

[214] Gillett, A History of Education, 219.

[215] Ibid.

[216] Gillett, A History of Education, 217.

[217] Gillett, A History of Education, 220.

[218] Gillett, A History of Education, 223.

[219] Gillett, *A History of Education,* 226. Quoting Spencer from Herbert Spencer, *Education: Intellectual, Moral and Physical* (London: Watts and Co., 1903) 11.

[220] James A. Johnson, Foundations Of American Education : Perspectives On Education In A Changing World, 15th ed. (Upper Saddle River, NJ: Pearson, 2011).

[221] Peterson, The Politics of School Reform, 11.

[222] Gillett, A History of Education, 210.

[223] Peterson, The Politics of School Reform, 11.

[224] Bill Labov, "The Logic of Non-Standard English," *Report of the Twentieth Annual Round Table Meeting on Linguistics and Language Studies,* ed. James E. Alatis (Goergetown University, 2007).

[225] Gillett, A History of Education, 228.

[226] Gillett, *A History of Education,* 132. Comenius quote from John Amos Comenius, *The Great Didactic,* M.W. Keatinge trans. (London: Adam and Charles Black, 1896), 250.

[227] Darryl Kipp, Blackfeet Immersion School Administrator, (from a talk at the Blackfeet Education Conference, Browning, MT 2005).

[228] Howard Gardner, http://howardgardner01.files.wordpress.com/2012/06/in-a-nutshell-minh.pdf, http://howardgardner.com/multiple-intelligences/ accessed December 12, 2013.
[229] The exception is charter schools where experimentation with time and funds is expected.

[230] **http://www.parker.org/pages/Francis_W__Parker_Charter_Esse/About_Us/Ten_Common_Principles** accessed November 24, 2014.

[231] John H. Falk and Lynn D. Dierking, *Learning from Museums: Visitor Experiences and the Making of Meaning* (Rowan and Mittlefield, 2000).

[232] Special education and gifted education within the public schools attempt to move toward individual needs but both are underfunded and too few students are accepted into these programs.

[233] http://en.wikipedia.org/wiki/List_of_countries_by_incarceration_rate

[234] http://www.money.cnn.com/infographic/economy/education-vs-prison-costs/

[235] Inuit goes to congress. http://www.aises.org/ AISES is a professional society established by and for American Indian and Alaska Natives that specifically emphasizes lifelong learning and educational achievement by utilizing cultural aspects with STEM (a federally-funded program to improve education in the fields of Science, Technology, Engineering, and Mathematics). Indigenous Science research at Tapestry Institute include: NSF Grant no. ARC-0503460. SGER: Making a New Collection of Indigenous Resources About Arctic Climate Change Available to the Public for Research and Education; NSF Grant no. GEO-0417447. Developing a Pilot Collection of Digital Native Science Resources for DLESE; NSF Grant no. ESI-0224900. Using traditional paradigms of Native Science to structure informal science education films (planning grant); NSF Grant no. GEO-0138004. Stories from the Circle: Science and Native Wisdom; NSF Grant no. DUE-9254171. Design and implementation of a Bioliteracy Laboratory course to replace traditional introductory non-majors biology laboratories at colleges and universities. D. [Hill] Adams and D. Wivagg, co-PIs. Taken from Tapestryinstitute.org accessed January 23, 2014.

[236] Dan Roronhiakewen Longboat, Andrejs Kulknieks, and Kelly Young, "Beyond Dualism" *Contemporary Studies in Environmental and Indigenous Pedagogies: A Curricula of Stories and Place* 9, 20 (Science Pub, 2013): 9-10.

[237] Eben Howard, doctoral candidate in Computer Science at Montana State University, Bozeman, MT.

[238] Howard Gardner, http://howardgardner01.files.wordpress.com/2012/06/in-a-nutshell-minh.pdf http://howardgardner.com/multiple-intelligences/ accessed December 12, 2013.

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