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Teacher Perceptions of Environmental Science in Rural Northwestern New Mexico Public Schools

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TEACHER PERCEPTIONS OF ENVIRONMENTAL SCIENCE IN RURAL NORTHWESTERN NEW MEXICO PUBLIC SCHOOLS

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DISSERTATION

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DEDICATION

This dissertation is dedicated to all of my family and friends, and especially to my two daughters, Jasmine Uchme E'hengmay and Sa'angna Mi'ila, who have watched me do this with wonder and love in their eyes for the past 10 years.

And, for educators everywhere. We will go far together.

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ABSTRACT

In this study, I explored what teachers perceive as the factors that impact their teaching of environmental science in rural secondary level schools in northwestern New Mexico. I adapted Bronfenbrenner's (1994) ecological systems model, based on four environmental subsystem levels (microsystem, mesosystem, exosystem, and macrosystem), as the conceptual framework to address the major research question of this study, and developed 18 interview questions to explore teachers' perceptions of factors that influence their teaching of environmental science. I investigated the perspectives science teachers have about environmental science topics and the influences they perceive that affect how they teach environmental science, and I sought to understand how these perceptions influence curriculum integration of place-based and culturally responsive environmental science material into their classrooms. My analysis exposed themes in teachers' beliefs, experiences, and objectives for teaching environmental science topics. Each level of the ecological framework unveiled multiple-level factors, including interactions between different ecological system levels that secondary level teachers perceived to impact their teaching of environmental science in rural northwestern New Mexican classrooms. My findings revealed similarities as well as differences between middle and high school teacher perceptions in regards to factors such as, the implementation of the Next Generation Science Standards, building students' core competencies versus teaching content for standardized testing, parental and community engagement, and procuring funding and resources to meet district and State science objectives.

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Chapter 1

Environmental science is a discipline that studies complex issues of ecologic concern, such as how climate change works and what causes it; methods to protect nonrenewable natural resources; and sustainability. It is an interdisciplinary field that combines theories and methods from the biological, physical, and social sciences (Spellman & Stoudt, 2013). Decisions related to sustainability and environmental science connect multiple disciplines, and the interdisciplinary nature of environmental science education connects philosophy, agriculture, earth sciences, sociology, engineering, politics, economics, biology, ecology, physics, and chemistry (Spellman & Stoudt, 2013). Environmental science, as explained by Best (1994), “embraces more” than mere science; it is based on interactions between humans and natural systems in the world. A number of significant global environmental topics make up the core study of environmental science education. These topics are cross-curricular and seek solutions to world environmental problems of global warming, damage to the ozone, deforestation, acid rain, soil erosion, and threats to endangered animal and plant species (Greenwood, 2016). Thus, environmental scientists try to understand the ways human activity and rapid technological advances have changed the earth’s biosphere and whether or not such changes are reversible.

The movement to bring awareness about the need to protect the environment dates back to the mid-19th century, during the time of the Industrial Revolution, when high levels of air pollution blanketed the industrial centers throughout Europe. In the U.S., the official beginning of environmentalism is considered to be the first Earth Day celebration (April 22, 1970), which lead to the creation of the Environmental Protection Agency

(U.S. Environmental Protection Agency, 1970) less than a year later, and also to the passing of the Clean Air Act of 1970 (U.S. Environmental Protection Agency, 1970), the Clean Water Act of 1972 (U.S. Environmental Protection Agency, 1972), and the Endangered Species Act of 1973 (U.S. Fish and Wildlife Service, 1973). Ten years later, the United Nations (UN) convened the World Commission on Environment and Development (WCED). Informally known by the name of its Chair, Gro Harlem Brundtland, the Brundtland Report, *Our Common Future* (1987), contains one of the most often cited definitions of sustainability:

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: 1) the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and 2) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs (Brundtland, 1987).

This definition has acted as a wellspring for other environmental declarations, such as talks amongst global leaders about climate change, and the drafting of the Kyoto Protocol (UNFCC, 2005) and the Paris Agreement (United Nations Treaty Collection, 2015). The objective of teaching environmental science is to help students to have a deeper understanding of the important environmental issues and to acquire the skills necessary to make informed and responsible decisions when it comes to protecting the environment. Three main goals of environmental science education are: 1) to learn how the natural world works; 2) to understand how we as humans interact with the environment; and 3) to determine how humans affect the environment, which also includes seeking solutions to deal with the negative effects on the environment (Spellman & Stoudt, 2013).

The Need for This Study

Given the population in New Mexico, it is important to consider how environmental science is taught so that it is relevant for the students. This study showcases how teachers are integrating important and topical environmental topics and issues into their science curriculum, and the creative ways in which they approach teaching environmental science, and how they address teaching environmental science in a culturally responsive manner, all of which would really benefit science education in the State. The need for this study also includes:

1. The importance of understanding how environmental science is currently taught and how teachers perceive it should be taught.
2. To understand how environmental science can benefit students and communities and the State as we move into the second decade of the 21st century.

Given the need to understand how environmental science is taught, in this study, I ask teachers, “What are the factors that impact teaching environmental science in rural New Mexico secondary schools?,” in order to explore the factors that affect teaching environmental science in secondary schools (grades 6-12) in rural northwestern New Mexico.

For this study, in order to frame the landscape of teachers’ perceptions of environmental science education in New Mexico secondary level schools, my investigation includes how teachers perceive the teaching of environmental science education, school support systems, and community engagement. I also explore teacher perceptions of how environmental science education extends into the community and home, and how this extension influences what they report teaching in the classroom.

Problem Statement

Major local environmental catastrophes such as the 2015 Gold King Mine wastewater spill into the Animas and San Juan rivers (EPA, 2015) and local and national environmental protests, such as protests around fracking in Chaco Canyon National Historic Park in northwest New Mexico (Moss, 2017); the sale of thousands of acres in both northwest and southeast New Mexico to oil and gas industries (King-Flaherty, 2018); and the 2016 Dakota Access Pipeline [DAPL] at Standing Rock, North Dakota (Simmon, 2016) have increased awareness about important environmental issues; thus bringing attention to environmental science education topics that directly relate to the local community.

New Mexico has been a leader in energy research and development since 1945. Mining districts for coal, industrial minerals, metals, uranium, and oil play vital roles in state economies. The Chino Mine, an open-pit copper mine in the small town of Santa Rita, New Mexico, is one of the three oldest open pit copper mines in the world, the other two being Utah’s Bingham Canyon Mine and Chile’s Chuquicamata Mine. The Four Corners region is the only place in the United States where four states (Utah, Colorado, New Mexico, and Arizona) intersect at one point and is home to the Navajo Nation, which maintained four mining and milling operations on federal Indian reservation land in northwestern New Mexico (Brugge, 2007). These operations have generated both advantages (i.e., funds generated from extraction royalties) and disadvantages (e.g., spills, contamination, and health repercussions from abandoned mine shafts). (U.S. Environmental Protection Agency, 2018). The uranium mining has had mixed results for the Navajo Nation, affecting the Navajo as a people both culturally and financially. While bringing much-needed funds to the tribal treasury, the radioactive contamination has left a legacy of health hazards in mining communities. Navajo Nation oil and gas operations in the 1950s and 1960s enriched the Navajo Nation as well, but have also caused environmental and ecosystem problems, contaminating water and damaging rangelands (Ulmer-Scholle, 2018; Reno, 1981). New Mexico is still a leader in U.S. uranium output, and most uranium production today comes from the Jurassic Morrison Formation sandstone and limestone uranium deposits in rural McKinley and Cibola Counties (McLemore & Chenoweth, 1991). However, there are a number of mining issues that New Mexico is currently facing, including global competition, conflicts between mining and other activities, and shortage of young geologists and engineers (McLemore, 2018). And although the mining sector has seen a 25% decline in its labor force over the past few years, the labor force is still strong in oil and gas extraction, employing more than 23,000 (New Mexico Department of Workforce Solutions [NMDWS], 2017).

Bordertowns adjacent to the Navajo Nation and other tribal reservation lands in New Mexico also have long socio-political and economical histories tied to the mining and extraction industry (Martinez, 2015; New Mexico Advisory Committee to the U.S. Commission on Civil Rights, 1975). Bordertowns, such as Farmington in northwestern New Mexico, are important to my research because of the location in which this study about how teachers perceive teaching environmental topics takes place and the context in which this study was done.

Environmental scientists are tackling tough issues in the face of the growing concerns we are experiencing today. They are interested in understanding the ways human activity and rapid technological advances have changed the earth's biosphere and whether or not such changes are reversible. Building a workforce that can advance science and technology innovations is a priority of national policy (U.S. Department of Education, 2016). As many as 120 million high-skilled job applicants with knowledge and skills in science, technology, engineering, and mathematics (STEM) disciplines will be needed by 2020. Most future job opportunities in energy and related manufacturing, in even traditionally blue-collar positions, will require more advanced technical skills. Changes to school science content standards, particularly those that affect what environmental science topics are taught, have been the subject of important policy discussions.

New common science standards for New Mexico schools were approved effective July 1, 2018. This study occurred at the same time as the preliminary debates around the State's adoption of common science standards in the 2018-19 school year, as well as how the State and districts plan to implement these new standards at the school level. New Mexico science teachers face a difficult challenge in implementing new science standards and they will need additional resources, such as curriculum development, instructional materials, and documentation examining early successes and challenges, if they are to successfully implement these changes into their curricula. The old standards will be transitioned out during the 2018-2019 school year, and the new standards are to be fully in place for the 2019-2020 school year. But because the standards assessment testing for the 2018-2019 school year will be based on the old standards and test grades 4, 7, and 11, science teachers in New Mexico public schools are being charged with simultaneously teaching their science subject matter using the old standards while beginning the implementation of the new science standards into their curricula. The 2019-2020 school year standardized assessment testing will be based on the new standards and will change to grades 5, 8, and 11. Moreover, under the approved state Every Student Succeeds Act (ESSA) plan, five percent of the school grading formula will include science proficiency rates beginning in the 2019–2020 school year (New Mexico Public Education Department, 2017). The ESSA replaced the No Child Left Behind Act (U.S. Department of Education, 2001) in December 2015 but it did not eliminate standardized testing. However, a student can be minimally proficient as described in the performance level descriptors and still pass the End of Course (EoC) as an alternate demonstration of competency for graduation requirements.

The new common science standards require students to have a contextual understanding of how scientific knowledge is acquired, applied, and connected (NGSS Lead States, 2013, pp. xxii-xxvi). In considering the various systems that influence how teachers teach about environmental science, this study focuses on teachers' perceptions of environmental science education in light of the new science curriculum adopted by the State. The study delves to reveal larger perceptions of environmental science that ultimately influence what and how science teachers teach.

As science teachers begin to implement the new standards in their classroom pedagogy, it is expected that their approach to environmental science in general, and climate change in particular, will be changing. However, curricular implementation also depends on other variables. Community demographics, for example, influence perspectives about climate change and pollution, and, unfortunately, Native American reservation communities and communities of color often bear the brunt of industrial processes and pollution (LaDuke, 1999). In the area involved in this study, some people work in the oil and gas extraction industry, while some others may participate in environmental activism. According to the concept of environmental justice, all persons, regardless of socioeconomic status, race or ethnicity, or geographic location (urban or rural) are not “forced to bear disproportionately the external cost of industrial processes” (Daudi & Heimlich, 2002). In rural northwestern New Mexico communities, particularly in San Juan and McKinley counties, a significant percentage of the population is Native American and engaged in issues of environmental justice. For example, in McKinley County, citizens of a reservation bordertown community have been fighting mining company HRI in court for more than two decades (Capitan, 2000; Capitan et al, 2006). Therefore, there may be more to consider about environmental science education than just teaching to fulfill graduation requirements.

Ecological Framework

The conceptual framework I use to guide this research is based on the work of psychologist Urie Bronfenbrenner (1979). His ecological model centered on the idea that multiple and overlapping contexts of a person’s environment directly influence one’s experiences and perceptions in life. His model proposes that development is a function of multiple forces and the interrelations of these forces within multiple settings, and within the context of these systems, relationships form a teacher’s environment and establishes structures as contexts for the development of their perceptions of how and why they teach important topics in environmental science.

Utilizing an ecological framework, I delve into environments that shape teachers' perceptions about what environmental science topics they teach and how they teach them. For example, political debates surrounding environmental science topics have been making their way into classrooms while states are deciding whether to adopt or reject new science standards that put a greater emphasis on controversial topics like the aforementioned climate change.

Bronfenbrenner's (1994) ecological theory of human development is well adapted to this research about teachers' perspectives on environmental science education because of overlapping influences within curriculum and instructional development. The application of the ecological framework to this research is important because it provides a way to examine external structures that influence teachers' perspectives on teaching environmental science, including place-based and culturally responsive environmental science learning. In other words, the ecological model recognizes both individual perceptions and other factors that influence teaching practice (i.e., school and administration, parents, community).

The ecological model adapted for this research begins at the individual level of the teacher, or the *microsystem*. The microsystem concerns interpersonal relations experienced in the immediate environment, such as the classroom, where proximal processes depend on content and structure to produce and sustain development (Bronfenbrenner, 1994). Attributes and characteristics of an individual (their personal disposition, race, class, gender, educational experience, and social background) are important contexts of agency that influence knowledge transfer through all other structures of the ecological model. This microsystem level gives us a deeper understanding of how participants are socially located and socially aware (or not) of events happening within the broader community, to the extent that an individual teacher is (or is not) integrated into the daily exchange of communal knowledge. Community beliefs and local knowledge that originally come from an area derived from oral story telling transpose into awareness. In the context of this study, it is at this level where it can be discovered how teachers perceive the environmental science curriculum and how their perceptions might translate into what topics of environmental science they include in their curriculum and how they teach those topic.

Just beyond the microsystem is the *mesosystem*. The mesosystem consists of the relationships existing in two or more settings. In effect, a mesosystem is a system made up of two or more microsystems (Bronfenbrenner, 1999, p. 17). A contextualized instantiation of a mesosystem would be a teacher's relationships with the students in the classroom and with adult colleagues at their school. It is at this level where teachers' perceptions of their administration and their support can be found, as well as administrations' expectations in the teaching of environmental science and how all these might translate into how instructors teach topics of environmental science.

The next level in the ecological model is the *exosystem*. The exosystem does not contain the individuals themselves, but is composed of what Bronfenbrenner (1999) describes as:

> the linkages and processes taking place between two or more settings, at least one of which does not contain the developing person, but in which events occur that

> indirectly influence processes within the immediate setting in which the individual lives (p. 19).

This is the setting of the community and social integration, which (in northwestern New Mexico) is influenced, among other factors, by the demographics of three major ethnicities: Caucasian, Hispanic, and Native American. In relation to this study, at this level is where we discover how teacher perceptions of communities (e.g., organizations) and parents might influence teachers and what they teach.

The final level, or the *macrosystem*, is composed of a large group that shares common characteristics as a culture or subculture (Bronfenbrenner, 1994). The macrosystem may be thought of as the “societal blueprint” of a research environment, or where the research is conducted; it consists of the patterns and characteristics embedded within the preceding systems (microsystem, mesosystem, and exosystem) and, in particular, refers to the given culture, belief systems, opportunity structures, bodies of knowledge, and resources available (Bronfenbrenner, 1994). In this study, the macrosystem is the State policy level that guides environmental science education. Additionally, specific social and psychological features that influence core conditions and processes occurring in the microsystem can be identified at the macrosystem level. For example, economic, cultural, and political factors of education that appear to influence microsystem levels are also macrosystem factors that influence conditions at that level, too. In relation to this study, at this level, it is where we discover how State policy might influence teachers' perceptions of what and how they teach environmental science curriculum, and whether they perceive that State standards allow them to be sensitive to the local needs and realities of the area as they teach topics about environmental science from a textbook.

Purpose of the Study

The purpose of this research is to explore teacher perceptions, which in turn can impact their teaching of environmental science in rural secondary level schools in New Mexico. This study looks at the perspectives secondary level science teachers have, and the influences that they perceive affect how they teach environmental science. One aspect of this research seeks to understand how teachers perceive factors that influence curriculum integration of place-based and culturally responsive environmental material into their secondary level science classrooms. Another aspect of this research explores perceived support for environmental science education at school and broader community levels.

Research Questions

I framed the following research question and subquestions using the aforementioned ecological model. My research question was:

What do teachers perceive as the factors that impact their teaching of environmental science in rural northwestern New Mexico secondary schools?

I tied the subquestions to Bronfenbrenner's four environmental system levels as shown in Table 1.1.

Table 1.1.

Research Subquestions Tied to Environmental System Levels.

Level	Subquestion
Microsystem	What are teacher perceptions about their current implementation of environmental science in the school curriculum? Are teachers able to integrate place conscious and culturally responsive environmental science education into their curriculum? What do they plan to integrate in the future to support environmental science?
Mesosystem	What are teacher perceptions of school and district administrators' expectations for teaching environmental science? Do teachers feel supported by their school administrators to teach environmental science? Do teachers feel encouraged by their school administrators to teach culturally responsive environmental science?
Exosystem	What are teacher perceptions of parental and community influences on teaching environmental science? How are teachers influenced by parents to teach environmental science? How are teachers influenced by the community to teach environmental science that relates to community environmental issues?
Macrosystem	What standards require teaching environmental science in public schools in New Mexico? Do these standards address teaching environmental science using culturally responsive and place-based methods?

In this study, I used a qualitative design to explore teacher perceptions of teaching environmental science curriculum. I also explored topics teachers like to teach about important environmental science concepts, such as energy or natural resources capital, and how these topics relate to their community. My inquiry included interviews and document reviews, and drew from individual teachers' perceptions of environmental science education.

Morgan et al. (2016) determined that science achievement gaps stabilize as students age. Thus, sustainable early childhood interventions are needed to address and close large opportunity gaps in science achievement. In New Mexico, at the elementary school level, science content is delivered by one teacher in a self-contained classroom who teaches all the core subjects (i.e., language arts, social studies, mathematics, and science). In secondary level schooling, science education in New Mexico is its own course taught in a departmentalized setting by a teacher who is endorsed in science content areas. Middle and high school are critical years for students to develop a strong understanding of, and appreciation, for science and the environment. In this study, I focused on teachers' perceptions of teaching environmental science in secondary level schools in rural districts of New Mexico. Within this broad umbrella purpose, the study also examined integration of place-based and culturally responsive teaching of environmental science, and school, administrative support, and community support for teaching science topics in a place-based or culturally responsive manner.

Research Design

I conducted in-depth interviews using semi-structured questions to allow participants to address their teaching of environmental science. I selected a total of thirteen participants to be interviewed for this study. The participants were a mixture of MS and HS science teachers with varying degrees of experience and teacher leadership roles. My data collection followed a "zigzag" process that entailed gathering information in the field, returning to the home office to transcribe and analyze, going back to the field to collect more information, returning to the home office to transcribe and analyze, and so forth (Creswell, 1998). The procedures for the collection and analysis of data are discussed in much greater detail in Chapter 3.

Significance of the Study

My research is significant because we are on the brink of many kinds of environmental catastrophes, be including the effects of global warming, contaminated water, and polluted air, and the students of today will be tasked with finding solutions to address the repercussions that will affect our communities in the near future. This research examines factors that influence the teaching of environmental science from an ecological perspective. Teachers in rural New Mexico have the added advantage (or disadvantage) of being in the midst of the effects of environmental science. For example, oil and gas infrastructure in the Four Corners region provides interesting environmental science curricula topics, such as air quality and fracking that directly tie to the local community.

When it comes to issues revolving around environmental science, what and how students are taught will determine whether or not they, and the generations to come, will have the ability to meet their own needs when they enter adulthood. Environmental science education exposes students to local and global environmental topics, engages them in problem solving, and brings awareness to ecological concern (Palmer, 1998). Rural secondary schools in northwestern New Mexico have many environmental challenges and issues, including toxic gases, particularly methane, that are leaking into the air – the nation's largest methane plume, located over the San Juan Basin, can be seen from space (National Aeronautics and Space Administration [NASA], 2014) – and the air pollution is and creating serious health risks for local communities. Environmental science education can address these challenges and issues facing our communities.

In the state of New Mexico, nuclear engineering, rocket science, and extraction technologies are key drivers of scientific knowledge systems. New Mexico has a rich environment for technology, with three national laboratories, three renowned research universities, and many nonprofit research institutions, and it has a long history of being a place where technologies are born. For example, Microsoft was founded in Albuquerque in 1975 (National Public Radio, 2008), and the Manhattan Project (atomic bomb) was created at Los Alamos during World War II (U.S. Department of Energy, 2018). The path to careers and success in these technologies is not always a straight line. There are broad possibilities outside of the traditional or obvious pathways for students with STEM degrees. Even students who end up in non-STEM career pathways benefit from instruction in STEM, as they gain the knowledge and skills they need for college, career readiness, and for taking on other critical roles in their communities. The New Mexico Public Education Department does not mandate specific environmental science education curricula and there is no environmental science literacy graduation requirement, but the need for environmental science literacy in New Mexico is steadily increasing, as is the need to build a community of culturally and geographically diverse New Mexicans that can understand public policy matters (Morgan et al., 2016) and who will have the knowledge, skill, attitude, and commitment to make informed decisions about their environment.

Every day, science teachers in rural northwestern New Mexico are confronted with different environmental scenarios, and this research study brings to the surface their perceptions and what influences the way they teach environmental science. The new science standards do not directly acknowledge the significance of the field of environmental science for the state of New Mexico, nor do they acknowledge the importance of teaching environmental science in a place-based and culturally responsive manner. Conducting in-depth interviews with teachers allowed a deeper understanding of their expectations around teaching environmental science and their perceptions of what they will need to be prepared for on the cusp of the State's adoption of new science standards.

Limitations and Delimitations

In this study, I explored teacher perceptions of factors that impact their teaching of environmental science in secondary level school settings. The limitations of this research include the following:

- Factors are based on teacher perceptions gathered from interviews. It is not known how truthful teachers really are in their responses to interview questions.
- Teachers may be biased to present a more positive picture than actually exists, and may have intentions that do not match reality.

The study may not be relevant and transferable to similar contexts in New Mexico and other states in the U.S., based on its qualitative design, which used a small sample that may not be considered representative of the area studied.

I only analyzed secondary level school teachers' perceptions about the integration of environmental science topics. Although there is a need for studies of the environmental science curriculum in elementary school grades, that topic is not part of the intended focus of this research project. Within the design of this project, I identified the following delimitations:

- Research took place within one academic school year (2017–2018).
- Middle and high school grade level teachers were included.
- No parents or students or school administrators were included.
- Research examined only teacher perceptions.

Chapter Summary

In this chapter, I provided some history and background information about the geographical area in which this study took place. I discussed environmental science, its beginnings, and the environmental issues being faced today. I outlined my ecological framework of this study, and discussed its purpose, design, and significance, and concluded the chapter with the limitations and delimitations of the study.

Definition of Key Terms

I use a number of key environmental science (ES) terms in this dissertation and therefore define them below.

Culturally responsive curricula - Curricula that uses "the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant," useful, validating, and affirming (Price, 2014).

Culturally responsive education - An approach to teaching that focuses on identifying and nurturing learners' unique and ethnically diverse cultural strengths and "using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively," (Gay, 2002). The lack of an Indigenous perspective in the education system continues to set Indigenous youth apart from their own cultures, instead of emphasizing the importance of educating youth in their own cultures, as well as using Indigenous cultural languages to educate them.

Curriculum standards - "Standards represent the goals for what students should learn. They are different from curriculum, which means the outline of the subject matter teachers teach, and how that subject matter is taught. Federal policies encourage states to adopt high standards, but do not touch on curriculum, which is a state and local matter" (NGSS Lead States, 2013).

Environmental science education - A multidimensional definition of environmental education was adopted at the 1972 Stockholm declaration, which states that "[t]he natural resources of the Earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate"

(UN General Assembly, 1972). Environmental science education positions these foundational concepts of environmental education into the ‘soft’ sciences.

Next Generation Science Standards (NGSS or NGS standards) - Based on a framework developed by the National Research Council (NRC), the NGSS are standards, not curriculum, and were developed by a consortium of 26 lead states. NGSS has been adopted in 19 states, and the District of Columbia, including Arkansas, California, Connecticut, Delaware, Hawaii, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Nevada, New Hampshire, New Jersey, New Mexico, Oregon, Rhode Island, Vermont and Washington (National Science Teachers Association, 2018).

Place-based education - The United Nations Education, Scientific, and Cultural Organization (UNESCO) identifies the role of place in environmental education. An understanding of environmental problems “should bring about a closer link between educational processes and real life, building its activities around the environmental problems that are faced by particular communities and focusing analysis on these by means of an interdisciplinary, comprehensive approach” (UNESCO-UNEP, 1988).

Chapter 2

Review of Literature

In this chapter, I present the literature and constructs relevant to this qualitative study, teachers' perceptions of environmental science. As this study analyzes the factors that impact the teaching of environmental science in rural areas of northwestern New Mexico, it is important to understand previous research and theoretical foundations pertaining to the integration of environmental science in science curriculum, as well as the constructs relevant to my research. The latter come from an ecological systems theory, based on a qualitative research design that utilizes Urie Bronfenbrenner's (1979) ecological model of human development. Empirical research models that have utilized ecological systems theory are discussed in the first section of this chapter. The second section is a comprehensive review of how environmental science is positioned in the Next Generation Science Standards (NGSS) and the New Mexico (NM) STEM Ready! Science Standards. The final section of this chapter examines literature relevant to the integration of environmental science in rural school communities.

Ecological Systems Theory

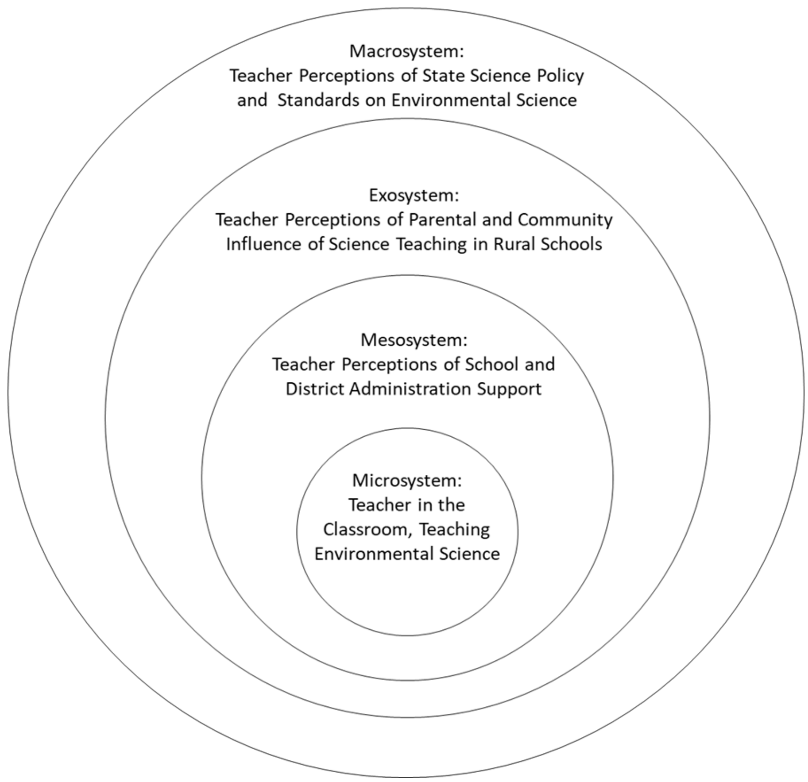
The Ecological Systems Theory described by Bronfenbrenner (1979) is a framework applicable to understanding environmental influences impacting human development at different structural levels, also known as systems.

As explained in detail later in this chapter, ecological systems models have been instrumental in understanding situational experiences within the context of interrelated and overlapping influences at other levels. By adapting an ecological framework (Brofenbrenner, 1977) to explain interrelationships of this study's research questions, it is possible to better understand factors that mold teachers' perceptions about the influences of individual, school, family, community, and larger societal structures on a teacher's development of their classroom curriculum. Once extrapolated, these forces fall into different environmental systems (i.e., the microsystem, the mesosystem, the exosystem, and the macrosystem). Each structure, or system level, of the ecological framework is a contextual environment that has influence on human behavior and (social) cognition. In this study, the microsystem represents the teacher and concerns interpersonal relations experienced in the immediate (classroom) environment; the mesosystem contains the teacher's relationship with school and district administration; the exosystem has to do with a teacher's relationship with parents and the community; and the macrosystem is the level that holds the State of New Mexico Public Education Department (NMPED). Adapting an ecological systems framework to the design of this qualitative study fits exceptionally well in a rural schooling context where outer environmental systems, such as State policy (macrosystem level), local community demographics (exosystem level), and school administration (mesosystem level) influence factors that impact teacher perceptions of environmental science at the classroom level (microsystem level). Figure 2.1 presents Bronfenbrenner's model adapted as the conceptual framework for this study.

These systems behave as nested structures, embedded "each inside the other like a set of Russian dolls," symbolic of structural layers of influences, as if one part is really an essence of the whole, multiple and overlapping aspects of a person's environment directly influencing their experiences and perceptions (Bronfenbrenner, 1994). This ecological model establishes structures as contexts for the development of teachers' perceptions of how and why they teach important topics in environmental science and acted as my roadmap to guide my research through the environmental structures as I explored what influences the teaching of environmental science in rural northwestern New Mexico.

Figure 2.1

Ecological Systems Model used as a Conceptual Framework.



The *microsystem* is the level at which this research begins. This level is important because interpersonal relationships extend outward from an individual's environment and, to a certain extent, transcend all other subsystems of the socio-ecological model. The microsystem level of this research model concerns the attributes of the individual, the teacher. Understanding individual characteristics is important in order to analyze the extent to which worldview and epistemology shape knowledge transfer of pressing issues in environmental science. The microsystem level involves an understanding of how an individual's personal background and interaction with the immediate environment—with family, peers and colleagues, and interrelated members of local community groups—influence the execution of certain curricula models in the classroom.

Just beyond the microsystem is the *mesosystem* level, which impacts the transfer of knowledge through interactions with two or more environmental systems. School is a structure in which teachers become architects of knowledge. School structure and administrative influences are implicated at the mesosystem level as socialization occurs and life-long learning habits are shaped by situational experiences and interaction with the world (Vygotsky, 1978; Bransford et al, 2000; Kirschner et al, 2006).

The *exosystem* level connects the processes that take place among the other levels of the socio-ecological framework. Because it is important to gain a deeper understanding about how participants are socially located and socially aware (or not) of events happening within the broader community, this level involves parents and the community, including businesses. Local demographics are also examined at the exosystem level.

The *macrosystem* level shows the extent to which environmental science education programs are sustained through State policy to support 1) the implementation of new science curricula to be place and culturally responsive and 2) ecological knowledge-building initiatives. The macrosystem level of this study includes an analysis of state science frameworks that guide environmental science curricula and topics such as climate change, water and air quality, and protecting the Earth's ecosystem.

Chronos translates from Greek as "time." The *chronosystem* is a level that represents time and space, and is the historic occurrences of what happened in that place in another time. The chronosystem is not extended within this research, but is worth describing for the sake of Bronfenbrenner's legacy impact on ecological systems theory. If you will, imagine the chronosystem as the backdrop of the research setting and the land's genetic memory in that place. Again, in the ecological systems theory, the chronosystem represents infinite time and space with geospatial location (e.g., longitude and latitude meridians). For Indigenous peoples around the world, for example, time and space make their relationships to the land real (Smith, 2012). And systems of time, as we know them, are as many as there are cultures in the world (Hall, 1983). Logically, oral traditions and cultural theories about space and time are tied to geographic location. Think of traditional names of geographic land formations and the stories of descendants from those areas. In New Mexico, the chronosystem as a backdrop would be the sequence of time going back, before the pre-Columbian era, over a millennial that ties the people and cultures to the land through history. Therefore, what happened hundreds of years ago should be considered for having influence at the chronosystem level.

Other social research has been conducted using Bronfenbrenner's (1999) ecological systems model to answer important questions. In a study about school safety using survey research (Hong & Eamon, 2012), the researchers used the ecological systems framework to understand student perceptions of feeling safe at school. Their model identified factors that influence student perceptions of unsafe schools at several ecological levels, but did not include the microsystem and chronosystem levels. Findings about perceptions of school safety were mapped to school environment (microsystem), parental involvement (mesosystem), and neighborhood, or area, of residence (exosystem). While the researchers concluded that interventions for increasing perceptions of safer school environments should occur at the family, school, and neighborhood levels, the study does not address the macrosystem level (district) influences about school safety policy in the first place. While my research also does not include the chronosystem either, it does look at macrosystem level (NMPED) influences on teachers' perceptions of teaching environmental science. Adapting Bronfenbrenner's ecological systems framework to the design of this qualitative study is an exceptionally well fit to discover and explore what teachers perceive are the factors that influence teaching environmental science.

Environmental Science Standards

The Next Generation Science Standards and the New Mexico (NM) STEM Ready! Science Standards were adopted by the New Mexico Public Education Department (NMPED) on July 1, 2018 (6.29.10 NMAC). The adoption of these combined standards replaces the K-12 version of science standards NMPED originally set in 2003 and updated in 2009. This replacement means more rigor for teachers and students.

Next Generation Science Standards. The Next Generation Science Standards were developed in 2013 as the result of collaboration between the National Research Council, the National Science Teachers Association, and the American Association for the Advancement of Science. A consortium of 26 states (New Mexico not being one of them) and other stakeholders in science, science education, higher education, and industry answered the call to transform science education, strengthen national K–12 educational pathways, and grow future STEM professionals (National Research Council, 2012). The framework they developed is based on critical thinking and hands-on learning approaches to engage students by connecting lessons to out-of-school experiences in students' home and community contexts (NGSS Lead States, 2013).

The NGSS positions environmental problems, or aspects of environmental problems, in general and do not pinpoint who or what causes or is impacted by the environmental problem. This may allow for teachers to draw upon their own expertise to interpret the environmental science problem, but it also assumes that the science teacher has an understanding of environmental problems. There are many more NGSS Performance Expectations (PEs) related to the causes and effects of environmental problems than there are PEs that include ways to address environmental problems. Several standards concern science and society, but emphasize the effects of natural hazards without considering human causes. Others specifically discuss human impacts. The following is an example of MS NGSS related to environmental science and natural hazards.

> MS-ESS3–2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
>
> [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior

processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods).

Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

This example of an NGSS MS environmental science standard concerns science and society. This standard emphasizes effects of natural hazards without man made impact. The following is an example of HS environmental science standards.

HS-ESS2–2. Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems.

[Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

This is an example of an NGSS HS environmental science standard concerning science and society. This particular standard addresses the increase in the earth's temperature, and while it considers natural causes of greenhouse gases it does not address or present for analysis any man-made causes.

The NGSS for human sustainability reads "[c]onstruct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity." These sustainability standards address important issues affecting the environment. In other words, fostering sustainable ecosystems requires the teaching and development of ideas about the restoration and management of the environment (Pielke Jr., 2005). Another NGSS that relates to climate change reads:

HS-ESS3–4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

[Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining).

Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

Although a secondary level student may not be able construct a thorough explanation of the effect of human activity on the environment, through these standards, they will be able to critically think about this.

Overall, the Next Generation Science Standards are more comprehensive than the 2003 New Mexico Science Standards. Further, the cross-cutting concepts also provide a schema for interdisciplinary connections. As I reviewed the NGSS, I observed that the clarification statements were broad and not always clear, and the scope of some of the science project examples seem seems to require extensive resources and outside of the classroom support.

New Mexico STEM Ready! Science Standards. The New Mexico STEM Ready! Science Standards are six other unique New Mexico state science standards. Review of these standards are significant because they capture the historical context of the implementation of new science standards. The following lists the six New Mexico STEM Ready! Science Standards.

1. 1-SS-1 NM. Obtain information about how men and women of all ethnic and social backgrounds in New Mexico have worked together to advance science and technology.
2. 5-SS-1 NM. Communicate information gathered from books, reliable media, or outside sources that describes how a variety of scientists and engineers across New Mexico have improved existing technologies, developed new ones, or improved society through applications of science.

3. MS-ESS3-3 NM. Describe the advantages and disadvantages associated with technologies related to local industries and energy production.
4. HS-LS2-7 NM. Using a local issue in your solution design, describe and analyze the advantages and disadvantages of human activities that support the local population such as reclamation projects, building dams, and habitat restoration.
5. HS-SS-1 NM. Obtain and communicate information about the role of New Mexico in nuclear science and 21st century innovations including how the national laboratories have contributed to theoretical, experimental, and applied science; have illustrated the interdependence of science, engineering, and technology; and have used systems involving hardware, software, production, simulation, and information flow.
6. HS-SS-2 NM. Construct an argument using claims, scientific evidence, and reasoning that helps decision makers with a New Mexico challenge or opportunity as it relates to science.

These science standards were adopted because NMPED wanted New Mexico-specific standards. These NM-specific standards challenge students to investigate topics happening in their own backyard.

Goals for Environmental Science Education

Enhancing science literacy. Achievement gaps, or gaps in performance, are also opportunity gaps (Morgan et al., 2016). Opportunity gaps can be thought of in terms of an asset-based model that seeks to eliminate deficit thinking when it comes to gaps in achievement. Opportunity gaps tend to be more prevalent in rural and minority communities and are created by qualified teacher shortages, external socio-economic factors, citizenship status, availability of resources, and detrimental policy (Ladson-Billings, 2006). Historical and ongoing inequities (e.g., opportunity gaps) limit access to educational opportunity:

> Children who are from traditionally marginalized groups attending U.S. schools are more likely to be provided with lower-quality educational experiences, including attending underfunded and lower-resourced schools where they are often taught by inexperienced teachers and/or those with lower expectations for the children's achievement (Morgan et al., 2016, p. 1).

Environmental literacy is the ability to determine the needs and health of the environment, and being environmentally literate is one way to find solutions to restore and maintain the health of these systems (Chinn, 2007). Increasing science literacy through environmental science education is one way to grow scientific citizens, who will be able to logically and critically observe and analyze the components of a problem affecting their community, and work at solutions to address said problem. This is a positive thing and part of science achievement because students' core competencies increase through critically thinking about a topic.

Developing environmental sensitivity. Being environmentally conscious does not require a student to be a top performer. *Responsive science education* is a teaching paradigm that works to engage students in science curriculum by making it more meaningful and relevant to their lives. Drawing on students' core beliefs about science and the environment builds bridges from content to personal household life. Science surrounds us in our lives at home, school and work. To be informed citizens of the 21st century, our students need to be able to not only judge policy issues that increasingly have a scientific or technical base, but to be empathetic and sensitive to the potential impact of environmental policy issues. Being *environmentally sensitive* is when a person acknowledges there is an environmental problem and wants to do something to solve the problem, or finds a solution for it. Environmental sensitivity basically consists of three components: 1) a feeling of consideration towards the environment that is manifested by consciousness, 2) interest and concern for the components of the natural world surroundings, and 3) personal abilities to be receptive to and experience these components (Pruneau et al, 1999; p. 28).

Science students of today will need to be environmentally sensitive as they employ their critical thinking skills to tackle the environmental problems that we will potentially face tomorrow. For instance, the Environmental Protection Agency (EPA) is in charge of protecting the environment but, unfortunately, in 2016, some provisions and protections under the auspices of the EPA such as emissions standards, and natural capital exploration on federal lands, have been overturned. The agency's workforce has shrunk to a level not seen since the Reagan Era (The Washington Post, 2018). Students who will be entering the work force in the next decade will be confronted with the repercussions and consequences caused by these politically motived actions and will be facing the monumental task of not only protecting the environment, but of undoing the damage that will have been done.

New Mexico, for example, is already experiencing the effects of the rollback of EPA and other environment protection regulations (Office of the Attorney General for the

State of New Mexico, 2018). Fortunately, a great instantiation of how responsive science education can affect populations was witnessed on February 2018, when New Mexico's Attorney General (AG), joined by California's AG, secured a preliminary injunction blocking the President and U.S. Department of Interior Secretary's attempt to suspend the Bureau of Land Management's "Waste Prevention Rule" (New Mexico Attorney General, 2018). This rule forces companies to "reduce waste of natural gas from venting, flaring, and leaks during oil and natural gas production activities" (Bureau of Land Management [BLM], 2016), on the basis that suspending the methane rule would result in irreparable harm to the environment and in waste of publicly owned natural gas. Later, in May 2018, the AG also joined a coalition of eight AGs in filing a lawsuit against the EPA over its failure to implement and enforce a critical landfill methane regulation, a violation of the Clean Air Act (New Mexico Attorney General, 2018).

School Support Systems for Environmental Science Education

Reducing poverty, sustaining development, and growing the economy of a community requires knowledge and education, and to accomplish those goals, a school's curricula needs to include knowledge, skills, and values that have been consciously and systematically thought out. Successful administrative leaders define a common purpose, motivate their subordinates to engage in a shared vision, and make certain that goals and outcomes are achieved. Strong administrative leadership is needed from state departments of education to provide curricula, materials, workshops, and in-service trainings (Sale & Lee, 1972). Supportive administrative leadership is particularly needed to help teachers prepare for environmental science curriculum changes (Spellman & Stoudt, 2013).

With the implementation of the NGSS, teachers are already preparing for environmental science curriculum changes. To prepare students to face the challenges awaiting them when they enter the adult world, dynamic curriculum that addresses emerging problems and trends in environmental science is needed in the schools and requires coordinated support (Sale & Lee, 1972).

Community Connections to Environmental Science Education

Developing the curriculum to encompass environmental issues that are relevant to both their families and community creates a successful curriculum that is meaningful to local culture and place (Martinez, 2015). The integration of geography, history, and local people in curriculum ties community topics to the classroom. There are other connections that are of great importance to open students' minds to new perspectives. Hutson et al. (2011) believe that showing the relation between science content and potential careers through field trips and other forms of experiential learning can help broaden visions. Unfortunately, limited resources make it challenging for teachers to plan out-of-classroom environmental science education activities. Those teachers who do connect the community into environmental science curricula often create private-sector partnerships on their own. Findings from a case study conducted by Minkler et al. (2006) show that potential outcomes of commmunity partnerships are based largely on leadership of teachers and strengthened by such things as participation, networking, understanding and sense of community and partnership, and sharing values. Teacher leadership in the community reinforces connection between students and learning.

Place-based Environmental Science

Teachers who connect environmental science education to students' cultures and places, will be able to engage students more deeply in scientific thinking and knowledge construction. In addition, teachers who integrate out-of-classroom learning activities, hands-on learning projects, and participation in science fairs into their science curriculum extend course content regionally and present real-world problems that students are more likely to relate to. Highlighting local issues (e.g., air and water quality) in is a way for teachers to draw upon prior knowledge, place, and culture as they prepare their curriculum (Chinn, 2007). Considering that place is a cultural construct that shapes identities and relationships (Greenwood, 2016) and that culturally responsive teaching may be described as a pedagogy that uses cultural knowledge to impart academic success (Ladson-Billings, 1994), place-based learning may draw upon both Western and Indigenous knowledges and traditions in practice (Lowan-Trudeau, 2012) to impart knowledge from a culturally sensitive and pertinent standpoint. Learning based on Western knowledge is traditionally a one-sided monologue, where the teacher passes information, or knowledge, to the student. Learning based on Indigenous knowledge is traditionally the sharing of knowledge, skills, and technology that the community has accumulated, and continues to develop, over time (Smith, 2012; pp. 61-80). *Place-based curriculum* development makes use of the geolocations where students live (Smith, 2016), and its implementation influences student attachment to place (Kuwahara, 2012) and provides opportunities for connecting classroom learning to the community. Environmental science and geospatial literacy demonstrate the appropriateness of geographical thinking generally to a philosophy of education. Places on the living earth are the connection of human-world relationships. "Lack of awareness of, lack of connection to, and lack of appreciation for places" occurs when place-conscious educational experiences are deconstructed (Gruenewald, 2003, p. 625).

Moreover, place-based science education improves engagement and retention, especially in rural educational settings (Semken & Butler Freeman, 2008), as students become immersed in, for example, local heritage, culture, and landscapes, creating a foundation for learning and encouraging teachers and students to turn their communities into classrooms. One of the most indispensable methods to help students fundamentally understand the roots and implications of local and global problems and explore theories to discover the means of solving them is by hands-on learning experiences. For students to recognize the impact of science on their own lives, it is important that they see the connection between science and the "real world," and place-based environmental science topics, such as cleanup of contaminated water, can be seen through a global lens to which they can relate.

Geographical experience begins in space and develops to include cultural and ecological aspects of community life (Gruenewald, 2003). A place-based environmental science curriculum reconnects students with the environment and introduces them to a sustainability mindset for the ability to continuously and indefinitely be more conscious in decisions and choices they make regarding the environment.

Geospatial thinking helps in the transfer of prior knowledge, but critical thinking about issues affecting the environment in relation to community requires a context of inquiry (Greenwood, 2016). Initiatives in place-based education have been linked to improved academic performance and wider thinking about growing global environmental issues (Barker & Pickerill, 2012).

Culturally-responsive Pedagogy

Culturally-responsive pedagogy interrupts dominant systems of education in which classroom settings reflect a one-way, teacher-to-student transfer of knowledge (Ladson-Billings, 1995a; Ladson-Billings, 1995b). According to Freire (2009), education is meant to be liberating, to increase consciousness, critical thinking, and constructive discourse about the politics of power. Therefore, culturally responsive schooling must be taken seriously if we are to improve science learning opportunities of Indigenous and other minority students, considering that curricula previously implemented with this approach have shown positive impacts on academic achievement for all students, especially historically excluded student groups (Kanaʻiaupuni et al, 2017; Gay, 2002; Gay, 2010). Students are more likely to feel empowered, to express their own voices, to value their own histories and cultures, and make personal connections to what is being taught when course curriculum integrates knowledge, experiences, and an understanding of life that is diverse, and when reading materials include different voices (hooks, 1999; Spring, 2016).

Culture is the source of one's values, beliefs, traditions, and one's bodies of knowledge from which we draw our views as to what is just. As explained by Chigeza (2011), science education should not operate under the assumption that all students must adopt the perspective of "Western" scientists but be responsive to culture. Even though science has been westernized for a long time, today's social and environmental problems require multiple perspectives for finding solutions. Western educational systems seem to have various limitations when it comes to addressing these issues and serving rapidly changing demographics of students. In states such as New Mexico, where minority-majority populations are served, there needs to be better available and updated professional development for teachers and administration that provides useful tools to recognize how knowledge connects to students' lived experiences and implement a culturally responsive approach.

Recognition and action in this context is actually a form of cultural justice (i.e., recognizing the impact of an unjust hierarchy and the majority population's voice on our history and on our perception of humanity). Maori scholar Linda Smith (1999) writes that Indigenous ways of thinking involve such practices as negotiating, claiming, and writing to advance discourse that counters Western standards of research. Negotiation informs social justice and the restoration of Indigenous peoples' cultures and languages (Smith, 1999). For example, the role of Tongan language and culture in school is kept in perspective by the adoption the Pasifika Response Model, which was negotiated for a teacher certification program in New Zealand. The program affirms Indigenous knowledge systems and "focuses on teaching Indigenous knowledge, models, methods, and content within formal or non-formal educational systems" (Manu'atu & Kepa, 2006, p. 178). Education departments may also consider a cultural competency certificate or cultural knowledge training that addresses the unique cultures in their states and demonstrates how scientific knowledge and beliefs can easily be transmitted through oral tradition and first-hand observation. Theoretical frameworks such as Tribal Critical [TribalCrit] Theory (Brayboy, 2006) and Red Pedagogy (Grande, 2008) support that knowledge transmission model. These frameworks have driven the decolonization of thought in relation to traditional Indigenous knowledges (Brayboy & Castagno, 2008). The Tribal Critical Theory provides a way to approach relationships between Native Americans and the U.S. government, and the Red Pedagogy theoretical framework "explores the intersection between dominant modes of critical educational theory and the socio-political landscape of American Indian education" (Grande, 2008, p. 233).

As discussed in the previous sections, environmental sensitivity and sustainability can be fostered in a culturally responsive approach to pedagogy. Indigenous critical frameworks and the example of former successful implementations abroad show how traditional knowledge can positively impact the way students are taught and provide desirable short term and long-term outcomes.

Traditional knowledge systems. Over a period of hundreds, even thousands, of years Indigenous people have been in direct contact with the environment, gathering, accumulating, and passing down knowledge that is specific to a location. This evolving knowledge is known as Traditional Ecological Knowledge (TEK), or sometimes called Indigenous Knowledge or Native Science. Environmental science education from Indigenous perspectives interconnects "spiritual relationships with the universe, the landscape, and other things, seen and unseen" (Smith, 2012, p. 77). An Indigenous worldview concerns traditional knowledge, much like the basis of a common law system of science, where universal constants emerge from a scientific law. The history of a place is essentially traditional knowledge. Traditional common law systems can be "complex philosophical instruments subject to analysis, interpretation, and metaphoric unpacking" (Lomawaima & McCarty, 2006). Western notions of space, however, are absolute, relational, and measurable.

Environmental Science and Teacher Perceptions

Environmental science education reflects cultural practices that are used to verify, expand, and clarify our knowledge base and to align science standards for what students must learn, what teachers must understand, and what school systems must support (Goodall, 1994). Our knowledge base is the foundation upon which we interpret the topics presented in the science standards. In an interpretive study of school teachers (primarily in Canada and Australia) that examined thinking and practice in environmental education, Hart (2003) concluded that environmental education in school does matter and what teachers think, what teachers believe, and what teachers do, ultimately shape their pedagogy. Hart looked at what happens in schools, and why, and found that knowledge, attitude, and behavior informed teacher thinking and motivation, while awareness, appreciation, and action drove teaching practice (Hart, 2003). Hart found, for instance, teachers who lead environmental education activities for students have (1) expanded world views that encompass nature, ecological sustainability, and environmental quality issues; and (2) intentions, beliefs, motives, and underlying assumptions that helped them create environmental citizenship, social consciousness, and environmental responsibility (Hart, 2003). This suggests that teachers' perceptions are of central importance, and understanding their perceptions is key to improving environmental science education, such as through professional development.

Environmental science curriculum development. Professional development encompasses specialized training, formal education, and advanced professional learning opportunities intended to help improve professional knowledge, competence, skill, and effectiveness. Effective professional development is one of the most important components of the implementation of curricula and new standards, such as the Next Generation Science Standards (Bellanca et al, 2013). In rural settings, distance education techniques may be considered in order to achieve the necessary minimum requirements to implement the NGSS in a cost-effective manner. A big part of teaching environmental science topics is trying to figure out what topics to teach and when in the curriculum to teach them, how to organize the course and what to cover. Science teachers are preparing their students to be the leaders who address our future environmental issues.

Professional development. Those teachers who integrate connections, to self (culture) and connections to world (place), into their environmental science curriculum will be able to engage students more deeply in scientific thinking and knowledge construction. In addition, teachers who integrate out-of-classroom learning activities, hands-on learning projects, and participation in science fairs into their science curriculum extend course content regionally and present real-world problems that students are more likely to relate to. Highlighting local issues (e.g., air and water quality) in lesson plan development is another way for teachers to draw upon prior knowledge, place, and culture as they prepare their curriculum (Chinn, 2007).

Family connections to environmental science education. Developing the curriculum to encompass environmental issues that are relevant to both their families and community creates a successful curriculum that is meaningful to local culture and place (Martinez, 2015). The integration of local geography, history, and people in curriculum ties community topics to the classroom. There are other connections that are of great importance to open students' minds to new perspectives. Hutson et al. (2011) believe that showing the relation between science content and potential careers through field trips and other forms of experiential learning can help broaden visions. Unfortunately, limited resources make it challenging for teachers to plan out-of-classroom environmental science education activities. Those teachers who do connect the community to environmental science curricula often create private-sector partnerships on their own. Findings from a case study conducted by Minkler et al. (2006) show that potential outcomes of community partnerships are based largely on leadership of teachers and strengthened by such things as participation, networking, understanding and sense of community and partnership, and sharing values. Teacher leadership in the community reinforces students' learning.

The National Science Teachers Association (NTSA, 2016) argues that a child’s interest in, and ability to learn, science is influenced by parent involvement (Epstein & Lee, 1995). Children learn effectively through actions and interactive education, so when parents start a project such as growing a garden, parents are sparking their child’s interest in, and ability to learn, environmental science because of its positive effect. When parents integrate environmental science lessons into home life through open dialogue and leading by example (e.g., recycling), an already curious child will be keen about learning environmental science by the example of their parents’ treatment of the environment.

Summary of Literature Review

In this chapter, I presented the theory and literature relevant to this qualitative study teachers’ perceptions of environmental science. I then presented a comprehensive review of how environmental science is positioned in the Next Generation Science Standards and the New Mexico STEM Ready! Science Standards. Finally, I examined literature relevant to the integration of environmental science in rural school communities.

Chapter 3

Methods

In this chapter, I explain in detail how the study was carried out: the research questions, the research design, and the procedures I followed for data collection. The first section presents the study context, research setting, and participant selection. Next, I describe the study procedures, including the collection and organization of the data as well as the role of the researcher and the methods I used for data analysis. I conclude the chapter with a discussion of specific details about protecting participant confidentiality and the procedures in place to maintain the study's trustworthiness.

Purpose of the Study

Utilizing a qualitative research design, the aim of this study was to determine teachers' perceptions of teaching environmental science (ES) topics in New Mexico public schools located in rural areas. Thirteen science teachers representing nine schools in five different northwestern New Mexico counties participated in individual, in-depth interviews.

Research Question and Subquestions

The main research question that guided this study was: *What do teachers perceive as the factors that impact their teaching of environmental science in rural New Mexico secondary schools?*

The main research question and its subquestions were addressed in the interview guide that was I used to obtain teachers' perspectives of teaching environmental science in rural northwestern New Mexico schools, specifically in middle and high school. The 11 sub-questions, based on Bronfenbrenner's (1979) ecological model, were used to systematically collect information from each subsystem (microsystem, mesosystem, exosystem, and macrosystem) that illustrates and comprises the New Mexico educational system where the environmental science curricula are being implemented. Table 3.1 summarizes the types of research subquestions developed, based on each environmental system, to help answer the main research question.

Table 3.1

Types of research subquestions developed.

Level	Type of Subquestion
Microsystem	Teacher perceptions about their current implementation of environmental science in the curriculum.
Mesosystem	Teacher perceptions of school and district administrators' expectations for teaching environmental science.
Exosystem	Teacher perceptions of parental and community influences on teaching environmental science.
Macrosystem	State science standards address teaching environmental science and culturally responsive and place-based methods.

The subquestions were tied to Bronfenbrenner's four environmental systems, and Table 3.2 presents the full list of all 11 research subquestions in detail.

Table 3.2

Research Subquestions.

Level	Subquestions
Microsystem	What are teacher perceptions about their current implementation of environmental science in the school curriculum? Are teachers able to integrate place conscious and culturally responsive environmental science education into their curriculum? What do they plan to integrate in the future to support environmental science?
Mesosystem	What are teacher perceptions of school and district administrators' expectations for teaching environmental science? Do teachers feel supported by their school administrators to teach environmental science? Do teachers feel encouraged by their school administrators to teach culturally responsive environmental science?
Exosystem	What are teacher perceptions of parental and community influences on teaching environmental science? How are teachers influenced by parents to teach environmental science? How are teachers influenced by the community to teach environmental science that relates to community environmental issues?
Macrosystem	What standards require teaching environmental science in public schools in New Mexico? Do these standards address teaching environmental science using culturally responsive and place-based methods?

Figure 3.1 presented below is the interview protocol, or guide, I used to conduct my interviews with the participants.

Figure 3.1

Interview Protocol.

RQ	1. What do teachers perceive as the factors that impact their teaching of environmental science in rural northwestern New Mexico secondary schools?	
	Sub-level Research Questions	**Interview Questions**
Microsystem	Consent Introduction to Interview Background Questions a. What are teacher perceptions about their current integration of environmental science in the curriculum? b. Are teachers able to integrate place conscious and culturally responsive environmental science education into their curriculum? c. What do they plan to integrate in the future to support environmental science?	1. What is your current position 2. How long have you held this position? 3. What type of experience and qualifications do you have to teach science? 4. How long have you been teaching science? 5. How would you define environmental science? 6. What is one of your favorite environmental science topics or lessons to teach at the secondary grade level? • How do you approach teaching it? For example, what methods do you use? 7. Are there environmental science topics within the curriculum that are directly connected to this community (place/area/county)? If so, how do you approach teaching these topics? 8. Are your students keen to learn about environmental science? If so, can you discuss some science projects they have done? 9. Do you think the secondary school science curriculum should integrate environmental science topics that relate to the local community? If so, please discuss how they can be integrated? 10. Would you be interested in teaching environmental science topics in the future? If yes, what are some of these topics?

Mesosystem	d. What are teacher perceptions of school and district administrators' expectations for teaching environmental science? e. Do teachers feel supported by their school administrators to teach environmental science? f. Do teachers feel encouraged by their school administrators to teach culturally responsive environmental science?	11. Tell me about your working environment, including your school and district, and the community you are in. • From your perspective, what are your school's and school district's priorities for science literacy? • How supportive are your school administrators of teaching environmental science? • What kind of support does your school and district supply for integrating environmental science topics that relate to the local community? • What kind of support do you need to integrate science topics that relate to your local community?
Exosystem	g. What are teacher perceptions of parental and community influences on teaching environmental science? 1. How are teachers influenced by parents to teach environmental science? 2. How are teachers influenced by the community to teach environmental science that relates to community environmental issues?	12. Do parents have an interest in environmental science education for their children? 13. Does your local community have in interest in environmental science being taught in schools? 14. Discuss a little bit about any environmental science lessons you teach that tie into important issues for this community. 15. What types of interconnections do regional businesses have with the district/school environmental science curricula?

Macrosystem	h. What middle school state standards require teaching environmental science in public schools in New Mexico? i. Do these standards address teaching environmental science using culturally responsive and place-based methods?	16. Which science standards do you think play the most important roles when you structure curriculum about environmental science topics? • Do these standards address environmental issues that relate to the local community and culture? 17. State adoption of the Next Generation Science Standards (NGSS) is now being considered at the executive level of the NM Public Education Department. • If you had to use the NGSS next year, what would change about how you approach teaching environmental science lessons? • Do you think you could teach environmental science the way you wanted?
Closing	Exit & Wrap-up thank you.	18. Is there anything else that you would like to tell me that I did not ask or that you feel would be useful to this study?

Conceptual Framework and Inquiry

I used Bronfrenbrenner's (1994) ecological systems model to frame this study. As such, sub-questions based on the four environmental subsystem levels (microsystem, mesosystem, exosystem, and macrosystem) were used for this study in order to address the major research question. The interview guide (see Figure 3.1, Interview Protocol) was composed of 18 questions that were structured to explore factors that influence teachers' perceptions of environmental science at each of these four environmental levels.

Microsystem level inquiry. The microsystem—in this case, the teacher perceptions at the classroom level—is presented the first level. The microsystem, which is the focus of this study, is at the acute, or the smallest level: the classroom. The microsystem is influenced by the other systems (i.e., exosystem, mesosystem, and macrosystem) because they hold the key to what resources for the classroom are available to teach environmental science. At the microsystem level, the teacher in the classroom has influence over the students but not much influence on the exosystem (parents and community), mesosystem (administration), and macrosystem (state education department) because, although the teacher can write letters, make suggestions, etc., they have no control over the decisions made either by parents and the community, or at the upper levels of school administration.

The microsystem analysis directly explored the teacher in the classroom. It looked at the demographics and qualifications of science teachers in secondary level education and how they (a) perceive the integration of environmental science topics into the State's science standards framework, (b) currently integrate place-conscious and culturally responsive environmental topics, and (c) plan to integrate environmental science topics in the future. I asked teachers interview questions that tied to the microsystem level to solicit data in regards to their perceptions about teaching environmental science.

Mesosystem level inquiry. The mesosystem analysis explored teacher perceptions at a school and district level concerning (a) administration expectations to teach environmental science, (b) support by local district or school administration to teach environmental science, and (c) whether teachers were encouraged to teach responsive environmental science. I asked teachers about their perceptions of science literacy, the kinds of support the school and district supply for integrating environmental science topics that relate to the local community, and the kind of support needed to integrate topics that relate to their local community. It seemed school-wide efforts to promote science literacy need to come from teacher-leaders, with the support of administration. An exemplary-rated teacher discussed challenges at the school level for decisions to support literacy through pushing student participation in school-wide extracurricular projects. Linda explains: “[W]e made it mandatory for the [department] to support [the national competition project]. Unfortunately, that hasn’t lasted because if you don’t have teachers that are passionate about competitions, then it doesn’t last.”

Exosystem level inquiry. The exosystem analysis explored how teachers perceive community and parental involvement in teaching environmental science in a rural environment. These sub-questions sought to explore (a) teacher perceptions of parental and community influences on teaching environmental science and (b) parent and community influences on how to teach environmental science. The four interview questions that I asked teachers at this level were designed to reveal teachers’ perceptions about how parents and the local community influence what environmental science topics they integrate into their science curriculum.

Macrosystem level inquiry. The macrosystem analysis explored the State policy level that guides environmental science education and looked at how teachers interact within the State’s framework. I asked the questions of teachers within this level that were designed to explore (a) factors that influence teaching environmental science in terms of interactions with the State’s science standards, (b) interconnections between state education policy for science standards and assessment, and (c) how environmental science state standards are implemented throughout the State using culturally responsive and place-based methods.

Rationale for Research Design

The research design employed a qualitative approach. I selected this approach based on my belief that, to deeply understand the multiple realities of New Mexico rural areas, it is necessary to adopt a constructivist paradigm that better explains the problem based on the practitioners' perceptions. Qualitative inquiry lends itself to understanding knowledge created for social benefit, the meaning that individuals or groups make of situations or problems within their environment. As explained by Creswell (2007), quantitative and mixed-method research certainly benefit social and educational research, yet, qualitative research is particularly beneficial when a specific issue is in need of in-depth examination.

A qualitative approach fits well with this research study, as it allowed for individual teachers' perceptions of environmental science to be explored. An exploratory qualitative approach was appropriate because my study's pursuit focused on exploring current practice and future aspirations (Patton, 1990). I sought to understand more about factors that influence the teaching of environmental science at different environmental system levels as explained by Bronfenbrenner. My study's design included these important qualitative research data collection techniques:

1. In-depth interviews.
2. Reflective journaling.

These data collection techniques are useful for capturing what is occurring in the research setting at the time of the study. In-depth semi-structured interviews create space for participant voices to be heard for improving knowledge (Wengraf, 2001). Reflective journaling as a method of reflexivity helps understand and reflect on external variables at play, or subtle experiences that have meaning, during the time in the field (Saldaña, 2015). Journaling creates another body of knowledge that adds perspective to interview data.

Philosophical tenants and procedures of qualitative studies have pointed interests in how relationships with the world are forged, in the context of a person's lived experience in their natural setting. Another tenant of qualitative research seeks to find meanings of experiences of participants, through structured interpretation and deep reflection (Creswell, 2014). An aspect of this qualitative research sought a broader understanding about teachers' perceptions of environmental science, how they approach teaching environmental science topics in rural New Mexico secondary schools.

Interviews. Interviewing is one of the most frequently used methods for generating data in educational and social science research (Marshall & Rossman, 2011). Within basic qualitative design, interviews may serve as the main instrument of data collection. Interviews help to generate rich data, provide a context of language, and result in an ability to approach analysis in different ways (Cohen et al., 2007; Patton, 1990). Individual in-depth interviews allow researchers to delve further into participants' attitudes and feelings as well as explore additional points presented in the conversation. I employed semi-structured interview techniques for this study to understand and allow teacher perspectives to emerge through voice and insight. In-depth individual interviews focused on:

1. Perceptions of environmental science,

2. Environmental science curriculum, including integrating place-based and culturally responsive topics,
3. Parent and community engagement, and
4. Concerns related to adoption of NGSS.

I followed steps for data analysis as suggested by Creswell (2014):

1. Organize and prepare the data for analysis.
2. Code data first by hand, then by qualitative analysis software application. In this particular case, ATLAS.ti (Windows Version 8.3.0; ATLAS.ti Scientific Software Development GmbH, 2017) was used.
3. Generate themes and categories from descriptions of setting, people, and context.
4. Advance discussion about hermeneutic meaning and descriptions.
5. Interpret findings and results.

Reflexivity. I kept reflexive notes in my personal researcher's journal throughout the time in the field. Researcher journaling was done to reflect on practice and time in the field. In my journal, I wrote whatever crossed my mind on issues that emerged during my time collecting data (Miles & Huberman, 1984), sometimes immediately after the interview, while sitting in my car or in the local coffee shop; other times, while I was reviewing my notes at the end of the day. I recorded reflections of several sorts, for example, I expounded on a sidebar that occurred when a participant walked me to my car and we stayed talking for an additional 45 minutes, and I noted relevant follow-up comments made after the interview. This writing helped me reflect on other avenues or additional points presented during the time in the field that extended interviews or document reviews did not capture. This reflection helped me to delve further into the experiences of the teachers interviewed.

Role of the Researcher

As the researcher, I was an active observer who identified the problem and designed the methodological approach to identify the factors that might be impacting teaching environmental science in northwestern New Mexico. As explained by Schram (2006), researchers must understand multidimensional experiences with a qualitative approach, since one's relationship with the world is truly situational (Schram, 2006, pp. 98-100). Part of the active nature of my participation comes from my previous experiences as a state licensed secondary school teacher, with more than 12 years of experience with education systems in New Mexico.

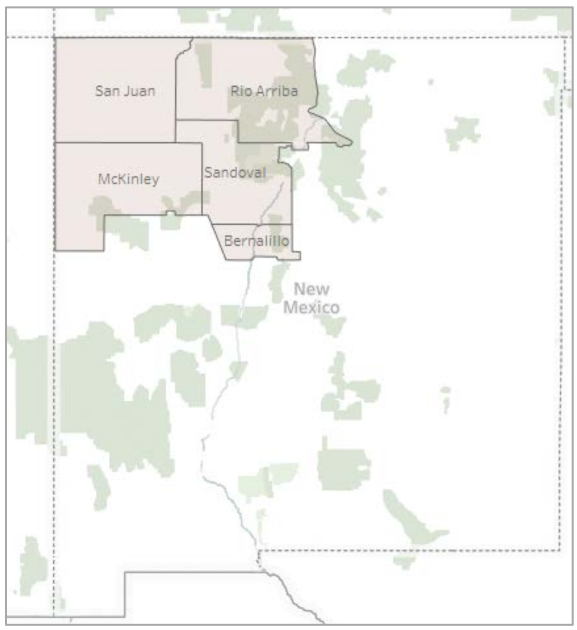
As a teacher, I taught social studies and worked with students on projects that were considered exemplary for national competitions, and because of my interests in the connections between social studies and environmental science activism, I am knowledgeable about interdisciplinary connections to important topics, such as climate change and emissions control. I understand what it is like to be a teacher and I understood, in my role as a researcher, that I had to tell the stories of these teachers and not my own. The obligation of the researcher is to present the situation at-hand through the lived experiences of the participants instead of decontextualizing it (Holliday, 2007).

Research Setting

This study was set in the public education landscape of rural northwestern New Mexico. The demographic landscape of northwestern New Mexico is important to this study because of the multicultural schooling context. The study was conducted in school districts located in five northwestern New Mexico counties: San Juan, McKinley, Rio Arriba, Sandoval, and Bernalillo. Figure 3.2, Map of the Counties, presents the region where schools are located and represented by teachers who participated in this study.

Figure 3.2

Map of Northwestern New Mexico Counties.



Source: Created in Tableau Software by author.

These counties have histories of rich culture and have land that is abundant in natural capital resources, such as oil, coal, gas, and uranium. Further, these county municipalities also share adjacent jurisdictional boundaries with sovereign New Mexico tribal nations.

School District profiles. Participants represented schools in five different local education agencies (LEAs). Table 3.3 presents science achievement data for grades 7 and 11 in these local education agencies.

Table 3.3

LEA Science Achievement Percent Proficient and above, by grade and subpopulation, 2018

	Caucasian		Hispanic		Native American	
Grade level	7th	11th	7th	11th	7th	11th
Statewide	64	50	37	22	25	15
LEA 1	#	#	#	#	24	31
LEA 2	#	#	44	50	#	#
LEA 3	67	55	48	27	37	20
LEA 4	51	53	41	16	19	9
LEA 5	#	#	#	#	#	25

= No data.
Source: NM PED 2018 Accountability Web files (public access).

Based on New Mexico Standards Based Assessment (NMSBA) scores (New Mexico Public Education Department [NMPED], 2018), 11th grade Native American students have the lowest science proficiency achievement in these northwestern New Mexico school districts. Hispanic students in these districts with environmental science electives that were part of this study outperform their Hispanic counterparts throughout the State. Gaps between Caucasian student populations and ethnic students of color remain wide. For example, statewide, 64% of Caucasian seventh grade students scored *Proficient and above* in science, which is 27 percentage points higher than seventh grade Hispanic students (37% at *Proficient and above*) and 39 percentage points higher than their Native American peers in the seventh grade (25% at *Proficient and above*).

School profiles. High schools with environmental science offered in the science course programming were targeted for this study. LEAs 2, 3, and 5 offered Advanced

Placement Environmental Science for high school. LEA 5 had environmental science as a capstone course for 12th grade, and LEA 2 had regular environmental science as an upper division HS elective course that used AP ES textbooks and curricular resources that the school already had in inventory. Other teachers without a specifically named environmental science course integrated environmental science topics within the science standards framework.

Data Collection Procedures

Institutional Review Board. Institutional Review Board (IRB) approval for this study was granted on December 18, 2017 and the approval letter is included in this manuscript as *Appendix A*. This study was approved under expedited review, due to its design. Research methodologies for carrying out research in small and rural communities were utilized as reference material, since the school districts targeted in this study were rural with minority student populations. I did not collect data (such as name, ID, address, or date of birth) that could personally identify any teacher. Also, I did not collect data that contained any combination of variables that could make the data identifiable (including combinations such as ethnicity, gender, and name of the school). All proposed study outreach and recruitment correspondence, including recruitment flyer, and the participant interview consent form are appended as *Appendices B-C*.

Data collection timeline. I received District permission from one district in time to proceed with concerted efforts inside the middle and high schools of that district, and targeted outreach and recruitment efforts were done for teachers in other districts. Due to the rural and remote areas of northwestern New Mexico, overall nine interspersed days total were spent in the field. Data were collected and analyzed throughout the first half of 2018, beginning in January 2018 and completed by August 2018.

Interview protocol. An interview protocol acts as a guide to help pace the interview and make the data collection process more systematic and comprehensive. Clarity in interview research studies comes through the ability to design a protocol with structured questions, mixed skilled communication techniques (Newton, 2010). The interview guide used to conduct interviews for this study consisted of 18 interview questions grouped within research questions in each of the environmental subsystems (i.e., microsystem, mesosystem, exosystem, and macrosystem), and may be reviewed in Figure 3.2. In developing an interview protocol, Merriam (2009) suggests interview questions be created with an extent of open-endedness to yield descriptive data, even stories, “the more detailed and descriptive the data, the better” (p. 99). I designed the interview instrument to conduct semi-structured, in-depth interviews with individual participants and connect to each sublevel of the ecological model. The goal of the open-ended interviews was to allow teachers’ perspectives to emerge through voice and insight.

Recruitment and consent. Recruitment efforts began immediately upon approval from the University’s IRB in December 2017. In order to reflect upon the experiences of rural secondary level science teachers, the recruitment of participants depended on teachers having experience teaching in a rural school. It was the end of the winter semester and teachers would return in January 2018. Recruitment was part of the consent process, because it began the process of providing information about the study. In the district with written approval, emails were first sent to principals of each high school and middle school informing them of my study and my intent to outreach to teachers. Email addresses of principals and teachers were obtained on each school's publicly accessed webpage. Four of the nine principals responded to my email immediately and referred their science department heads as contacts. Then, I sent study informational flyers to the science department heads of the schools whose principals had responded to my emails and made contact with those individuals. Participant outreach and recruitment then consisted of several strategies to inform potential interviewees about project details. These strategies were personal direct email contact, personal visits, and follow-up communication. I went to the four schools and the principals walked me around to different science teachers, which was, in a sense, a great way to reinforce my follow-up recruitment efforts for participation in my study, based on the personal recruitment email I recently had sent to each science teacher.

Interviews of teachers in the district that had granted approval were later conducted in the schools, in teacher classrooms. All other participant interviews, which were outside of the approved LEA, were conducted in other locations. Participants who were teachers in other schools agreed to meet for an interview at a mutually agreed-upon location that established an environment in which the participant felt comfortable during the interview process. These environments were private enough to maintain confidentiality and conduct recorded interviews. Individual interviews provided a context within which participants were able to express in their own way their personal understandings about the perceptions of environmental science based on their experience (Patton, 1990).

Interviews were digitally recorded with permission obtained after informed consent was presented. Interviews lasted for approximately one hour. They were transcribed as quickly as possible, which helped initiate a reflective 'audit' about how the interview evolved, noting any observations, impressions or interruptions during the interview (Newton, 2010). My study's parameters were well defined because the interview guide helped to focus the interview time and cover teacher perceptions occurring at each subsystem.

Sampling. I used a purposive sampling strategy to recruit possible participants as volunteer because, as explained by Creswell (2007), participants sharing similar experiences allow the researcher to forge a collective understanding (pp. 62). A purposeful sample was the initial sampling technique used for this study, since the target population was a select group of science teachers who worked in rural schools. Participants were known to meet the criteria of being a science teacher at the time of participant selection and confirmed during the informed consent process when stating background and their qualifications to be a science teacher. A snowball, or chain effect, type of sampling, is deemed to be an effective form of recruitment (Creswell, 1998). I quickly set into motion a snowball sample, which was subsequently used to spread interest "from people who know people" by reference, word of mouth, and extended outreach communiqué via email and fliers. I sent 'cold' emails to the leaders of New Mexico Environmental Education networks and associations, using the webpages of these organizations to recruit science teachers for interviews. Word of mouth led to four interviews from teachers outside of the one school district.

Participants

Thirteen secondary level science teachers participated in this study. Four of the 13 participants were male (31%). Six participants were HS teachers (46%) and seven were MS teachers (54%). Ten of the science teachers held some type of leadership role at the school or district level (77%). Experience teaching science ranged from 1.5 to over 21 years, with a mean number of years' experience equal to 9.5. Teachers were then classified based on their teaching experience as novice (less than three years), expert (three to eight years), or veteran (more than eight years). All participants have all had taught environmental science in rural New Mexico public schools. Brief summaries highlighting each participant are presented in *Appendix D*. *Appendix E* Participant Demographics and *Appendix F* School Demographics present the demographic data of the participants and the schools. These individuals taught students from rural areas and their perspectives about integrating environmental science topics in their classroom science.

As I interviewed the first nine participants, I transcribed the recordings and then hand-coded the transcripts along the way. After hand-coding the transcripts, I put them into the ATLAS.ti (v.8, 2018) qualitative software to find out what common issues frequently arose. A number of similar patterns in the data emerged. In the interim, I conducted two more interviews. After the interview recordings were transcribed, I entered the two transcripts into the ATLAS.ti (v.8, 2018) qualitative software. When compared to the themes that emerged from the initial nine interviews, new themes had emerged in these two new interviews. Because of this new information, I decided to secure two more interviews, for a total of 13 participants in my study.

Data Analysis Procedures

Analysis and interpretation of data based on qualitative research methods involve the exploration and examination of purposively selected texts to find meaning in patterns and themes that inform the research question (Zhang & Wildemuth, 2005). In traditional qualitative content analysis, coding of raw (text) data is approached inductively so that categories emerge naturally. I analyzed the transcribed interviews using qualitative analysis procedures of coding and mapping data (Creswell, 2008 p. 215). The data analysis process is presented in this section.

Preparation of data. The first step to qualitative analysis was preparing audio records for analysis. This prepartation included recording and then transcribing all interviews conducted to enhance reliability, as explained by Creswell (2007). Besides field notes previously taken, the audio files help in making specific comments, tone of voice, and pauses be fully documented.

I organized data from the thirteen 45- to 60-minute in-person interviews by first transcribing audio files, which I printed as double-spaced, one-sided sheets with two-inch right margins for hand coding. This produced 280 pages. I reviewed the interview transcripts multiple times and followed a code mapping process in two phases (Saldaña, 2013), described below.

Defining Unit of Analysis. The second procedure to carry out the qualitative analysis of text was to define the unit of analysis. Once the data were collected in interviews, I transcribed each individual recorded interview as a separate unit of analysis. As I finished transcribing each audio recording, I immediately read the transcript a minimum of two times, making notations, in order to gain an understanding of the participants' perspectives (Creswell, 2007). Significant phrases and sentences were identified from teachers' perceptions that represented factors that influenced teaching environmental science. Once significant statements were identified, I examined them again for recurring patterns or themes that "cut through" the data (Merriam, 2002, p. 38). After repeating this process for each individual unit of analysis (i.e., the transcribed interviews), I then combined the 13 individual units of analysis into one compiled document for further analysis.

Coding data and generating themes. The third step to carry out the qualitative analysis was to categorize and code. I used a two-phase coding process. I used a two-phase coding process, based on methodologies described by Merriam (2009), Miles & Huberman (1984), and Patton (1990). I organized clusters with similar meaning into themes, then I used these common themes to develop the findings of this study.

I generated coding categories using a preliminary ecological systems model and a context chart (Miles & Huberman, Qualitative Data Analysis, 1984). ATLAS.ti (v.8, 2018) qualitative data analysis software was used as a tool to help generate visual patterns within the interview data, so that meaning and descriptions could be formed quickly and effortlessly to understand connections. Once patterns in the data were discovered for each individual interview, I analyzed them together within the environmental systems that are discussed as the findings of this study (Merriam, 2002). These data were organized in 'raw' format and hand-coded. Interviews were transcribed into typed-written text, following qualitative procedures delineated by Patton (1990), Creswell (1998), and Guba & Lincoln (1994). Coding attributes is a qualitative data analysis system in which the researcher needs to: (a) be organized; (b) have perseverance; (c) have the ability to deal with ambiguity; (d) exercise flexibility; (e) be creative; (f) maintain strict ethical practice; and (g) possess an extensive vocabulary (Saldana, 2015). Coding helped identify repetitive patterns that grouped together based on similarity or commonality, and these repetitive patterns helped find emerging themes. My coding steps included highlighting important statements or quotes that helped to demonstrate how the teachers perceive and teach environmental science topics.

The ‘necessary personal attributes for coding,’, as posited in Saldana’s (2015) *The Coding Manual for Qualitative Researchers*, require the researcher’s analytical skills to be directed toward induction, deduction, synthesis, and logical and critical thinking. I applied an inductive approach for the coding and grouping tasks as, according to Zhang & Wildemuth (2005), it maintains the integrity of the text analysis process and integrates thematic meaning as a systematic process throughout the data collection and analysis process. Table 3.4 shows the coding system designed to support data analysis using ATLAS.ti v.8.

Table 3.4

List of Code Families and their Members.

Code Family	Codes	Quotation
Microsystem: Teacher background and qualifications	Beginning level Classes taught Experienced High School Intermediate level Middle School Qualification, MA	“I am highly qualified to teach middle level science and math, as well as having a K-9 and 5-9 license to teach Algebra 2 and Science 2. So, if I wanted to teach science at 9th grade, I’m certified to do that, as well. I started out teaching science at [name of school] for 3 years. So, I’ve taught science, altogether, almost 5 years [and total is 12 years].”

Code Family	Codes	Quotation
Microsystem: Environmental science curriculum integration	Definition of ES Enhancing core competencies with ES ES integrated with world problems ES integrated within Curriculum & Community	"So, I'm always about the critical thinking piece. So if you can bring in stuff like, what I was talking about, the TED talks and get a discussion going, and then, if you wanted to – and then extending upon that and being, like, okay, like, all the TED talks need to be watched, all the topics need to be talked about, all the – which one most resonated with you, and then having them do a research project and having them – but they're not just doing a research project to get information, but, like, now, how can you create change within your family? How can you create change at the school, or in our classroom? How can you create change within the 6th grade, you know? And not having them start big, but start small, like within your family. What are some changes that you think you can make, based on what you learned, right, how can you – and I think that's where it needs to start, though, is the family connection."
Mesosystem: Administrators & district support/cultural responsive environmental science	Lack of district support School administration support School district support	"…Well, if it's performance based – I haven't looked at the environmental ones, but the performance based ones, we have to – I mean, science is supposed to be hands-on, that's what it's supposed to be, and – so, going out and doing, we have to have the money to do that. We have to have the buses, whatever it takes. We're out in the middle of nowhere and, so, we have to have the resources it's going to take to do all that. And that's what worries me, they're going to expect us to do all this stuff with no resources – again."

Code Family	Codes	Quotation
Exosystem: Perception of parental and community to teach environmental science	Curriculum & ES are contextual to demographics Community business support ES integrated with world problems ES integrated within Curriculum & Community Parent's support Poverty as a factor Spirituality and cultural issues in Native education	"…It depends on the kid. We have a ninety percent poverty rate here at the school, so a lot of our parents work 3 jobs and don't see their kids much (…)"

- The *Code Family* corresponds to the category theme I used to analyze the data at particular system levels, based on the ecological systems model defined by Bronfrenbrenner (1994). These categories are exosystem, macrosystem, mesosystem, and microsystem. For example, the exosystem corresponds to the teachers' perceptions about parental and community participation in environmental science in rural New Mexico.
- The *Codes* column shows the codes I used to identify findings by theme or category level.
- The *Quotations* column shows a single example of an actual quotation from my interview transcripts that I assigned to the code bolded in the 'Code' column.

Environmental system levels, such as macrosystem, as well as the rest of the code family codes were based on interview data from teacher perceptions that emerged during the data analysis process.

Phase 1. In the first phase, I read each interview transcript and manually highlighted key information as code names. I read hard copy transcripts a minimum of two times and wrote notes that were captured as a priori codes on the paper document using different color ink pens each time. I applied an inductive approach for the coding and grouping tasks as, according to Zhang & Wildemuth (2005), it maintains the integrity of the text analysis process and integrates thematic meaning as a systematic process throughout the data collection and analysis process. To that end, I then circled repetitive codes in a thicker felt tip pen to map them as clusters of themes to see how categories of codes were forming in the document text. Once codes were highlighted and there was evidence of reoccurring themes, I then considered how these could be categorized into levels and linked them to the systems adapted from Bronfenbrenner's (1994) ecological model of human development: microsystem, mesosystem, exosystem, and macrosystem. To really understand coded themes and linkages to the ecological systems model, I decided the next step was to use a qualitative data analysis tool.

Phase 2. The second phase of coding interview data involved utilizing a computer assisted qualitative data analysis software (CAQDAS) as a tool. ATLAS.ti qualitative software provided a seamless technological environment to categorize, filter, and map connections within the transcribed interview data. This qualitative software analysis tool was used to classify codes into patterned groups and families. Patterns in codes were specifically organized by the analysis framework. These were mapped for relationships and interactions. Once patterns in the data were discovered for each individual interview, I analyzed them together within the environmental systems that are discussed as the findings of this study (Merriam, 2002). Themes emerged from the data for each of

Bronfenbrenner's four environmental levels (macrosystem, exosystem, mesosystem, microsystem), including concerns about how the Next Generation Science Standards (NGSS) will be implemented and what resources will be available to successfully implement the standards. Other themes that emerged included a concern about gaps in K-12 science curriculum and concerns about a lack of labs and other resources required to properly teach environmental science topics. These themes illustrate findings presented in this chapter.

Text analysis. Data were synthesized and the results are presented in Chapter 4. A total of 260 codes were generated in ATLAS.ti (v.8, 2018) from the total transcripts. (See Table 3.4 for the coding system I designed to support the data gnerated.) The reoccurring themes were coded, then coded again to reduce data into similar codes, and, finally, categorized within the four environmental sytems. An example of how codes were generated before beign reduced is shown in *Appendix G* Environmental Science Topics. From that point, code groups, or "code families," were created. Some of the code groups are listed in *Appendix H* Macrosystem code co-occurrances, to illustrate how data were mapped into categories. Codes were grouped within each system as well as within environmental science topics, as these topics came up in conversation but also as a question that asked teachers to define environmental science.

Ethics and Considerations of Research

Research methodologies for carrying out research in small and rural communities were utilized as reference material, since each of these school districts has high-density minority populations. These methodologies consider privacy protection and ethical practices to secure the identity of the participants.

"Privacy can be defined in terms of having control over the extent, timing, and circumstances of sharing oneself (physically, behaviorally, or intellectually) with others" (Maxwell, 2008). Ethical concern is an inherent characteristic of qualitative research and is an integral component to any research design (Maxwell, 2007). Since there are risks involved when human subjects participate in a research project, I took measures to ensure all participants were safe and protected, including outlining risks and assurances in an informed consent document. This study adheres to privacy and ethical standards. I did not collect any data (i.e., name or date of birth) that would personally identify any participant, nor did I collect any data containing any combination of variables that would be identifiable (including, for example, a variable combination such as ethnicity, gender, and name of the school).

Reliability. Kvale and Brinkmann (2009) explained that, "[v]alidity refers in ordinary language to the truth, the correctness and the strength of a statement" (p. 246). "It is important to ensure that a study investigates what it says it is going to investigate" (Kvale & Brinkmann, 2009, p. 246). I embraced this challenge and, in its spirit, I took measures to ensure the trustworthiness and reliability of this qualitative research.

A strategy qualitative researchers can use to increase internal validity and is investigator triangulation (Merriam, 2009). I used the triangulating analyst technique, where the services of a professional researcher were obtained to conduct inter-rater reliability. This professional researcher holds two doctoral degrees (PhDs) and has a background in program evaluation. Sections of transcripts were shared and coded individually and then discussed together. Codes generated during this process amounted to an inter-rater reliability rate of 88%. This was a reliable rate.

Trustworthiness. As aforementioned in previous sections, I established procedures to ensure that my study could be trustworthy in a similar context. Basic qualitative traditions were used for the methodology and the design in this research. Rural area teachers seldom have their voices heard, but this study provided an opportunity to document and reflect upon their perceptions and experiences regarding teaching environmental science topics in a consistent, organized, and respectful manner.

One of the steps that were taken was the examination of all the interview questions by the dissertation committee members to ensure that they corresponded to Bronfenbrenner's ecological model and sought information trustworthiness that I set out to discover and "not leading in nature" (Kvale & Brinkmann, 2009, p. 246). According to Creswell (2007)," trustworthiness can also be enhanced through the use of detailed field notes and audiotapes." Thus, other steps that were taken to ensure trustworthiness were the recording of all interviews and detail-oriented field notes.

Another important way for researchers to capture additional thoughts while coming and going in and out of the field is through journaling. Reflexive understandings come from maintaining a journal that the researcher can reflect on to understand one's self as they progress in the research project. I also maintained a reflexive journal detailing the data collection and analysis process of this study. Upon reflection of notes taken after the interviews, it is evident that such journaling helps to ensure that the data and the results are trustworthy.

While "multiple strategies for ensuring trustworthiness were utilized throughout this research study, including following a consistent method for data analysis, bracketing prior personal experiences, keeping reflective memos, using a sample that adequately enabled the experience to be examined, and interviewing until saturation was achieved and no new themes were uncovered" (Creswell, 2014, p. 203), I further ensured the trustworthiness of this study through triangulation and prolonged contact, along with reflexivity and journaling (Plano Clark & Ivankova, 2016).

Community sharing of results. Community engagement can be a potential force of beneficial support for positive outcomes, especially in building science literacy (Holly, 2013). Community sharing is expected in a formal presentation meeting and results will be reported to the district Superintendent who authorized this research be conducted in the district's schools. I ensured that the data collection processes and outcomes benefit the community because the findings strengthen environmental science discourse and bring awareness of these topics in a way that can be applied as a community school-based model. I concluded work on good terms and left the participants with good feelings when departing from the field, as Schram (2006) recommends.

Chapter Summary

In this chapter, I discussed how this study was carried out. This qualitative study utilized the tradition of basic qualitative design to understand the factors that impact teaching environmental science in rural schools in northwestern New Mexico. In this chapter, I detailed qualitative design and procedures used in the collection and analysis of data for this study. Data collection focused on exploring and understanding science teachers' perspectives. Qualitative research design supports the idea that factors that influence the participants are an important part of their experience. The chapter's discussion highlighted details about the qualitative design and approach to the procedures for the collection and analysis of data as well as details about the role of the researcher, research settings, and ethical considerations.

Chapter 4

Analysis and Findings

In this chapter, I present the findings from an analysis of teacher perceptions, based on interview data.[1] The analysis exposed themes in teachers' beliefs, experiences, and objectives for teaching Environmental Science (ES) topics that include interactions between different ecological system levels (i.e., microsystem, mesosystem, exosystem, and macrosystem). Examined in detail, said themes, once categorized at each level of the ecological systems framework, unveil the multiple-level factors that teachers perceive as impacting their teaching of environmental science in rural northwestern New Mexican classrooms. The analysis also addresses similarities and differences between middle school (MS) and high school (HS) teacher perceptions.

My main research question for this study was, "What do teachers perceive as the factors that impact their teaching of teaching environmental science?" I conceptualized the subquestions using the ecological systems framework, and these are detailed in Chapter 3. The adapted version of Bronfenbrenner's (1994) model of ecological theory of human development and how it was used as a conceptual framework from which to analyze data was discussed in Chapter 2. Being that education is part of human development, the education system in rural northwestern New Mexico can be understood from the standpoint of ecological theory. The events that take place at the microsystem level (in this case, the classroom) have a direct influence in the way interactions and

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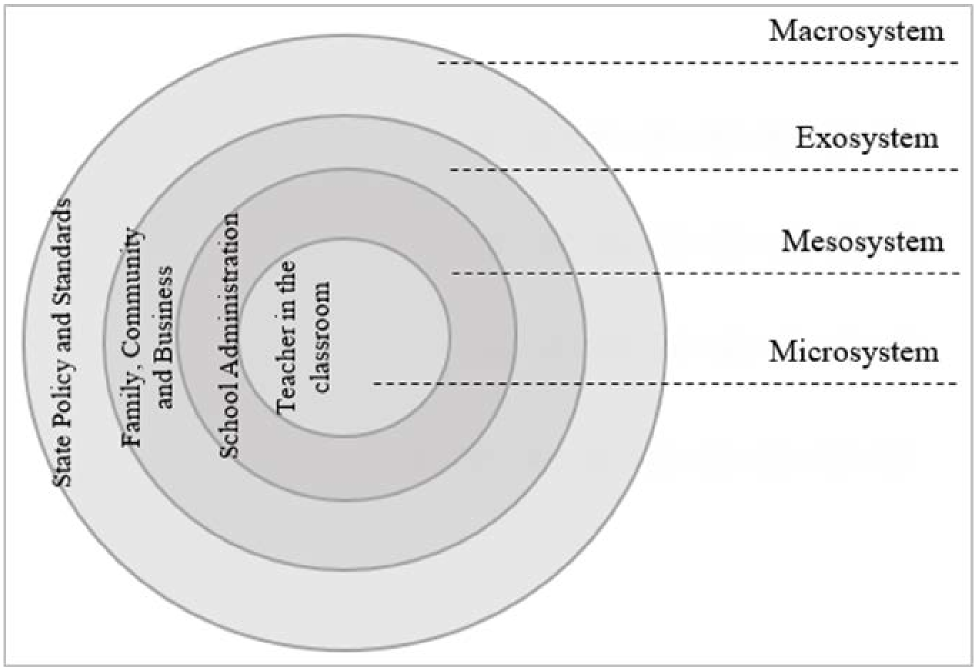
[1] Interview transcription key:
(…) text removed to carry on sentence to clarify quote;
[ ] edit made to make a beginning of a sentence or phrase;
– pause.

decisions at other levels of the ecological system occur. And the same occurs vice versa: Whatever decisions are made at the macrosystem level (in this case, the State education department) affect other levels of the ecological system. The analysis of teacher perceptions first begins at the macrosystem, because when a teacher begins teaching environmental science, he or she usually begins by trying to understand the standards and the requirements and policies set forth by the State.

I organized this chapter into five main sections, starting with the themes that emerged for each ecological system during my analysis of interview data. The first section presents analysis of the perceptions that MS and HS teachers have regarding the macrosystem level, which focuses on policy, standards, and adopted curriculum framework. The second section presents the perception of MS and HS teachers regarding administration, which is at the exosystem level. The third section is an analysis at the mesosystem level, which includes business and community, and the fourth section focuses on teacher perceptions at the microsystem level, which reflects the teachers' interactions in the classroom. Finally, the fifth section presents teachers' perceptions of how these ecological systems interact with one another. Figure 4.1 is a diagram of the four ecological systems as they relate to this study.

Figure 4.1

Ecological Systems Framework.



Macrosystem Analysis

Macrosystem Sub-research questions: What state standards require teaching environmental science in public schools in New Mexico? Do these standards address teaching environmental science using culturally responsive and place-based methods?

The macrosystem subquestions focused on State standards related to environmental science and whether they address culturally responsive and place-based methods. In this section, I present an analysis of MS versus HS teachers' perceptions about macrosystem level factors that affect teaching environmental science in secondary education. Six main themes emerged in the data analysis. They include: 1) curriculum integration, 2) lack of continuity across curricula, 3) interdisciplinary curricular integration with environmental science, 4) professional development, 5) instructional materials, and 6) culture and diversity.

Theme 1: Curriculum integration. Instructional emphasis is embedded at each grade level. Analysis of interview data showed that MS teachers tended to be concerned about student preparation for standardized tests, while HS teachers appeared to be more conscious about the importance of curriculum integration at all grade levels. MS teachers' main concern was to increase knowledge performance to be proficient in science, reading, and mathematics in preparation for the rigor of HS. HS teachers, however, seemed to be more concerned about curriculum integration and finding ways to build students' scaffolding, motivation, and critical and analytical skills so that they are able to face real life problems and be(come) college and career ready.

MS teachers' perceptions. MS teachers perceived a push for cross-integration of English Language Arts (ELA) and Math standards to teach environmental science curriculum in an attempt to support said disciplines, which are considered of great importance when evaluating achievement in the Partnership for Assessment of Readiness for College and Careers (PARCC) test.

Although MS teachers are supportive of these other disciplines and want their students to be prepared for the PARCC test, they perceived that the State science assessment is also important because it counts in the school grading formula and achievement measurements delineated by the federally mandated Every Student Succeeds Act (ESSA) and the New Mexico ESSA Plan. Quinn, who has five years of experience teaching science in a rural public MS, expressed how "[teachers] were asked to support ELA – science was asked to support ELA and math, so use the ELA Common Core standards, to integrate that into science lessons." The opposite does not seem to be emphasized -- the integration of science into other disciplines. In this regard, Jessie said:

> "Elementary school level focus is reading and math, reading and math. Got to get them ready! If most teachers could figure out that you could do all of that through the lens of science, you can incorporate all of it together. But I think some of them are just kind of scared to do – they don't have a science background, they don't know what to do. So, you know, they're just doing the best they can, trying to get their kids where they need to be before the PARCC rolls around."

Another teacher sees an opportunity in the NGSS to shift the current focus so that science can become more integrated in Math and ELA content. Linda explained: "if you understand Standards and you know your topic, then you know your subject area really well, you can always make Standards fit what you are doing."

HS teachers' perceptions. HS teachers believed that, interdisciplinary content should be integrated at the curriculum level, despite the high-stakes state assessments (e.g., PARCC), because providing measurable fully integrated content would help students attain and/or reinforce core competency skills in math and language arts. Regarding this perspective, Rowen, with more than 15 years of experience teaching in the public-school system, affirms that

> "Everything goes hand-in-hand. I mean, it doesn't matter what you're reading, writing, or speaking about, it can be anything, having to do with anything. They all go hand-in-hand, so I see science and social studies teachers both really supporting the literacy – language arts department in our school."

Theme 2: Lack of continuity across curricula. Experienced teachers in HS seemed to know the way the macrosystem works and somehow know, with predictability, that models, standards, and policies change in cyclical manners. Their years of experience and content knowledge seemed to give these science teachers the confidence to integrate any new standard, or framework, into their current pedagogy. In contrast, MS teachers, including the experienced ones, felt it was a daunting task to take on new curriculum integration. There seemed to be more resistance at the MS level when it came to the adoption of the NGSS and MS teachers perceives that they need collaborative support from the school, parents, and community, to effectively integrate environmental science topics into their curriculum.

MS teachers' perceptions. When teaching environmental science, teachers perceived a curricular gap between elementary school and middle school. These teachers seemed to perceive that the lack of integration/ transition between elementary and middle school science curricula is a main issue that prevents facilitating the science curriculum at the MS level, particularly in 6th grade. In order to integrate environmental science into the MS curriculum, it is necessary for students to have basic foundations to understand what is being taught in their science class (e.g., basic scientific vocabulary). Cody, an experienced instructional coach rated as highly effective, considers that

> "it would be (…) great if (…) 6th grade teachers meet with 5th grade teachers and -- or 7th grade -- you know, and 8th grade teachers meet with the freshmen science teachers, so that they could kind of get a gist of what we were about, that would be a great – great thing to set up. But there isn't anything…"

HS teachers' perceptions. HS teachers perceived a lack of continuity in the science curricula for MS and HS. The need to create bridges for science among elementary, middle, and high school is a shared concern of MS and HS teachers. Unfortunately, teachers at the secondary level seemed to be skeptical about the plausibility of smoothing the transitions among elementary, middle, and high schools, and strengthening general continuity. Rowen said in this regard:

> "I don't see – logistically, I don't see that becoming a reality. As far as maybe a formal PD [Professional Development] day, they could do something like that [to hold PD with MS and HS teachers], but, then, you're talking maybe once a semester and it's not enough to make an impact."

Theme 3: Interdisciplinary curriculum integration with environmental science. HS and MS teachers perceived different challenges regarding environmental science education and the implementation of new science standards. MS teachers are dealing with a number of challenges and their concerns included (a) closing the gap in science literacy that comes from little or no science at the elementary school level, (b) preparing students to be proficient on standardized tests, and (c) preparing core competencies for higher grade levels. For example, 6^{th} graders are entering MS with gaps in science knowledge, so teachers must build core foundations at a fast pace while covering mandatory standards at grade level. In addition, teachers perceived a pressure to prepare students to be at proficient for assessment on standardized testing. At the HS level, however, teachers perceive the NGSS as a policy requirement that needs to be integrated into their curriculum and course offerings. To do so, teachers just need to figure out how to make environmental science curricula fit into the new standards.

MS teachers' perceptions. MS teachers stated they were open to the NGSS and welcomed the idea that these new standards will provide the opportunity to make science more experiential and hands-on. The experiential component is a change from science standards that were adopted in 2003. In this regard, Cody stated: "I know that we're doing the adoption of the Next Gen[eration Science] Standards and…[the] more we can make it relevant to the kids, the more we can tie it back to the realistic [world]." Quinn explained:

> "one of the big shifts with the adoption of the STEM – the New Mexico STEM-Ready Science Standards is that it's phenomena-based so we're engage – so educators are engaging students in [the material] by beginning a lesson using a phenomenon, by exposing them to a phenomenon, and having students work to use scientific concepts and scientific practices to explain the phenomenon."

Linda gave a detailed explanation of how the new standards supported an opportunity for integration:

> "I am really excited for the hands on. I believe we need more STEM in our classrooms, but we have to have time for them. STEM activities can take time. When you're talking science, technology, engineering, math, what if you have a great kid who can understand how to do stuff in science but then they can't do the math part? So you got to be able – they – you have to be well-rounded enough to know they can do these components but maybe not these components, so you have to be smart enough to build that side up for your students so that they can see the whole picture. So I'm really excited about that."

HS teachers' perceptions. HS teachers seemed to be inclined to support interdisciplinary curriculum integration across content subjects at all levels, such as school, district, and policymakers. They seemed to be aware that new standards are being implemented and that they have been invited to complete PD for the Next Generation Science Standards (NGSS). Rowen said:

> "I'll be honest, I haven't [taken a look of the NGS standards], … here in the [name of] District, we use proficiency scales and measurement topics, so I don't normally go out to the CSS [Common Science Standards] website, or I wouldn't do the [NGSS]. I would look at the measurement topics for my district; which are already put together."

Teachers seemed to be in favor of building their own instructional model based on their cultural and demographic needs. However, some of the teachers seemed to be confused about the implementation of the NGSS and their integration of course curricula within the local model. A teacher who is now supporting the professional development program and also helping new teachers to become familiar with what they call the [District] Model of Instruction, stated:

> "I'll be working mostly with new teachers that are new to the district or new to the profession. And then, I will also be doing Professional Development based around the ideas of what's called the [District] Model of Instruction, so our protocol that are the focus of [District] schools. So, some of that could tie in really well. We got a relationship piece that needs to be built, so I think that some of that could definitely be tied in to project-based learning for our students and some teachers."

Theme 4: Professional development. Teachers perceived that there is no clear path or instructions on how to integrate environmental science into the new curriculum using the NGSS. They were aware of the disparity in the allocation of resources and the need for professional development to build teacher capacities necessary to accomplish their environmental science curriculum at school. Teachers need to get the 'know-how,' to be trained or refreshed on how to plan cross-cutting standards-based lessons, and be armed with the necessary resources to accomplish ambitious learning goals. Ideally, teachers would seek, from the macrosystem level, feasible policies that take into account the necessary financial resources, appropriate teaching materials, and professional development relevant to the context of New Mexico to help them integrate environmental science into the curriculum and close the existing gap of science knowledge among educational levels.

MS teachers' perceptions. MS teachers were very concerned about resources and PD to implement the NGSS into their curriculum. In this regard, Phoenix, a science department head, commented that, while facilitating statewide science teacher training on the NGSS adoption, that:

> "A lot of teachers are scared, and when you actually look at [the NGSS] online, it looks a bit overwhelming because it's like a complex model, it's like, gosh, it's all over the place … But, anyways, … to keep everybody on -- bookmarked on that one page, frequently asked questions, because they still don't know what a State level -- what it's is going to look like. We have lots of good questions, who's going to design the tests, is it being aligned [to the textbook and standards]?"

On the monetary aspect of resources, Cody stated with dread:

> "It has to be more process – project-based. These kids are going to have to do

> more research, more writing. It's going to change the way we teach, no doubt about it. (…) hoping it will make it better. I really do. But we have got to have money. I mean, it can't – we can't -just continue to buy projects out of our own pockets, which happens a lot. But we'll have to – we'll just have to figure it out. It's going to take time. Nobody's expecting the [NGSS] to be totally smooth and running next year. But we'll get in to them, and we'll start figuring out how to do this, and it will take us a few years but we'll get there."

HS teachers' perceptions. HS teachers called for curriculum development programs to better integrate policy mandates and curriculum and further build core competencies among their students. For some teachers, PD should emphasize, promote, and prioritize best practices for curriculum integration. Tayler, a 20-year veteran teacher, in her interview, remarked,

> "Integration needs to be into everything, into every standard that you teach. It's not a set alone, you know, it's integrated into everything … which it should be, because your environment is affecting everything from the cellular level to the ecosystem level."

Theme 5: Instructional materials. HS and MS teachers needed instructional resources and materials to integrate environmental science education so that it is relevant to New Mexico.

MS teachers' perceptions. At the macrosystem level, MS teachers believed that limited economical resources and policy makers' interests drive policies and mandates. Teachers considered that they have participated in textbook reviews but that their evaluation of the textbook is not considered, that New Mexico's curriculum standards should be included, at the time when instructional materials are selected, mainly because of costs. Ronnie, a MS teacher for over 21 ½ years, explained more about her experience with textbook adoption in the past:

> "We had textbook adoption about seven years ago. We had amazing science books that had everything in it for the New Mexico State Standards. It was geared for New Mexico. That company was in competition with another company – a couple of companies – and we asked for that company again and they went with the cheaper company, which was 50% cheaper…The teachers asked for the same company and the district went with the different company that was cheaper. There's a reason why they're 50% cheaper. They don't focus on New Mexico standards, and half of our standards are not in the book, so we have no resources."

Peyton, a MS teacher rated as highly qualified with more than six years of experience, described how important it is for her to have instructional materials that are relevant to New Mexico: "I would like to see one that's more naturally suited for New Mexico and the issues that we have here in New Mexico, because we have some real specific issues."

HS teachers' perceptions. HS teachers believed in integrating curriculum by using problem-based learning strategies. These teachers integrated different subject matters into a series of defined problems that students can relate to, and created a hands-on experience for them.

Theme 6: Culture and diversity. Meeting the needs of student diversity in northwestern New Mexico is an issue at the State level that both MS and HS teachers perceived as being underdeveloped from the macrosystem level perspective. In New

Mexico, working in rural communities, especially in bordertown communities that are adjacent to tribal reservations, implies a mixing of cultures with different perceptions of one another. Some teachers may not be aware of their own ideologies about other cultures and groups. The teachers who addressed this subject perceived that, at the policy level, cultural diversity in the context of New Mexico is not a focus in the implementation of the environmental science Performance Expectations (PEs) in New Mexico’s science standards framework. Their rationale stems from three main issues that require more attention: 1) creating professional development that demonstrates to teachers how to be culturally sensitive and responsive in the teaching of environmental science; 2) giving teachers access to resources that support environmental science curriculum in rural northwestern New Mexico schools; and 3) developing instructional materials that support culture and place-based pedagogy (e.g., relevant to Native American and Hispanic students’ languages and cultures). They would like to see less focus on standardized test results and more focus on helping communities and families be vanguards of the environment.

MS teachers’ perceptions. MS teachers were aware of diversity in rural northwestern New Mexico. They were very conscious about adapting the curriculum to their demographic reality. Blu said, in this regard:

> “[I]s my curriculum always changing? Yes, and it should change. Right? Based on what I learn and what I’ve come to understand, what I’m trying out. But I make an effort every year to focus on one thing that I’m like, okay, I’m going to try this and I’m going to commit to this despite however many values I have and figure out how to make this work.”

HS teachers' perceptions. At the macrosystem level, HS teachers perceived that, in many respects, diversity is palpable in rural communities. It can be observed among school districts where some schools have access to resources while a school on the other side of town may have very limited access to resources. There are some school districts that count on community business support, while other schools in a very near district do not have any community support. Lupe provides an additional perspective,

> "Yeah. The local community is very, very supportive. But in terms of parents specifically. And the people who are supportive are more, you know, affluent, private owning ranch owners – private land owners. So they – and not to downplay their support, but they also have an ulterior motive, in which they want to expand how they make money and that's also doing outreach and whatnot. So I understand that part, but their motives, I feel, are good – their intentions are good, they want us to be a part, you know, of the community."

Summary. Teachers are looking (1) to work with the State Department of Education to have a robust curriculum framework that integrates environmental science and (2) to strengthen science literacy in the K12 (Kindergarten through 12th grade) educational system, (3) to close gaps in science literacy by instilling science knowledge and skills for mastery at the elementary school level, and (4) to make the environmental science topics more relevant to place and culture in New Mexico. While the focus of MS teachers was based on teaching a standards-based curriculum and focusing on reaching high achievement scores on standardized tests (e.g., 7th grade NMSBA), HS teachers seemed to be more concerned about building core competencies, such as analytical and critical thinking skills, to prepare students to be college and career ready. Some of the emergent topics at the macrosystem level permeate into inner systems (i.e., exosystem, mesosystem, and microsystem), affecting the whole ecological system of environmental science education in rural schools of northwestern New Mexico, as is discussed in the following sections.

Exosystem Analysis

Exosystem Subquestions: *What are teacher perceptions of parental and community influences on teaching environmental science? How are teachers influenced by parents to teach environmental science? How are teachers influenced by the community to teach environmental science that relates to community environmental issues?*

In this section, I present the themes that emerged in the analysis of the exosystem, the ecological level in which parents and the school communities interact with the school system. Interview data showed that both MS and HS teachers perceived parent participation in the environmental science curriculum as an important issue in the implementation of the core curriculum. Three main themes emerged in the data analysis. They include: 1) parental involvement, 2) community integration, and 3) cultural responsiveness.

Theme 1: Parental involvement. MS teachers were, overall, more positive about the plausibility of integrating parent participation into their projects, as opposed to their HS peers, who seemed to have reluctantly relinquished their hopes of parental integration, considering the level of independence that being in high school brings to most students.

MS teachers' perceptions. Based on teachers' perceptions, parent participation was more likely to happen when teachers integrate parents into curricular activities. Family connections will, thus, depend on how the teachers tie the environmental science curriculum to parental participation. Blu, who has 12 years of experience, believes that it is possible to create change from environmental science lessons by having students start small, within their own families. For instance, utilizing inquiry-based teaching to address big ideas such as, "What are some changes that you think you can make, based on what you learned? I think that's where it needs to start, though, [it] is the family connection." Phoenix, an Earth Science teacher with 21 years in the field, bridges her MS classroom to families through the use of instructional technology. One of her assignments is to watch a video about volcanoes featuring Valles Caldera with their families. When the students come back, she says classroom dialogue becomes about, "ah-hah" moments, "because a lot of parents, have lived their whole lives in New Mexico and had no idea we're the Volcano State."

While the previous two teachers displayed positive attitudes about integrating parents into the environmental science curriculum, other teachers were less positive regarding the plausibility of said integration. Two other MS teachers find family engagement as a time-consuming and challenging task. The environmental science standard based curriculum already takes practically all of the teachers' attention and integrating parents into their curriculum would require being thoughtful, creative, and committed to do some extra planning. In this regard, Jessie expressed concern about taking time from the day to make connections to family:

> "[It] would be fun but the focus is so much on how we perform on our testing that if we take away from teaching information that might be covered on the test, then we're going to lose score points, which affects our evaluations, so … The parents, they don't come into the classroom much."

Linda, who has been teaching for 18 years, considers that rural living conditions may be impacting parents' participation. In this regard, she said, "I've got some kids who do not live in [City] [i.e., they come from the Navajo Reservation]. I have some kids who travel extremely far to be here every day."

HS teachers' perceptions. Teachers considered that environmental science topics should be integrated with the curriculum at different levels, such as school, home, and the community. Two of seven HS teachers considered that parental involvement would be higher if teachers would make the effort to integrate students' homes and communities into the school curriculum. Lupe, a novice with a year and a half of experience, believed that teachers do not express their needs enough. In this regard, she said: "no one is showing me interest, but if I looked – if I went out looking, I'd possibly find a few parents interested. But no one's jumping up and down to, you know, assist..."

When trying to integrate parents into their environmental science curriculum and projects, other teachers considered that there is a lack of parental participation that could be due to external factors, such as constraints in their financial means, having multiple jobs, and parent education levels. Four of seven teachers were not very optimistic when they were asked about the level of parents' participation in environmental science projects or when suggesting topics to be integrated into the curriculum. In this regard, Tayler, who has 20 years of experience in the public school system, said: "I don't see a lot of parent involvement to know if they're taking an interest or not (…) [W]e've had a few parents go on that field trip with us. That's three parents out of my 160 students."

However, parental and community participation may be a matter of attracting interests in a different manner, from a fresher perspective. Lupe noticed how the community will attend a "volleyball game on a Tuesday night, but not to the class science project". To her, "it felt as though science didn't have a priority as an entertainment."

Theme 2: Community integration. One issue worth noting was a common concern among the teachers interviewed about environmental science curriculum as controversial science because of an underlying conflict of interest with the local economy base which, in northwestern New Mexico, is dependent on the oil and gas industries. Teachers were aware of how to build relationships with local industries and businesses to receive financial and other support for their classroom projects. Nevertheless, few have chosen to overtly teach advocacy about topical environmental issues and actions students can take to care for the environment, as it could be detrimental for the support of environmental science extracurricular activities and the human resources that volunteer to help teach certain science topics.

MS teachers' perceptions. At the MS level, teachers perceived environmental science topics as controversial content because the northwestern surrounding areas are predominantly influenced by oil and gas and the mining industries and seem to be adamant about teaching critical aspects that could negatively impacting income sources. For example, Linda explained that

> "[f]ossil fuels is a big deal and I know that people are afraid to go there, you know, because we don't want to affect the industry and the money – but there should be a way for that to somehow come together."

Rowen also showed her concern, saying:

> "We have a coal-powered plant right down the street, and there's another one nearby, and we talk about how the two things you can see from the International Space Station are the China wall and the Four Corners emissions from the Four Corners power plant, and what it's done to the health – different health things we see going on around our community that could be caused from the pollution."

Cody also saw this topic as controversial curriculum because, in her area, some oil companies are leaving due to federal emissions compliance issues, affecting the financial stability of the town and surrounding areas. She further explained:

> "…many oil and gas companies that have left have created this town (…) [I]t's affected this town (…); not only if you're oil and gas but think about everything else. The medical facilities, the hospitals. I mean, the revenue from them. They want to shut down PNM [the electric power company in New Mexico], or the APS [Arizona Public Service electric company] power plants, (…) they're coal produced power plants, because the EPA [Environmental Protection Agency] wants to come in and because they say there are too many toxins in the air. Well, that affects our schools because a percentage of their earnings goes to our public schools here in this district."

Middle school teachers unanimously agreed about the controversial nature of the environmental science topics in the curriculum. Even though many towns in this Four

Corners' county have a distinctive smell of methane coming from leaks during extraction, according to Linda, there is an undeniable economic interest to maintain environmentally unfriendly practices for the sake of survival of the towns and the financial support to northwestern New Mexico rural schools.

HS teachers' perceptions. HS teachers also perceived the need to integrate the environmental science curriculum with the community's needs. However, they seem to overtly push for advocacy and critical thinking. Roland, with 15 years of experience, supported the idea of integrating environmental science with advocacy in their local community, by saying:

> "I think that's really easy [to integrate environmental science with community]. When we were first doing single-stream recycling here in [City], my students went to the City Council meeting, incorporating language arts and the ability to write a persuasive letter, and then oral speaking, to be able to speak to the City Council about how important it was for us to have single-stream recycling here in town. And I think just networking, making sure that we've communicated with community members and looking at how students can learn to be advocates for themselves and their town".

Teachers critically thought that it was controversial to teach environmental science in a community that is economically dependent on mining, oil and gas natural extraction. Rayne, who has been teaching for eight years, asserted that
"these topics in environmental science can be political debate, which is, a lot of times, good. … [W]e can bring in a lot from our area because we do have a play between the

environment and the job availability in our area, (…) and, sustaining this over the long haul, not just right now."

As we move further into the 21st century, the new trend in the job market will be green-collar jobs for millions of American workers and, despite the controversial nature of the environmental science topics such as climate change and fracking, teachers, while understanding the predominance of non-environmental friendly business in the area, wanted to promote green-collared jobs and wanted to make students college and career ready by teaching relevant environmental science topics.

In this regard, Grey, a teacher leader with 11 years in the field, also considered that they have been integrating environmental science and have been supported by the community, especially local businesses and professionals. She affirmed that:

> "[Company] is a big contributor to the science fair. As a matter of fact, we got a lot of businesses that contribute to the science fair in a lot of ways (…) We try to [recruit] people in from wherever we can to talk to these kids."

Theme 3: Cultural responsiveness. Our students today need to be prepared to take on more than meeting their current own needs. From a culturally responsive perspective, it is important to integrate environmental science from a holistic, Indigenous worldview, especially when serving Native students. An Indigenous lens may help harmonize the disparities evidenced and give future green-collar professionals the necessary critical skills to become informed environmental citizens, making the right choices towards a sustainable style of life. Just like symbiosis occurs between the humans as individuals and the circles in which they interact, there should be a symbiotic relationship between environmental science topics and society. In other words, from an

Indigenous lens, individuals would be able to connect, be, understand, and respect the environment.

MS teachers' perceptions. The Native American voice among the participating MS teachers believed that environmental science education should be taught from an Indigenous lens to make it more comprehensive.

Blu explained how the worldviews of Indigenous peoples are considered to be less by Western cultures and that they need to be validated in environmental science curricula before attempting integration in diverse classrooms:

> "[F]ighting for this Indigenous education, (…) teaching through an Indigenous lens. And this is me. I'm Native, I'm Navajo. This is our creation story. This story has been passed down for thousands of years, and, yet, I get in school and you're going to tell me that this is not valid? Of course it's not valid to you because you don't understand it. And how can you understand it when you don't know the language (…) [T]here's these different studies that keep coming out that continuously validate what we have already known for thousands of years. Why? Because we had a connection to the Earth, we had a connection to our environment, we understood our environment, and we respected our environment. We understood the relationship that we had with our environment. Now, do we know that now? No. Because of deculturation and assimilation and colonization, we've been separated from that (…) I think a lot of teachers, educators in general, could really benefit from it [i.e., Indigenous education lens]."

HS teachers' perceptions. From a culturally responsive perspective, an expert teacher who is active in the Native American community considered that environmental science should be harmoniously integrated with students' worldviews at all levels. Dillyan, who has been teaching for eight years, considered that environmental science should be integrated with family and community, as well.

> "My own personal lens is always going to be from an Indigenous standpoint, from a Native standpoint. And because of the work I choose to do, and from the demographic that I choose to do it with, I think that Indigenous lens lends credibility to what I do as far as environmental, because environmental doesn't just encompass natural resources and when we are looking at interactions that are even at the micro scale, interactions with families, students, interactions communities, tribes, and in this context, all these things interplay with each other."

Summary. Finding solutions to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987) is a sustainability goal that summarizes environmental science education. Teachers' perceptions at the exosystem level were concentrated on the need to integrate parents and community into the environmental science curriculum to try to find balance in the role of capital interests versus environmental sustainability. Local industry is still there, but companies are closing, as one teacher expressed, "[Funding] came from [Oil Company]…, they're like, "we just write our yearly check to regional science fair and there's our donation." The current educational system demands a lot from MS and HS teachers implementing environmental science curricula and does not provide the financial means, professional development, nor the time allotment necessary to find said balance.

Mesosystem Analysis

Mesosystem Subquestions: *What are teacher perceptions of school and district administrators' expectations for teaching environmental science? Do teachers feel supported by their school administrators to teach environmental science? Do teachers feel encouraged by their school administrators to teach culturally responsive environmental science?*

In this section, I discuss MS and HS teachers' perceptions of how administrations support their teaching of environmental science. Four main themes emerged in the data analysis. They included: 1) support tied to funding, 2) local funding interests, 3) lack of culturally relevant science material, and 4) pressures of high stakes assessments.

Theme 1: Support tied to funding. Teacher in both MS and HS appreciated an administrative push for science literacy and welcomed science programming initiatives in the schools.

MS teachers' perceptions. MS teachers had mixed perceptions about their school administration. Some teachers felt that the administrative level was not supporting them to achieve the teaching expectations set forth for environmental science standards. Peyton, with six years in the field, shared her perception about her district administration's level of support for teachers who want to complete a professional development activity saying:

> "I signed up for a seminar at the [New Mexico Museum] that is going to go over evolution and different things; it's an all-day seminar. But, I have to pay my way there … it's free but I still have to pay my way there and probably stay in a motel,

> because it starts at 8 a.m. in the morning so I'm not wanting to leave my house at 4:30 a.m., but I have to do that on my time."

It seemed like administrators need to articulate what their range of assistance is and to make known what their expectations about science literacy in the schools are so that they can hold teachers accountable later. In this respect, Blu, a highly qualified teacher, suggested how leadership should set priorities for science culture at a school (or district) level, in order for the system to work:

> "[A]s an administrator, you need to hold people accountable to this if this is what your –this is your school, this is your baby, like – you need to be like, this is what our expectations are, X-Y-Z, this is how we're going to compensate you as teachers for doing this, and if you don't do this -- if you don't want to do this, then guess what? We're not going to hire you back next year. But they – it takes guts, I guess. It takes [fearlessness], I don't know. It takes something."

There were other teachers who expressed full administrative support. They brought up what contributed to a supportive school environment. Cody, a science teacher with seven years in the field, discusses this in more detail:

> "I think that [priority for science literacy should be given] because, one, it's important at this school. Our administrator allows – we're a strong science team and it has everything to do with every teacher doing their job every day to their fullest extent."

Despite the different experiences, teachers at the MS level agreed in that the goals set forth in the NGSS and New Mexico standards for science can be fully accomplished with the school and the district administrations' support. Effective professional development is one of the most important components of the implementation of curricula and new standards (Bellanca et al, 2013). A big part of teaching environmental science topics is trying to figure out what topics to teach and when in the curriculum to teach them, how to organize the course and what to cover. Teachers expressed that in order for them to meet the demands that teaching environmental science entails, their district administrations need to provide them with professional development; resources to accomplish science objectives, exemplary lesson plans, and coaching programs. Phoenix, who has 18 teaching science, explained the value of professional development programs:

> “[W]e have two school groups, intact grade level, coming so that they can learn – we’re going to be talking about weather units and the Standards and NGSS, because it’s going to look a little different when it rolls out, which is going to be hard for teachers. I hope we don’t scare our science teachers off because all next year is the old text, so you have to prepare from the old text Standards as you’re learning the new NGSS because the next year, you’re all on NGSS. So I hope it’s not going to scare them too much. I mean, change is always so hard, for everybody, no matter what the profession”.

HS teachers’ perceptions. At this level, teachers’ concerns came from the emphasis administrators and district leaders make on assessments and standardized tests, which leads teachers to cover a breadth of content. This, in turn, may have negative repercussions on students’ future standardized test scores. Skylar, with 20 years of teaching experiences and 8 of those teaching science, explained this:

> “The depth at which we [teachers] are teaching them is huge and they keep shortening – what we were talking about, they keep shortening our class time in

> order for us to be able to accomplish this. We're like, hmmm, wait, wait, you know, you just added more to my plate but you took away the time that I have to teach that. So … I mean, our kids get only one shot to pass the science test."

Teachers who perceived that they are receiving support from the school and district are very positive about how the support received is encouraging them to keep enriching their science lab or science curriculum. In this regard Skylar reflected on the history of environmental science education during the time of his teaching and department leadership:

> "[District] schools are pretty progressive in what we have for electives. We've definitely got the core courses, but we got a lot of other stuff, too. The principal is really very, very supportive of STEM and STEAM projects, so any change – he's always pushing it, trying to get more and more technical stuff into the school."

HS teachers in one LEA felt they have extended support of the district for their environmental science lessons. Grey, a departmental head with 11 years of experience, talked about how connections in class were made from a district level standpoint to students' personal lives:

> "One of the extensions on that is really neat. We have an energy specialist that works for [the LEA] under a grant and he is tasked with saving energy across the school district. So, [he comes] into the classroom and talks a little bit about what he does. They get some pretty big "ah-hah" moments when they start crunching those five, six-digit numbers that large establishments deal with [for costs of energy]. Then, they're able to see – make that comparison to those large numbers

versus the actual natural capital that's coming from the earth, whether it's burning coal or distilling petroleum, whatever may be the case."

Theme 2: Local funding interests. District and school administrators can help advocate for increasing interest in environmental science by supporting teachers with resources and appropriate professional development to execute district and school-wide science literacy goals that tie to place and culture. Teachers showed concern that the budget allocations from the district are inadequate and insufficient to meet their curriculum requirements and that they had to write letters to ask for donations or support to accomplish their science objectives (field trips, labs, etc.). At the MS level, teachers discussed budget and funding support, such as the budget authority for instructional resources to teach environmental science incorporating culturally responsive and place based pedagogy. Mostly, teachers at the MS level either have to pay out of their own pockets or have to seek donations to carry out the basic science curriculum and it is up to the teachers to fundraise for the science materials they need.

MS teachers' perceptions. The implementation of NGSS in rural school communities seemed to bring an unintentionally recursive sense of uncertainty. In this regard, some teachers reiterated the lack resources availability in rural and remote schools. Jessie, a teacher with 21+ years of teaching experience, stated:

"We're out in the middle of nowhere and we have to have the resources it's going to take to [implement the NGSS]. And that's what worries me, they're going to expect us to do all this stuff with no resources – again."

HS teachers' perceptions. The extracurricular activities of many science programs have to depend on outside funding sources more and more, since the district allocation of monies has been dwindling or is currently non-existent. Grey, a HS science teacher and department head, said:

> "A lot of that is funded – it's not funded through a district, there's no school monies allocated, so we're funded solely based on donations – company donations, and we've seen from this year … to participate at the International Science Fair … we've had to cut our number in half this year just because we [don't'] have this set chunk of money that was left to send those kids to the International [science competition]."

Theme 3: Culturally-relevant curricula development. When ties are made to place and culture, environmental science curriculum becomes relevant to the students. Teachers expressed wanting to create culturally-responsive curricula, but changing the system and the way environmental science is taught may be impossible because of the way the structure of the educational system is set up around State assessments that are tied to how districts, schools, and teachers are evaluated and rated. All MS and HS students need to meet these assessments, although the disadvantage with the environmental science curricula is that the assessments do not always incorporate local place and culture.

Teachers' perceived that students need to meet proficiency levels and since culturally responsive measures are not included in assessment, it makes it difficult for teachers to adapt the course blueprint to integrate place and culturally responsive curricula. In this regard, teachers are not always prepared to teach responsive curriculum that ties to a students' culture. Teachers would benefit if district or school administration sponsored professional development around place and culture to strengthen this aspect in teachers' practice.

MS teachers' perceptions. Based on teachers' perceptions, schools have their own culture around priorities and expectations for science literacy. Blu, with 12 years of experience teaching MS science, expressed her frustration with her own school's priorities when trying to find ways to increase her students' science vocabulary. She stated: "[Y]ou can't really change the culture of the school unless you give people a choice."

In another area school, for example, teachers are concerned about preparing students for the Standards Based Assessment. In this regard has worked with teachers across the State to bring a new perspective about culturally-responsive curriculum, one that ties material to students' lives. Jessie explained how curriculum goals are tied to the successful utilization of contextualized teaching material. However, a priority of science literacy is executed at the school level. Ronnie substantiates the science literacy support at her MS: "Our school pushes it big time. [Science] literacy is a big deal."

HS teachers' perceptions. HS teachers did not broach this topic.

Theme 4: Pressures of high stakes assessments. MS teachers feel pressured to teach science curriculum based on the end of course (EOC) exams and State science assessment, since these assessments are tied to school grades and teacher evaluation. HS teachers did not bring up a concern about EoCs and other high stakes assessments.

MS teachers' perceptions. In terms of administrator expectations for teaching environmental science, there is an underlying tone of discord for interaction with MS science teachers and the teacher evaluation. Blu brought up how science gaps could impact an evaluation, since one of the measures in the value-added model (VAM) is student growth. She critiqued the way teachers are evaluated by rhetorically asking:

> "How accurate is that? And you're only doing [observation for teacher evaluation] twice a year, and, yet, that's supposed to be my grade as a teacher? Oh, and you're taking into consideration, my kids have gotten no science in – little to no science in elementary school, right?"

Blu's comment instantiates how teachers felt there is a disparity between what is expected and what their daily work entails. Teachers have to prepare students to do well on State assessments, without taking into consideration how curricular gaps affect them, because their school and their own professional evaluations are tied to said efforts.

HS teachers' perceptions. HS teachers expressed no concern about this topic.

Summary. Teachers' perceptions at the mesosystem level were focused on meeting school and district expectations for achieving science standards. Teacher perceptions of support by their school administrators to teach culturally responsive environmental science was not pronounced, as there is no standard framework to reference.

Microsystem Analysis

Microsystem Subquestions: *What are teacher perceptions about their current implementation of environmental science in the curriculum? Are teachers able to integrate place conscious and culturally responsive environmental science education into their curriculum? What do they plan to implement in the future to support environmental science?*

In this section, I present an analysis of teachers' perceptions about teaching environmental science at both MS and HS levels. Based on perceptions at this level, teachers felt like they have no control over the decisions made at the other levels. Four main themes emerged in the data analysis. They included: 1) lack of curricula continuity, 2) develop core competencies through integration of environmental science, 3) focus on student preparedness, and 4) Build relevant curriculum models to meet the diverse needs of rural students.

Theme 1: Lack of curricula continuity. Analysis of interview data indicated that there seems to be an agreement about lack of curricula continuity among elementary, middle, and high schools, especially when it comes to the science curriculum, which teachers perceived to be all but absent at the elementary level. Teachers at both MS and HS levels seemed to be voicing the desire for smoother transitions and more cohesive curricula to support the formation of the core competencies needed to be successful in the next school level.

MS teachers' perceptions. MS teachers shared their perceptions about the integration of environmental science into the educational curriculum. They considered that environmental science as an integral component of the knowledge and values taught that tie to life as a whole and as such, it should be integrated at all levels of education. From a Native American teacher's perspective, Blu explained that environmental science is a subject that ecologically connects to aspects of life outside the classroom. In this regard, she explains:

> "what I think of, in environmental science, it's more comprehensive than just what we're teaching about the environment; it's more so like teaching about our

> relationship to the environment and how what we do affects the environment, how does that affect us, and how does it affect everything in the environment; and then, how can we come to this, like, advocacy – like, if this is our relationship to the – there's a symbiotic relationship, right? Then how do we maintain that balance?"

It seemed that, in order to be comprehensive, MS teachers are using cultural integration to teach environmental science. Phoenix shared that, in her community, some teachers able to integrate culture and belief within the environmental science curriculum. She brings Native American students' stories (e.g., Navajo stories tied to the earth and stars) into the curriculum because she has noticed that these stories are very easy to incorporate into the lessons and that, by using these stories, other demographic and ethnic groups can learn. She states: "Native Americans have all these stories about the different constellations and everything, and, so, it's really easy to pull them in..."

In another example of how environmental science connects culture, Quinn commented on how he connects the topic of the natural capital of the state: "the effects of mining that occurred from the fifties to the nineties (…) how mining affected the environment and the ecosystems, but it also talked about how mining affected the Navajo as a people, culturally, financially." Linda, a veteran middle school teacher, provided additional perspectives about how she integrated students' cultures into her classroom,

> "[This school enrolls] all the Native American kids off of the reservation right here… And the ones that border the reservation tend to be very traditional, so it's interesting because Shiprock is the volcanic magnet, right? So it used to be an active volcano at one time, and they have – it was wonderful, we just did that

project last month, where they had to pick a tectonic plate or some – you know, something to do with volcanos or earthquakes or, you know, with plate tectonics, and a lot of kids picked Shiprock because that's familiar to them. So, we get these nice "ah hah" moments of, "oh, I didn't know Shiprock had anything to do with volcanic activity" because they have the traditional Native stories. So, it's kind of – it's been really fun every year to see them incorporate those stories, go home and talk to their families about it, go home and share information…"

HS teachers' perceptions. HS teachers seemed to see environmental science, not only as curricular, but also as a way to help preserve their natural resources, their way of life, and their culture. In this regard, Dillyan, a teacher who now works as an administrator specialist with tribal schools who has more than 8 years of experience teaching science, shares his Indigenous viewpoint:

"…environmental science, I can give you a dictionary version of it but I don't think that encompasses what and then I had to put it out there with a little disclaimer. I always look at things thru the lenses – and I think all of us look at things thru the lenses, our own personal lenses – and my own personal lens is always going to be from an Indigenous standpoint, from a Native standpoint. And because of the work I choose to do, and from the demographic that I choose to do it with, I think that Indigenous lens credibility to what I do as far as environmental, because environmental doesn't just encompass natural resources and on a broad scale, it's looking at interactions that are even at the micro scale, with interactions with families, with students, interactions with communities, tribes, and in this context, all these things interplay with each other".

Some HS teachers considered that, in rural northwestern areas of the State surrounding the Four Corners, it is crucial to integrate environmental science curriculum and actively involve the community as a way to join efforts and resources towards a greater good. When teachers were asked about their favorite topics to teach environmental science and integrate the community, Rowen, a teacher with 15 years of experience, happily explained how he has been able to achieve both in an appealing way:

> "I would say either solar energy or recycling. To me, those are my two favorite things, so – I wrote a grant when I was at [Name of] Elementary and received $20,000 from [Company] to install solar panels on the school; so we ended up spending the whole year learning how to read information from the inverter, we talked all about PB cells, made fun videos, we made placemats to put in local restaurants to invite – you know, the students made placemats that taught eaters about solar energy and then invited them to come to [School] (…) So solar is one of my favorites to teach, I think it's super-fun. I also love recycling because I think it's the most important thing we can do on the planet, and it's so easy to incorporate into language arts, history, [and] social studies."

Theme 2: Develop core competencies through integration of environmental science. Traditionally, white-collar jobs are defined as management or administration and blue-collar jobs are defined as manual labor, but green-collar jobs, because there is a broad range in the common goal of improving the quality of our environment, encompass a spectrum of job and career opportunities from manual labor to management and administration that address concerns about the environment. Both MS and HS teachers felt the need to integrate environmental science curriculum at all levels, not only in the science curriculum, and to use problem-based, project-based, case-based, or scenario-based learning to support the formation of core competencies and positive values. Both groups of teachers believe that by using such methods, they can meet the new science standards while the formation of core competencies needed for students to succeed both academically and in the real world.

MS teachers' perceptions. MS teachers are concerned about helping their students develop core competencies such as critical thinking, problem-solving skills, reasoning, and analysis, among other higher-level cognitive skills. Teacher perceptions at this level revealed the desire to do so but, likewise, an eminent need to integrate the science curriculum and aim to develop/ build up competencies that would allow students to think about science critically and solve real-life problems. Linda, briefly explained the school system's reality in this regard:

> "Wouldn't you think that would be a step in the right direction: [to] have your MS teachers building-up and scaffolding the information for your HS teachers so that the HS teachers know [what we are teaching] – there's such a disconnect between elementary and science – you know, the teachers here at mid-school, and the science that they do at the high school. They have no clue [about] what we teach here."

HS teachers' perceptions. One of the concerns from HS teachers was dealing with the lack of sequence in the science curriculum, which is carrying on from elementary school. However, some HS teachers hope that elementary school teachers somehow would integrate science in the language art and math curricula. In this regard, Rowen said:

"When I talk to my elementary-level friends, they say that science has basically disappeared in K-5. That wasn't the case when I was there, but that's been a lot of years. And as we really push to move students to proficiency in English and math, that's really been the focus. Now, for me, that's really a no-brainer that science meets English and math, so I don't know how that really looks if teachers are not pulling that in, or are in a different way, but science class as it was is no longer really there. But I would hope and pray that teachers are bringing that in a different way."

Theme 3: Focus on student preparedness.

MS teachers' perceptions. Students are keen to learn about environmental science, but sometimes they face problems understanding science topics due to the curricular gap between elementary and middle school. To close the gap and engage students to critically think about relatable science affairs, some teachers create group projects aimed to show relationships among phenomena. Based on her 12 years of teaching experience, Blu commented on her strategy,

"The whole idea of coming – relating it back to themselves, and how is this topic affecting you – directly or indirectly, it's still affecting you and how is it doing that. Getting them to think about it, this cause and effect. Because all science is pretty much cause and effect, right? … So how do you help to develop (…) core competencies (…) with your students and with your kids? (…) [W]ith this curriculum, stop focusing on the Standards and [ask yourself:] (…) what do I really want my kids to learn. What do I really want my students to learn, what do I feel is important for them to understand; and then, guess what, you'll find the Standards that fit. And if you teach them those researching skills and those critical thinking skills, and then you give them a project where they have to research their own stuff, you'll find, when you give them the space and the time to focus on what interests them, you'll have some really amazing things come out of them."

HS teachers' perceptions. New Mexico has an abundance of sunshine, for example, but countries with far less sun days, like Germany, are making more strides in pushing solar energy (Clean Air Technologies, 2017). The critical roles European countries are playing with solar and alternative energy today could secure their future as world leaders in renewable energy development. HS teachers are concerned about helping students to be successful as environmental citizens. To sociologically create the desired critical mass, teachers considered that integrating environmental science with the formation of core competencies is urgent. With her seven years of experience, Taylor stated:

> "I just want them to be able to [understand], okay, look at all of this diversity around you. It's pretty amazing. Just open your eyes and look and see what's here, what's around you. When you do go camping, how do you – how do you go and enjoy that and do that activity and leave the smallest impact that you can. You know, how do you leave [nature] as we found it. I guess sometimes you don't find it in great shape but … You know, just to get kids aware of that, yes, you are having an impact here. Everybody – you think that, oh, just because I toss, this is just one coke cup, it's not going to make a difference if I just toss it out the window. Everybody in [town] with that same mentality, what do we get to live with around here? So, that – I mean, if nothing else as far as environment,

if they can carry that much outside of my classroom, then – you know, they may not remember in 20 years how – what the energy transfer was of the pyramid, but … if kids can just realize, … [yes,] you're having an impact and things are going to come back and they're going to impact you, so, what kind of flow do you want that to be?"

Theme 4: Build culturally responsive curriculum models. MS and HS school teachers were conscious about the importance of integrating culture within the environmental science curriculum and put into question the authority of who decides what is taught and how it should be taught. To counteract conformism, some teachers select Native American stories to enrich their curriculum and promote cultural integration as a way to explain scientific phenomena from other perspectives.

MS teachers' perceptions. Teachers expressed concern over authority of who decides what is taught. In other words, some teachers were reluctant to conform and teach "by the book."

The age of the earth is an example of the many controversial topics that environmental science contains. The planet's billion-year history is controversial because it points to the theory of evolution. Blu teaches her MS students about scientific laws and theories, often from an Indigenous cultural perspective, which provides a critical lens from which to view science. In this regard, she expressed,

"The big bang theory is still a theory, it's not a law because it hasn't been proven. You can state your reasons why you think it's that way. But there are many Indigenous people throughout the world who have their own stories that are thousands of years old that are just as valid – probably more valid because they are thousands of years old, whereas that theory is only a few hundred – maybe a hundred or two, you know? … They don't want to us to teach creationism, though. They won't – they don't want us to teach the creation stories as theories around how the world began, right? But I'm like, that's where the critical thinking is supposed to come in."

HS teachers' perceptions. Teachers at this level said that they know how to integrate what they know their students need, in a system of which they already know the way it works. HS teachers seemed to be more confident with their mission as a teacher, and they seem to be more autonomous in selecting the content they integrate in their lessons. Teachers seemed to be inclined towards cross-content integration using a problem-based approach when teaching environmental science in their classroom. Lupe, with one-and-a-half years of experience, ties environmental science to land, construction, mining, and ranching, all of which integrate into her content:

> "I would define environmental science as the science that connects humans and the rest of the earth. Basically, we've excluded ourselves from nature. That's the general present consensus that I'm getting. And environmental science is a science that brings that back together. And you're not apart from it; you're a part of it. Everything that surrounds you is environmental science. These walls, they're made from adobe, or they're made from gravel or sand, or carbon dioxide is in it. [These are] copper tables [we are sitting at]. Everything is environmental science, so environmental science class is basically bringing that together and getting a person to understand that there's value in nature because everything around you is nature that has been altered."

Summary. The microsystem analysis of both MS and HS teachers' perceptions highlighted integrating environmental science curriculum. The teachers were able to express their concerns about the questions they have and the challenges they anticipate to teach environmental science under the auspices of the new science standards, as well as to express what they perceive they are being inundated with in the classroom by the demands made upon them by the other ecological systems (in this case, the State Department of Education, the district and school administrations, and the community).

Major Findings and System interactions

In this section, I organized the findings related to my main research question, "What do teachers perceive are the factors that impact their teaching of environmental science in rural northwestern New Mexico secondary schools?", according to the interactions that can be observed between the four levels of the ecological systems framework.

Macrosystem and Microsystem Interactions.

Science knowledge gaps across grade levels. Teachers perceive a gap in science knowledge across grade levels, starting at elementary school continuing into high school. This gap has a snowball effect when it comes to teaching science curricula in general, and environmental science curricula in particular, especially in middle schools, where 6th grade teachers are tasked with not only creating a science foundation most 6th graders lack, but simultaneously teaching grade level curricula and building student's science knowledge in preparation for 7th grade and NMSBA testing.

MS science teachers report they are dealing with students' knowledge gaps and are trying to integrate environmental science topics into their current science curriculum, while they are simultaneously trying to build core competencies, such as analytical and critical thinking skills, to help students be proficient in science, which will be demonstrated when students take their State science assessments at the end of the course. Based on teachers' perceptions at the MS grade level, three concerns at the macrosystem emerged within the learning environment. These concerns were 1) the socioeconomic context; 2) the policy context; and 3) the community context. These three concerns are the reason why teachers seek collaboration at these ecological system levels: at the exosystem level, they seek support from parents and community; and at the mesosystem level, they seek support from their school administrators and district administration. MS teachers seem to require more support from multiple dimensions as well as more instructional materials supporting their missions (core competencies, New Mexico science standards, and NGSS), all of which are imperative to help their students succeed at the next level.

The HS teachers seemed to be more confident integrating curriculum from an interdisciplinary perspective, perhaps because the particular teachers interviewed had more experience. As a result, they how the (macro) system works, and they seemed to be less concerned with new policies from the State and what the underlying framework for course curricula is and more focused on engaging their students with interesting science curricula. HS science teachers have repeatedly observed how educational reforms always implement something new – a new ideology -- for the betterment of the system, but not necessarily having thought through its long or short-term effects on teachers and students (e.g., No Child Left Behind, 2001; Every Student Succeeds Act, 2016; Common Core State Standards Initiative-PARCC, 2013; etc.).

At the macrosystem level, teachers perceived a contradiction between how policymakers who are the authority for oversight of new curricula mandates are supposedly supporting cultural inclusivity and diversity in new standards and how said support is not tailored for rural school contexts where the cultural diversity of the student populations are the most prominent. Some teachers perceived there to be a subtle, and disturbing, contradiction to stated policy when they receive professional development programs and instructional materials where the cultural diversity piece is obviously lacking. New Mexico is in a position to be a leading state, one that clearly provides cultural responsive curricula that respects and honors its diverse population to increase academic achievement.

Macrosystem and Exosystem Interactions.

Collaboration. At the macrosystem level, it is perceived that MS teachers are calling for more collaborative partnerships between parents, community, and the school to integrate environmental science into their curriculum. Teachers seemed to be very positive about including parents in their environmental science projects; however, it seemed like parents' participation is a challenge in rural and remote New Mexico. Some teachers perceived that challenges and factors that influence parent participation may be related the demographics of their school communities, including a high poverty ratio. At the HS level, teachers perceived parents' participation with a less optimal perspective. Interview data showed how HS teachers invite parents and community members to participate at school events and to solicit input for extended curriculum support; yet, there still is a lack of engagement, perhaps because of non-interest, or perhaps because of other priorities and commitments, on the parents' part. This group of teachers express that low participation may be due to demographic factors of the community.

Exosystem and Microsystem Interactions.

Community. Community participation was more integrated at both MS and HS grade levels. Rural northwestern New Mexico is very diverse and certain schools within a district seem to have more access to community support than others. Some schools receive a very limited budget from the district in order to implement the science curriculum. They seemed to reach out and have access to organizations around or within the community that provide them with monetary endowments, or support them with expert professional specialists who come to classrooms and share environmental science experience career growth. There are organizations that support schools with economic donations so that teachers are able to buy their necessary materials and lab resources, or use the money for transportation related to science outdoor learning and field trips. MS teachers expressed concern about the necessity for teachers to write to businesses in order to secure donations, so that they can acquire the necessary resources to accomplish their environmental science curriculum objectives.

Lack of parental involvement. The lack of parent participation at the MS and HS grade levels seems to affect the microsystem, which means that teachers are developing environmental science curriculum and implementing their instructional objectives without input or feedback from parents. Teachers at the microsystem level were concerned that spending time trying to encourage parents to engage and participate in science activities will take away from the limited time they have to build students' core competencies, such as analytical and critical thinking, to ensure that they will pass the standardized tests.

Contradictions. At the exosystem level, another interaction that emerged from the analysis concerns the contradictions teachers perceive when they teach about controversial environmental science topics, such as climate change, pollution, water quality, and fracking, within a community where the economy is based on natural resource extraction. Based on their perceptions through the interviews, teachers were conscious of a level of controversy around receiving support from business organizations that have economic interests in the community. Teachers in these communities perceived themselves as being in a no-win situation, as they have to teach environmental science in an environment where the local economy is based on natural capital industries, such as ranching, mining, and natural resource extraction but, at the same time, these are the businesses that are supporting the schools by providing additional – and much needed -- resources, including volunteers as well other types of financial support.

Mesosystem and Microsystem Interactions.

Creating agency for development. An interaction between the mesosystem level and microsystem level that I discovered while analyzing data for this study is that teachers were incorporating fundraising activities as part of their administrative functions outside of teaching. These fundraising efforts subsidize the inadequate funding that are allocated to science classrooms. At the district (exosystem) level, grant writing should be incorporated into their professional development programs to support classroom learning activities at the microsystem level.

Parents and families. Parent engagement and community participation is another theme that emerged in the analysis. Creating appropriate professional development for teachers will provide better strategies and resources so that they can strengthen their approaches to working with culturally diverse students and their families.

Cultural responsiveness. Analysis revealed that, based on a Native American perspective, environmental science topics should be integrated into the science curriculum with a holistic approach. At the exosystem level, culturally responsive curriculum not only resonates with the students but integrates the entire family as well as the local community because it makes the lessons personal to them. From teachers' perceptions, the exosystem level is also affected by the macrosystem level because there is a gap between science instructional materials and culturally responsive resources, which requires teachers to supplement their planned lesson with their own instructional material, much of the time, at their own expense.

Mesosystem and Macrosystem Interaction.

The diverse demographics that characterize rural northwestern New Mexico seems to be a factor that each school district represented in this study faced within their schools. Teachers at both middle and high schools have mixed perceptions when referring to school administration support about how to address cultural diversity. MS teachers called on their administrators to facilitate professional development that gives clear direction on how to integrate environmental science with cultural diversity and New Mexico context in mind into their classroom science curriculum. They are also concerned about accessing the NGSS website because the design is overwhelming and intimidating. Although they expressed being excited for a revision of science standards that were adopted in 2003, they felt overwhelmed with the information they have gleaned about these standards. They seemed to need support to help them integrate the new standards into their lesson plans, to create hands-on activities as well as to integrate a more culturally-responsive environmental science curriculum into their current science lesson plans. MS teachers need more support at the administrative level, district level, and from the community, and they also want more parental engagement, in order to accomplish the ambitious learning objectives set forth.

HS teachers who were more confident about implementing the NGSS into their curriculum seemed to perceive new standards as being more cyclical, along the lines of an educational agenda that they will discover how to make work within the established system. At the HS level, there seemed to be more concern about preparing students with the core competencies necessary to be successful for college and career.

MS teachers were very concerned about new standards and having to integrate new curriculum into their long list of standard objectives to be covered on the science assessment test. At the microsystem level, they looked for administrative support from their district and school to accomplish those instructional goals for students. The teachers felt doubly pressured because their students' assessment test scores will be reflected on their teacher evaluations, as well. For HS teachers, however, science standards integration, at the microsystem level, seemed to be not of a concern, and they didn't seem to be very worried about receiving the professional development to accomplish the science standards objectives. In fact, some of the HS teachers seem to perceive that the new NGSS are more comprehensive, rigorous, interdisciplinary, and support hands-on project based teachings.

Based on teacher perceptions, MS teachers are concerned that they have limited time for environmental science curriculum integration, or designing a more culturally responsive curriculum, because they have to prepare students to reach proficiency on State assessments and district tests.

MS and HS teachers were both trying to be culturally responsive when teaching environmental science. They were, for example, integrating Native American viewpoints to explain science, including such things as Native American creation stories or ties to stories about the constellations. They were also integrating place to teach environmental science within their geographical locale. Teachers connected students to the rivers, the earth, and places where they live and go to school.

At the mesosystem level, both MS and HS teachers were conscious about the lack of resources that they have to work with at rural schools. MS teachers were concerned about the pertinence of instructional materials the school and district choose for science instructional standards because they have to adapt and design resources to cover the instructional needs of rural northwestern New Mexico communities. The teachers were conscious that, at some schools, there is support and, at other schools, they were lacking the benefits of having the equipment and funding required to accomplish the science standards objectives. MS teachers were also conscious that in order to design a culturally responsive curriculum, they have to have not only their administration's support, but they also required more customized professional development programs as well as financial resources to guarantee the accomplishments of the instructional objectives.

MS teachers were very dedicated to teaching core competencies, such as critical thinking and analytical skills, informational reading and writing, problem solving skills, etc., to their students because they were worried that MS students are not prepared for the demands that will be placed on them in high school. MS teachers care about helping students develop these skills but, at the same time, they want to cover all of the subject areas their students will need to know in order to be proficient on the state science test.

Overview

In the overview of the entire ecological system, themes that emerged from policymaker (macrosystem) level serve as important guidelines that are executed through the mesosystem, where districts are supporting schools by giving clear guidelines and designing professional development programs that help teachers to better integrate the science standards into their current curriculum. Teacher perceptions through interviews revealed these professional development programs and guidelines need to be more relevant to the challenges they face in their teaching. See *Appendix I* for a concept map of the connections between perceived factors that impact teaching environmental science. Instructions need to present a model of exemplar lessons that promote comprehensive application of these science standards into the curriculum. Teachers felt that, at the mesosystem level, district and school administrators need to support better engagements of parent, family, and community into their science curriculum.

Summary

In summary, the events that take place in each ecological level affect other ecological levels in a systemic way. In general, this can be instantiated, as discussed in this chapter, in how mandates coming from the macrosystem (NMPED) level affect the nature of the activities and trainings implemented at the mesosystem (district) level to comprehensively apply state and national standards at the microsystem (classroom) level.

Chapter 5

Findings, Implications, Conclusions, and Recommendations

The purpose of this chapter is to interrelate teachers' perspectives on systems that influence teaching environmental science education and environmental science in secondary level (grades 6-12) schools in the rural northwestern area of New Mexico. As presented in Chapter 4, Bronfenbrenner's (1994) theoretical model (see Figure 2.1) suggests that interactions among environmental systems progressively become more complex. This means that events at the macrosystem level heavily impact events at the microsystem level.

This chapter is divided into four sections. The first section summarizes the research findings; the second section provides implications of this study; the third section presents conclusions; and the fourth section suggests recommendations for future research.

Findings

The focus of this study was secondary level science teachers' perceptions of factors impacting their teaching of environmental science. The research question that guided this study was: *What do teachers perceive as the factors that impact their teaching of environmental science in rural northwestern New Mexico secondary schools?*

The data collected revealed that larger perceptions of environmental science ultimately influence how teachers integrate important topics into current curriculum, and consequently, how their perceptions about environmental science may directly influence students' reflections upon environmental awareness in their community and the outside world. The main findings teachers perceived as factors impacting their teaching of environmental science at both middle school and high school include:

- Perceived gaps in the K-12 science curriculum.
- The need for a culturally and demographically relevant adoption of the Next Generation Science Standards (NGSS) in New Mexico, especially in rural, bordertown communities.
- Attention needed to place-based and culturally responsive curricula stemming from connections with the community.

Gap between elementary and middle school science knowledge. Closing this gap implies the need to evaluate how science is taught in rural northwestern New Mexico elementary schools, and determining strategies to better meet the needs of diverse elementary students to prepare them for challenges they will face in middle school. Attention to historic and on-going gaps in science literacy has been a focus of educational researchers for over a decade (Landson-Billings, 2006), so this finding was not a surprise.

Morgan et al (2014) pointed out there is a need to create early childhood and elementary school interventions in science literacy in order to help close these gaps. And as noted earlier, Epstein & Lee (1995) found a child's interest in learning about basic scientific principles and environmental issues is influenced by parental involvement (such as growing a garden together, etc.) during a child's early years.

Science teachers at the secondary level could be a central guiding force in shaping environmental science curriculum reaching across all grade levels, including elementary schools. As Hart (2003) suggests, science literacy involves much more than basic scientific concepts (e.g., environmental citizenship, consciousness, and responsibility). It is therefore conceivable that a secondary level teacher could help coach an elementary school teacher to incorporate some of these concepts into his or her classroom activities.

Teachers perceive that their students are keen to learn about environmental science. Thus, a viable science curriculum transition between elementary and middle school will create a bridge to close the perceived curricular gap and help students understand more complex science topics and perform better as they progress into higher education.

The need for culturally and demographically relevant adoption of the Next Generation Science Standards. Districts must design teacher professional development for culturally relevant and place-based interdisciplinary collaboration to help increase the attention on science literacy from a community-oriented position. There are teachers in my sample who reported a need to receive localized professional development. More specifically, they felt the need to draw community and local knowledge systems into environmental science curriculum development and also help provide resources to enhance teacher training. Walter & Anderson (2013) would consider this an *epistemological* approach to knowledge development, in which local community environmental knowledge is of great value, in contrast to other forms of knowledge that may or may not be relevant to the needs of science educators such as those represented in this research sample.

In the context of the student demographics in New Mexico, TribalCrit theory (Brayboy, 1999), Red Pedagogy (Grande, 2013), and Native Science (Cajete, 2016) are a few applicable approaches from which to consider how a side-by-side alignment of the New Mexico STEM Ready! Standards and local knowledges intersect to increase positive student outcomes. Heightened insight about and support of this need at the macro level

(State Department of Education) will provide local school leaders with a coordinated system to strengthen curriculum adoption at the micro level (classroom teaching), where the intersection of diverse backgrounds and communities is eminent.

District administration could provide teachers with resources to accomplish NGS standards for environmental science objectives, offer exemplary lesson plans, and have coaching and professional development programs available. These programs could consider how to integrate place and culture of the local community in professional development, especially in remote and rural New Mexico with diverse communities in order to help teachers offer more relevant and pertinent information so students develop an integrated perspective.

Develop culturally responsive curricular models in collaboration with the community. Developing culturally responsive curricular models includes designing and providing access to instructional materials relevant to Native American communities in New Mexico, as well as students from other cultures. This can be accomplished by enriching school libraries and classrooms with science resources supporting New Mexico Science Standards that supplement textbooks lacking in place-driven contents. At the macro level, the state could also encourage sharing of curriculum and instructional resources created by other districts in New Mexico, as well as in other states, to assist in developing a best practices model geared toward environmental science educators. Also, the state could encourage the development of a facilitated online community of practice enabling teachers to network through a virtual space and interact dynamically with one another sharing lesson plans, environmental science resources, teaching materials, and also engaging in peer coaching modules.

Implementation of the changes suggested above could address the existing discord in environmental science curriculum, especially for Indigenous students, and may shine light on the dramatic differences in cross-cultural schooling in science, thus promoting a decolonizing curriculum to improve scientific literacy of all students, Indigenous and non-Indigenous alike (Aikenhead & Elliot, 2008).

Conclusions

With new common science standards being implemented, teachers' approach to environmental science in general, and topics such as climate change in particular, will be changing, and teachers will need additional resources for curriculum development, such as culturally relevant and place-based instructional materials to implement these changes successfully. Even though some teachers in my sample expressed excitement about how NGSS are better integrated and cover material in-depth with relevant topics that are of importance for their diverse students, other teachers felt that a number of factors need to be addressed to satisfactorily integrate place-based and culturally responsive environmental science curriculum in secondary level schools in rural northwestern New Mexico, especially with the implementation of the Next Generation Science Standards (NGSS) and the New Mexico STEM Ready! Science Standards in school year 2019-2020.

Interview data suggest that teachers in northwestern New Mexican rural areas perceive the implementation of environmental science standards and curriculum is impacted by factors such as place and culture. For example, most teachers described limitations in their ability to fully integrate connections to place and culturally responsive pedagogy in their curriculum. In this regard, there are institution challenges limiting the development of culturally relevant science curriculum. Specifically, how teacher education programs do not necessarily embed culturally and linguistically responsible pedagogies and methodologies in their curriculum (Brayboy & Castagno, 2008).

According to teachers in the northwestern quadrant of New Mexico, these challenges are common and relevant in secondary schools where there is a high percentage of Native American students, considering that Native American students comprised 33.7% of the student population in one of the bordertown school districts (New Mexico Public Education Department, 2018). This same source reveals that in another district, the total Native American student population is even higher at 78.9%, and comes from more traditional families living on the adjacent reservation. Although some teachers perceived there are environmental science topics that can naturally be viewed from a Native American standpoint, challenges of teaching science from a Native viewpoint include: lack of understanding about Indigenous New Mexico tribal cultures, no supplemental New Mexico Native science curricula, minimal understanding about what oral stories are appropriate to share, and Western science dissonance with traditional Native knowledges.

Taking advantage of the context of changes in newly adopted science standards, training addressing these and other things could help non-Indigenous teachers broaden their own views of environmental science and change their perspectives in a way that would affect all students for the better, Native American or not. A multicultural perspective would allow complementing the curricula and integrating worldviews.

For instance, astronomy is a common topic between Western and non-western cultures that can be exploited to breach the current gap between science and culture. From an

Indigenous perspective, astronomy is a tradition filled with stories passed down generationally for thousands of years. Teaching about the solar system and constellations would be one way to integrate Indigenous science into common science standards, as stated by Phoenix, a non-Native science teacher in Chapter 4 of this document.

In fact, teachers observed students more fully engaging in environmental science curriculum when cultural beliefs and traditional stories about place were integrated into the science lessons, thus creating a more culturally inclusive learning environment. In this regard, teachers have been able to have deep discussions about the land and make cultural connections with their students. Jessie in Chapter 4 provided an example of this when he talked about Shiprock being a “volcanic magnet.”

Furthermore, environmental science provides teaching opportunities for teachers in rural reservation and bordertown areas, as these communities have issues that directly connect to environmental science topics within the curriculum. One environmental science topic Participant Quinn in Chapter 4 explained that the effects of mining from 1950-1990 in northwest New Mexico integrated well into an energy unit, because of how it impacted not only the environment and ecosystems, but also greatly impacted the Navajo community, as a People—culturally and financially. On the other hand, Ronnie described in the previous chapter how some of the learning opportunities presented to her students in the state adopted textbook did not relate to New Mexico specific curriculum.

Even though teachers overall perceived the ability to integrate place-based and culturally responsive environmental science topics into the new science curriculum as a positive influence, other teachers felt the content standards might not necessarily be conducive to integrating place-conscious and culturally responsive topics into the curriculum. On the other hand, Taylor in Chapter 4 demonstrated considerable cultural sensitivity by pinpointing differences between two districts when discussing teaching students about owls.

Teachers like Linda perceive what is culturally appropriate in their current schools, thanks to the traditional knowledge and cultural beliefs of bordering tribal communities. This is not the norm, however. Indigenous cultural knowledges may be unfamiliar to the majority of teachers in New Mexico, and the newly adopted state science standards and NGSS do not fully address the special and unique needs of New Mexico's rural areas. The need to adapt these standards to the state's rural communities and the lack of response from authorities to help teachers connect science to students' diverse cultural backgrounds make the recognition of Native science and the use of decolonized approaches to teaching science imperative. Ideological differences in knowledge systems between Western and Indigenous science have created counter curricula development to address disparities in elementary and secondary achievement amongst students in the United States and abroad (Kanu, 2007; Brayboy & Castagno, 2009; McCarty, 2009; Savage et al., 2011). Native American science proficiency levels and advanced science course taking rates are too alarming to ignore as the state adopts new science standards. The State Department of Education should compile this and further data to make an informed decision allowing them to provide teachers with the tools and resources requested to successfully implement the new standard changes.

The conclusions of this study, based on teacher perceptions of the primary factors impacting teaching environmental science in the northwestern quadrant of New Mexican public schools are:

- Educators continue to rely on textbooks and materials adopted by the state to guide their organizational curriculum when instruction should be based on solving real world environmental science problems that concern the local community.
- Environmental science educators view the targeted areas of Common Core Standards, which are English Language Arts (ELA) and Mathematics, often marginalize science while alarming gaps in science achievement continue to broaden, especially for Native American students.
- There is a lack of culturally responsive/relevant curriculum in environmental science, especially for Indigenous Native Sciences.
- There are diverse teacher opinions about environmental science topics that could support curriculum model development and resources at the macro-level.

This study brought many questions to the forefront, and future research could very well extend this study. The use of state-wide surveys capturing teacher identities, individual and focus group interviews with teachers, and science achievement regression analyses for student groups statewide would be beneficial in providing a time-series snapshot of where environmental science education is positioned within the implementation structure of the NGSS and New Mexico STEM Ready! Standards. Any one of these suggestions should provide information about how culturally responsive and place-based curricula affect the way environmental science is taught over time.

The fact that this study considered underrepresented demographics gives rural teachers a chance to voice their perspectives and needs, not only about their perceptions of factors they feel impact their teaching of environmental science topics, but also about the Next Generation Science Standards implementation and the opportunities and challenges that come from switching to the new science standards in the context of rural and culturally diverse school settings. From the innovative ways teachers try to connect environmental science topics to students' everyday environments, to the challenges they encounter in trying to find funding and resources for their science curriculum, teachers' responses reflect a shared passion for science among colleagues, as well as a common desire to engage students in critical thinking processes that will influence how they make decisions affecting them in the future.

Because New Mexico is awakening to environmental science issues, such as climate change and water contaminated by corporate polluters (Senator Martin Heinrich, 2018), it is critical to examine how teachers perceive the changes being made to school science content standards, particularly those that affect what environmental science topics are being taught. Bordertown metro areas have century-long histories of racialized conflict that have been described as civil rights violations against members of local Indigenous Native Nations by non-Native citizens (United States Commission on Civil Rights, 2004). Data collection over time about bordertown schooling is important to support further understanding about student and teacher experiences. This way, more could be understood about how teachers' ideologies influence how they share knowledge about environmental science education with their students.

The social, political, and economic contexts of where I did my study in northwestern New Mexico is a place of oil and gas, and is a place that nourishes the majority of the New Mexican economy. The area has a long – and somewhat, sordid – history of mining, and there are a number of environmental controversies that are rooted in that history. There are environmental activist movements occurring in the northwestern region of New Mexico to protect Chaco Canyon from fracking and to bring more knowledge about uranium mining on the Navajo Nation reservation lands. Based on evidence of the mining and ranching industry’s influence in the area, I cannot help but think about the impact oil and gas production has on environmental science curriculum and what influence they have on the pedagogical dispositions of the teachers who work in this region. Understanding the context of place and culture in educational research is important in order to recognize positionality and power and create an environment of change at macro levels (Smith, 1999).

Limitations of this study. This study focused on rural secondary schools because those schools are many times overlooked. Although this study may be applicable to other content and studies in states with similar rural schooling characteristics, there are several limitations to this study. This study only focused on rural area schools in the northwestern quadrant of New Mexico. Only 13 teachers representing nine secondary level schools in five different northwestern rural New Mexico counties were interviewed to capture their perceptions of teaching environmental science. This study focused on teacher perceptions, and not factors and conditions about how teachers view their students or the curriculum and the content. Administrators and parents were not interviewed, which means their perspectives and viewpoints were not taken into consideration. We do not know from this study how parents and administrators perceive geographical, socioeconomic, and familial factors. Also, an individual’s perception of an experience is unique to their embodiment of a situation.

Recommendations

Future research should include data collection not only from teachers, but also from students. This would enable researchers to identify what teachers perceive about the identity of their students, as well as their own epistemology, such as who they are, where they come from, and what is their tie to the area (Smith, 1999). Other factors to consider in future research might include:

- interviewing parents and administrators to learn about who they are and what their perceptions are;
- interviewing community members who work in gas and oil to know what they think about green energy and to understand their perception of environmental science;
- using mixed methods study to triangulate various perspectives;
- including observations in a representative pool of classrooms;
- including more Native American voices to expand on teacher perceptions;
- integrating more facts about the infrastructure and industry workforce of the areas selected;
- considering similar research with professors and students in institutions of higher education regarding their perceptions of teaching and learning environmental science in districts with large Native populations.

Finally, with the landmark ruling on the consolidated *Yazzie v. New Mexico* and *Martinez v. New Mexico* (2018) lawsuit that upheld action taken by parents and school districts, the State Department of Education must now address how historical and current injustices, including the lack of appropriate funding levels for programs and relevant curricula. Such lack of adequate funding has led to disparate outcomes for students throughout the state, especially for the state's economically disadvantaged Native American and English language learner students in rural areas (Center on Law and Poverty, 2018).

In conclusion, this study should provide a stepping stone to understanding factors influencing environmental science instruction, at least from the perspective of a sample of middle and high school teachers in districts with high numbers of Native American students. Any of the recommendations for further research listed above would add more dimensions of understanding to this very important topic, particularly in view of the consolidated *Yazzie v. New Mexico* and *Martinez v. New Mexico* (2018) ruling.

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Appendix A

IRB Approval

OFFICE OF
THE INSTITUTIONAL
REVIEW BOARD

DATE:	December 18, 2017
REFERENCE #:	24617
PROJECT ID & TITLE:	[1169890-1] Teacher Perceptions of Environmental Science Education in Rural New Mexico School Districts
PI OF RECORD:	Charlotte Gunawardena, PhD
SUBMISSION TYPE:	New Project
BOARD DECISION:	DETERMINATION OF EXEMPT
EFFECTIVE DATE:	December 18, 2017
REVIEW CATEGORY:	Exempt category # *2, 7*

DOCUMENTS:

- Advertisement - Participant Recruitment Flyer for Research Study 12-11-2017.docx (UPDATED: 12/12/2017)
- Advertisement - Study Recruitment Email Template.docx (UPDATED: 12/12/2017)
- Application Form - Project Information Form (UPDATED: 12/11/2017)
- Consent Form - ConsentForm-Survey_Interview_Focus Group_v12122017 FINAL.doc (UPDATED: 12/12/2017)
- Data Collection - Interview Guide 12-11-2017.docx (UPDATED: 12/12/2017)
- Letter - Farmington Municipal Schools Letter of Support-Julienne.pdf (UPDATED: 12/11/2017)
- Other - Project Team (UPDATED: 12/11/2017)
- Other - Scientific Review (UPDATED: 12/11/2017)
- Protocol - Protocol (UPDATED: 12/12/2017)

Thank you for your New Project submission. The UNM IRB has determined that this project is EXEMPT from IRB oversight according to federal regulations. Because it has been granted exemption, this research project is not subject to continuing review. It is the responsibility of the researcher(s) to conduct this project in an ethical manner.

If Informed Consent is being obtained, use only approved consent document(s).

This determination applies only to the activities described in the submission and does not apply should any changes be made to this project. If changes are being considered, it is the responsibility of the Principal Investigator to submit an amendment to this project for IRB review and receive IRB approval prior to implementing the changes. A change in the research may disqualify this research from the current review category.

The Office of the IRB can be contacted through: mail at MSC02 1665, 1 University of New Mexico, Albuquerque, NM 87131-0001; phone at 505.277.2644; email at irbmaincampus@unm.edu; or in-person at 1805 Sigma Chi Rd. NE, Albuquerque, NM 87106. You can also visit the OIRB website at irb.unm.edu.

Appendix B

Recruitment Flyer

Department of
Organizational Information & Learning Sciences

University of New Mexico

PARTICIPANTS NEEDED FOR
RESEARCH IN EDUCATION

We are looking for volunteers to take part in a research study of
Perceptions of Environmental Science Education.

As a participant in this study, you would be asked to:
participate in an individual interview.

Your participation would involve one interview session, for approximately
45-60 minutes.

For more information about this study, or to volunteer for this study,
please contact:

Marie Julienne, Doctoral Student
Department of Organizational Information & Learning Sciences
at
505-303-0619
Email: **mjulienn@unm.edu**

The PI for this study is: Professor Charlotte 'Lani' Gunawardena
Contact: 505-277-5046

This study #24617 has been reviewed and approved by the
University of New Mexico IRB

Appendix C

Informed Consent

THE UNIVERSITY of NEW MEXICO

Teacher Perceptions of Environmental Science Education in Rural New Mexico School Districts

Informed Consent for Interviews

Version Date: 12/12/2017

Marie Julienne, a doctoral candidate from the Department of Organization, Information & Learning Sciences is conducting a research study, under the supervision of Professor Charlotte "Lani" Gunawardena. The purpose of the research is to explore teacher perceptions about environmental science education in New Mexico. You are being asked to participate in this study because of your background and experience as a science educator.

Your participation will involve participating in an individual, in-depth interview. The interview should take about 45-60 minutes to complete. The interview includes questions such as, '*Which science standards do you think play the most important roles when you structure curriculum about environmental science topics*? and, '*Discuss a little bit about any environmental science lessons you teach that tie into important issues for this community*.' Your involvement in the study is voluntary, and you may choose not to participate. You can refuse to answer any of the questions at any time. There are no names or identifying information associated with your responses and no identifiers will be linked to data. There are no known risks in this study, but some individuals may experience discomfort or loss of privacy when answering questions. Data will transcribed, analyzed, and then destroyed.

The findings from this project will provide information on teachers' perceptions of environmental science education. If published, results will be presented in summary form only.

If you have any questions about this research project, please feel free to call the PI, Professor Charlotte 'Lani' Gunawardena at (505) 277-5046. If you have questions regarding your rights as a research subject, or about what you should do in case of any harm to you, or if you want to obtain information or offer input you may call the UNM Office of the IRB (OIRB) at (505) 277-2644 or irb.unm.edu.

By signing below you will be agreeing to participate in the above described research study.

Name of Adult Participant	Signature of Adult Participant	Date
Name of Research Team Member	Signature of Research Team Member	Date

Number: **24617**
Version: **12/12/2017**
Approved: **12/18/2017**
Expires: **EXEMPT**
Institutional Review Board
(505) 277-2644 | irb.unm.edu

Appendix D

Teacher Participant Profiles

Name*	School Level	Years of Teaching Experience	Teacher Background Summary
Ryan	HS	8	HS science teacher and, for the past three years, department head. This instructor has a Bachelor's degree in Biology and an additional bachelor's in secondary education, a Master's degree in curriculum and instruction, specific to critical pedagogy and learning with an emphasis in educational technology. This teacher has taught 7 different science classes over the last 8 years, served on 10-plus leadership teams. Level 3 master teacher license from the PED with an endorsement in science education, gifted education, and bilingual education and technology education, 9-12.
Skylar	HS	20	Has been teaching HS Honors Biology for the last 9 years and AP Biology for the last 8. She has a Bachelor's degree in Biology and a second degree in science, a Master's degree in Curriculum and Instruction with an endorsement in secondary science. A 20-year veteran teacher, with 10 years at MS level. Her husband has an oilfield business, so she gets to see all sides of the spectrum and thinks that we have to live in this real place where all of the sides of the environmentalist spectrum have to give a little bit to work together.
Dillyan	HS	8	Recently accepted an administrative education specialist position for a little over a year; previously taught science for approximately 8 years. Originally got into water research and was part of a team that developed a method of analyzing water toxicity that is now utilized in third world countries.

Name*	School Level	Years of Teaching Experience	Teacher Background Summary
Lupe	HS	1.5	Seven years of college education, resulting in a bachelor's degree in Conservation biology, Wildlife management, and a master's degree in Natural Resource Management. In second year of teaching MS and HS science. Master's in Biology. Teaches ES and biology. Tutored college biology for a year. Uses AP ES textbooks for a HS ES course.
Grey	HS	11	A HS science teacher for 11 years, and a department chair for 2 years. Has a professional background in Electrical Mechanical Engineering, a Bachelor's in teaching, and a New Mexico teaching license endorsed in science and math, K-12. This teacher likes to make an emphasis in robotics and technology. The environmental catastrophe in Fukushima, Japan is such an important topic to him and he will not eat Pacific Coast seafood. He wants to see more research developed around fusion energy. His class is planning on building solar cars soon.
Rowen	HS	15	Bachelor's degree in interdisciplinary studies, master's degree in reading and curriculum and instruction, Pre-K through 12 specialty teaching license, Level 3 teacher with endorsements in reading, science, social studies, TESOL, language arts, and history. This teacher has been teaching classes for 15 years and this is her 3rd year at HS level. She taught middle school for 5 years and elementary (5th grade) for 7 years. This teacher went to Malaysia 3 years ago and did a PD for their teachers, and some students, as well, around the topic of energy education.
Quinn	MS	5	Has a bachelor's degree of science in biology and a master's degree in secondary education, taught MS math and science for seven years. As he refined

Name*	School Level	Years of Teaching Experience	Teacher Background Summary
			his teaching of science, he was able to bring the local-specific examples into the classroom to make it more relatable to students and to show them connections between what they learn in the classroom and what is happening in the real world and in their own area.
Blu	MS	12	Teaches 6th grade science and one section of Algebra 1. Teacher has taught science almost 5 years, and additionally has taught math for two years. Highly qualified to teach middle level science and math. Teacher has grade 5-9 license to teach Algebra 2 and Science 2. This teacher really enjoys the advocacy piece – she helped develop a 6th through 12th grade science curriculum for a Native community school that was more comprehensive and talked about teaching science through the lens of advocacy.
Ronnie	MS	21+	A 21 ½ year veteran teacher currently teaching seventh grade Life Science, with a bachelor's degree in elementary education with a minor in social studies. She is also a science fair coordinator and does science bowl competition. Students like to use her room during lunch to prepare presentations for other classes to include things involving their environmental district.
Cody	MS	2	Level II, rated highly effective, teacher endorsed to teach science. Teaching eighth grade science for approximately two years, and is an instructional coach within the school. "[…] if it's not relevant to them as a 13 or 14-year-old – as a 33-year-old – why would you want to learn it?" Her mom lives on the Animas River, so, she had kind of a connection to the devastation of the ecosystem that happened during the 2015 Gold King Mine environmental catastrophe.

Name*	School Level	Years of Teaching Experience	Teacher Background Summary
Phoenix	MS	21	Science department head and teaching all 6th earth and space science. Teaching science for 18 years out of a total of 21 years of career. Strong background in the medical community, with a bachelor's degree in science and a master's degree in curriculum education. This teacher holds a level 3 teaching certificate and is science-endorsed in K-8. She taught in a UNM program for science methodology for pre-service teachers on how to incorporate science in an elementary classroom setting. At New Mexico's centennial, back in 2012 when NM turned 100 years, one of her lesson plans was selected to be incorporated into the celebration.
Peyton	MS	6	A highly qualified, Level II science teacher with a TESOL endorsement, who has been teaching seventh grade science for the past two years, previously teaching sixth grade for 4 years. Currently, pursuing a master's in Pedagogy Learning with an emphasis in TESOL. She was livid when her daughter told her that her HS science teacher said: I sure hope that you're ready to learn because you've had a three-year vacation.
Linda	MS	21	Entered her 21st year teaching in January 2018. All but 3 years have been in [city district]. Has K through 8 certification in elementary education, and also has quite a few science hours through college just through Bachelor's degree. Has Master's in curriculum education, or Pedagogy in Learning. Really enjoys teaching geology and the geosphere, and also likes teaching weather science topics.

Notes: *Names are fictitious to maintain confidentiality.

Appendix E

Teacher Participant Demographics

Gender	MS / HS Level	Grade Level(s)
F	Middle	6, 7, 8
M	Middle	6, 7, 8
F	Middle	7
F	Middle	6, 7
F	Middle	6, 7, 8
F	Middle	7, 8
F	Middle	7
M	High	9-12
F	High	10, 11,12
M	High	AP
M	High	11
F	High	9
F	High	10, 11

Appendix F

School Demographics

School	School A	School B	School C	School D	School E	School F	School G	School H	School I
2017 School Grade	B	A	NA	B	NA	B	B	B	C
2018 School Grade	C	B	D	D	NA	C	D	B	C
Percent Hispanic	36%	24%	#	3%	6%	25%	29%	21%	24%
Percent Native American	22%	23%	#	97%	94%	38%	23%	62%	20%
Percent Free or Reduced Lunch	27% and 6%	19% and 7%	#	47% and 2%	69% and 14%	45% and 11%	37% and 10%	61% and 10%	26% and 8%

Source: New Mexico Public Education Department.
= Data not available.

Appendix G

Environmental Science Topics

Appendix H

Macrosystem Code Co-occurrances

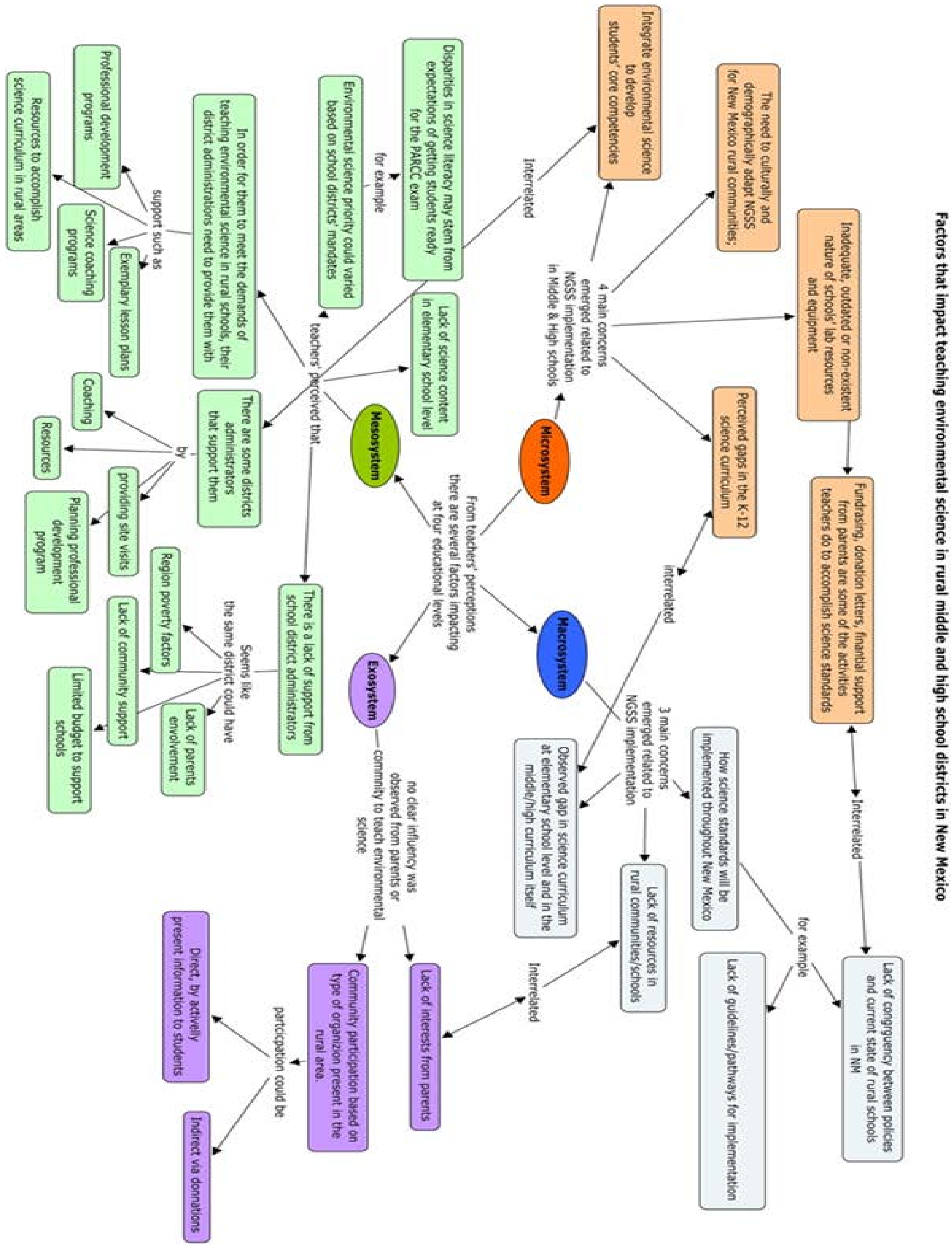
Example of Co-occurring Codes for Macrosystem level Using ATLAS.ti

HU: Teaching environmental science

*Macro Policy NM standards vs NextGen {127-0} [29]
Number of ES classes {9-0} [2]
Curriculum & ES are contextual to demographics {31-0} [22]
Community business support {4-0} [2]
Controversial reasoning teaching ES {33-0} [36]
Definition of ES {10-0} [1]
Enhancing core competencies through ES {33-0} [34]
ES factors problems/conflicts with policies {38-0} [41]
ES integrated with world problems {35-0} [27]
ES integrated within Curriculum & Community {37-0} [25]
ES teacher characteristics {20-0} [13]
Experienced teachers 7+ {8-0} [1]
Factors that facilitate or are missing in Curriculum {78-0} [82]
Teachers from Grade {6-0} [3]
Lack of district support {10-0} [5]
Lack of familiarity w/NGS {1-0} [1]
Next Gen Standards {24-0} [25]
NGS vs Proficiency scales {6-0} [8]
NGS vs text books {8-0} [8]
Lack of optimistic perception about NGS {18-0} [20]
Lack of Parent's support {7-0} [1]
Poverty as a factor {8-0} [1]
Teacher’s Qualification, MA {18-0} [1]
School administration support {15-0} [7]
School district support {15-0} [6]
Spirituality and cultural issues in native-a education {5-0} [5]
Teacher's support needed {15-0} [11]
Teacher caring about science education {13-0} [10]
Teachers agreed about Next Gen Standards {10-0} [10]

Appendix I

Factors that Impact Teaching Environmental Science



Appendix J

Example of ATLAS.ti Code Network – Indigenous Perspectives

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