DISSERTATION

FIELD EXPERIENCE IN SCIENCE FOR FIFTH GRADE STUDENTS - A MIXED METHODS STUDY OF LEARNING ENVIRONMENTS

Submitted by

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In partial fulfillment of the requirements

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY BARBARA PATTERSON ENTITLED FIELD EXPERIENCE IN SCIENCE FOR FIFTH GRADE STUDENTS - A MIXED METHODS STUDY OF LEARNING ENVIRONMENTS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

FIELD EXPERIENCE IN SCIENCE FOR FIFTH GRADE STUDENTS - A MIXED METHODS STUDY OF LEARNING ENVIRONMENTS

The purpose of this research is to compare students' perceptions of the learning environment in a traditional science classroom and a field study classroom. This mixed methods study used a sequential explanatory design. Phase one was the quantitative phase using two survey tools. A modified version of the "What is happening in this Classroom Survey" (WIHIC) (Fraser et al, 1996) and the "Test of Science Related Attitudes" (TOSRA) (Fraser, 1982) was administered to 60 fifth grade students from one school. Data was then disaggregated by socioeconomic class and ethnicity. Results from Phase one showed that students prefer the classroom for investigation and prefer the field environment for enjoyment of science. Differences in ethnicity and class were small but Hispanic students prefer the field for investigation and equity. Students that are low socio-economic class rank cooperation in the field higher than the classroom and students that do not qualify for free or reduced lunch prefer the field environment for enjoyment of science. Finally, there are strong correlations for the variables of cooperation, investigation, equity and enjoyment of science in both the classroom and the field environment.

Questions raised from the analysis of the survey data were further explored through qualitative data collection methods in phase two. Student responses to three questions were coded using template analysis to provide answers to the "how and why" field experience effects students' attitudes toward science. Three themes emerged from the coding of the results. These results showed that students are physically engaged, develop a sense of place and learn skills in the field that reinforce concepts learned in the classroom. This information will help teachers in developing quality and meaningful experiences for all students. "Closing the gaps among minority groups while improving achievement of all students constitutes the dual goals of education in the nation" (Lee et al., 2004, p. 827) and the incorporation of field experience for science education can meet this goal.

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CHAPTER 1: INTRODUCTION

One of the most pressing education policy challenges that the United States currently faces is the gap in academic achievement that persists between minority and disadvantaged students and their European American counterparts. "Closing the gaps among minority groups while improving achievement of all students constitutes the dual goals of education in the nation" (Lee, Deaktor, Hart, Cuevas, & Enders, 2004, p.287). Although minority students have demonstrated slight increases in achievement, their scores remain well below those of White students and the gaps persist across many age levels (Lee et al. 2005). Hispanic or Latino/a Americans, persons who trace their origin or descent to Mexico, Puerto Rico, Cuba, Spanish speaking Central and South American countries, and other Spanish cultures (US Census Bureau, 2006), are the fastest growing population in the United States. In addition, students who qualify for free or reduced lunch, as defined by the National Assessment Educational Progress (NAEP) and Colorado Student Assessment Program (CSAP), are classified as low-socioeconomic class and represent 25% of the population at large. Many children and youth classified as low income are African-Americans (43%) or Hispanic (40%) and most live in large urban areas.

This study was designed to explore the value of field experience in improving attitudes toward science, especially with low socioeconomic class Hispanic students. "If science is to be relevant for all learners, it must respond to and emerge from the life experiences, questions, and interests of all learners" (Fusco, 2001 p. 860). Traditional

school environments measure achievement by one's capacity to gather and remember correct answers. In contrast, learning outside school involves shared reasoning and activity situated in real-world cultural contexts. Science taught in a natural environment incorporates inquiry, is culturally relevant to diverse student populations, and provides a sense of place for a student.

This research study investigated the differences between two learning environments: a traditional science classroom and a field study classroom by focusing on students' perception of the environment and attitude toward science. It applied a field of research referred to as learning environment research, which seeks to, according to Fraser (1998), "describe educational contexts and to identify relationships among the curriculum, teaching practices, and various environmental variables." Zaragoza and Fraser (2008), a leader in this research field state: "as a result of students' exposure to a more favorable learning environment, student achievement, learning, and attitudes to science could all change." My research has investigated this assumption.

This chapter provides an overview of the research study and introduces some of the existing literature on the effect of field experience on students' science attitudes. This chapter also outlines the research problem and research questions, defines the purpose of the study, defines the terms used in the document, describes the study's limitations and delimitations, and concludes with the investigator's perspective. The National Science Foundation (NSF) provided funding for this project. The grant established Centers for Learning and Teaching in the West (CLTW), and provided money for research, fellowships for graduate students, and professional development for middle school

science and mathematics teachers to minimize the achievement gap in mathematics and science for minorities.

Background/Overview

Introduction

As Nieto (1994) explains, "students frequently report that what they learn in school has little relevance to their lives outside the classroom and to their futures." This is particularly evident in school science that typically reflects middle-class experiences and excludes the lives of students who are mostly on the margins of science, such as students from the non-mainstream culture. One of the most powerful teaching strategies for these students is the use of the local field environment (Riggs, 2004) because students who study in a field environment are actively engaged in their learning. This engagement allows students from diverse backgrounds to participate as equally as students in the mainstream culture. As Gay (2000) states, "using the cultural knowledge, prior experiences, and learning styles of ethnically diverse students to make learning more relevant and effective for them is imperative in our schools today."

Learning Environments

One of the ways to look at the effect of different instructional environments on student learning is through the study of learning environments. This research dates back to 1968 when Herbert Walberg and Rudolf Moos began to observe that science attitudes and achievement can be influenced by the environment in which the learning takes place. The importance of the classroom learning environment has been increasingly recognized in the last twenty years and considerable progress has been made in the investigation of this important concept, especially in the development of a variety of survey tools (Fraser,

1986, 1994, 1998; Fraser & Wahlberg, 1991; Wubbels & Levy, 1993). Such survey tools included the widely used Learning Environment Inventory (LEI) (Walhberg & Anderson, 1968), and scale called the Classroom Environment Scale (CES) (Moos, 1979), and the "What is Happening in this Classroom" (WIHIC) inventory developed by Fraser, Fisher, and McRobbie (1996), which is well adapted for measuring middle school students' perceptions of a learning environment. This survey has been used to study the influence of classroom environments on a wide range of learning environment topics, from exploring interpersonal behavior and gender differences in the Jammu province of India (Koul & Fisher, 2005), to cross cultural studies in Taiwan and Australia (Aldridge & Fraser, 1998). It has also been used as a tool to investigate the effects of educational innovations (Zandvliet & Fraser, 2004). In all of these studies, the WIHIC scale is consistently found to be reliable, valid, and useful in various subject areas and with different grade levels (Koul & Fisher, 2005; Aldridge & Fraser, 1999; Richards, den Brook, Bull, & Fisher, 2003, Forman, 2003).

Field Experience

For over 30 years, science educators and researchers have advocated the use of outdoor areas for science instruction (Brennan, 1967; Disinger, 1984; Leftridge & James, 1980; Prather, 1989; Stapp, 1970 embedded in Bourne, 2000). The majority of these studies indicate that "although students can learn about the environment from print, visual teaching materials, and indoor lab activities, students learn just as much or significantly more when the experience is linked with a natural and familiar environment" (Cronin-Jones, 2000).

Past research studies have focused on the effect of field experience on environmental behavior and motivation. Barnett, Lord, Strauss, Rosa, Langford, & Chavez (2006) used the study of urban ecology to increase minority and low-income student participation in real-world science in an urban setting. Students involved in the urban ecology project developed a better understanding of scientific methodologies and displayed an increased sense of environmental stewardship when compared with students who received traditional science instruction. Legault (2000) showed positive effects on students' environmental knowledge, attitudes, motivations, and behaviors after the incorporation of an environmental education program into the sixth grade curriculum. Additionally, a study by Cornell University found that students who participated in a citizen science project demonstrated an increased knowledge of biology and an increased understanding of scientific inquiry (Brossard, Lewenstein & Bonney, 2005). These studies provide evidence that field experience can improve the engagement, science knowledge, and behaviors of students in majority and minority cultures.

Other research studies have looked at programs that incorporate field experience into their curriculum with a focus on academic achievement. For example, standardized test scores have been used to show improvement in science as well as in other subjects. In their study "Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning (EIC), Lieberman and Hoody (1998) established a relationship between the performance on integrated environment-based assessments and achievement on standardized tests. Research by Bartosh, Ferguson, Tudor, and Taylor (2006) showed that when schools integrated environmental education into their curricula, students improved performance in traditional disciplines as well as in science classes. These

studies call for more in-depth research to investigate the cause and effect relationship between the implementation of environmental education and student achievement.

In spite of the evidence, environmental education and field experience remain optional in the school curriculum. Administrators and teachers are burdened with reports and state mandated testing as they struggle to meet accountability. More evidence is needed to convince teachers that field experience can improve science attitudes for mainstream and non-mainstream students. This study attempted to do that by looking at attitudes of students toward science in two settings and the relationship between student perceptions and positive attitude. It also looked at how and why these learning environments affect student learning specifically for race and class. One of the most definitive statements in support of the National Science Education Standards (NSES) is "the classroom is a limited environment, and the school science program must extend beyond the walls of the school to the resources of the community" (NRC, 1996). As Fusco (2001) stated, "If science is to be relevant for all learners, it must respond to and emerge from the life experiences, questions, and interests of all learners."

Statement of the Research Problem

"Improving the achievement of a substantial percentage of non-mainstream students presents one of the most formidable educational challenges of our time" (Valencia, 2002). The gap in achievement between Hispanics and European Americans continues to grow and is considerably wider than for European American, African Americans, and American Indians.

Of all the types of learning environments in science teaching, the outdoor environment is the most neglected both by science educators and researchers. Teaching

science in the field provides unique opportunities to investigate the natural world of students' everyday lives and improve science achievement. Students benefit from field experience in multiple ways. On one level, they learn about real-life local issues and how their community deals with them. They see the intersection of social, economic, political and psychological processes. Students who are concrete and active learners often become more engaged than if they were passively sitting in a classroom (Kakela & Robinson, 2006). Teaching in the field uses more of a constructivist perspective and honors the knowledge that students come to the classroom already knowing and moves them from there. To encourage the incorporation of outdoor field experience into the curriculum, more evidence is needed to support new initiatives and fund field experiences.

Purpose of the Study

The purpose of this study was to investigate the traditional science classroom and field study classroom in terms of the students' perceptions of the learning environment and their attitudes toward science. The perceptions of the learning environment and the attitudes toward science of students are affective domains that influence what student achievement and success in science classes. The purpose of this study is to make recommendations that can be used to minimize the achievement gap for minority students. Hispanic students and low socioeconomic students may benefit from field experience that actively engages students in their community. According to Kajela and Robinson (2006), students who learn in this way emerge as more creative, critical, integrative thinkers and, hopefully, they will become empowered, life-long learners who will be able to make positive contributions to the environment and society. In addition, teaching strategies that are employed in field experience may inform teachers as to ways

to transform the classroom to engage students more fully, and provide meaningful connections from science to their daily lives.

This study will add to the existing research by providing more evidence for incorporating field experience for improving students' attitudes in science, especially for minority students. It is significant in that much of the research on the classroom learning environment has been done with math and science classes and few studies have looked at the outdoor environment for improving the learning, achievement, and attitude of students. It is also unique in that the data is disaggregated by ethnicity and socioeconomic class.

Research Questions

This study investigated the differences between a traditional classroom and a field study classroom in terms of the learning environment. The study also investigated the differential effectiveness of a field-study center for students differing in socio-economic class and ethnicity. Fifth grade students participating in field experience respond to three scales from the "What is happening in this class" (WIHIC) questionnaire and one scale from the Test of Science Related Attitudes (TOSRA) survey to compare their traditional science classrooms with the field study classrooms. The study was a quasi-experimental design, common to many studies involving human subjects in education, due to the difficulty of using randomized assignment of participants to groups. This study used a sequential explanatory format that allowed the researcher to collect quantitative data and then further explore questions raised from the survey results using qualitative methodology.

The specific research questions were:

1. Are there differences between the traditional public school science class and the field study class in terms of:
   (a) learning environment and,
   (b) attitudes toward science?
2. In terms of learning environment and attitudes toward science, is the field study class differentially effective for:
   (a) students from a high or low socioeconomic class and,
   (b) Hispanic students and other students?
3. Are there associations between the learning environment and students' attitudes toward science?
4. Are there interactions between the ethnic group and the socioeconomic class?

The following three scales from the WIHIC were used for this study:

1) *Investigation* (emphasis on the skills and process of inquiry and their use in problem solving and investigation)
2) *Cooperation* (extent to which it is important to complete activities planned and focus on the subject matter
3) *Equity* (extent to which students are treated equally by the teachers).

The fourth scale, made up of seven questions from the TOSRA that was used to assess students' attitudes of these two different learning environments, is:

4) E*njoyment of science lessons scale.*

Once the survey was completed, qualitative data were collected from students through observations and scientific notebooks. The reason for the qualitative data collection was to further explore questions that were raised from the analysis of the quantitative survey results. Therefore, the actual questions that were asked in the qualitative phase of the study were determined after analyzing the quantitative data. The following question guided the development of phase two of the study and was used to develop the scientific notebook and observation protocol:

> How do educational experiences, in terms of investigation, cooperation, equity, and enjoyment of science in field based environments differ with experiences in traditional classroom environments?

The study used a sequential explanatory mixed-methods approach, which provides a quantitative analysis of the two learning environments and further explains the critical components that result in differences between field-based learning environments and classroom-based learning. It is unique in that it looks at the differential effectiveness of these two learning environments for low socioeconomic class and Hispanic students.

Definition of Terms

Constructivism – Constructivism is also called social constructivist theory. It is based on assumptions that individuals seek understanding of the world in which they live and work and rely on participants' views of the situation being studied (Lincoln & Guba, 2000 embedded in Creswell, 2003).

Inquiry – Inquiry is "the creation of a classroom where students are engaged in essentially open-ended, student centered hands-on activities" (Colburn, 2000).

Latina/o – This label more accurately reflects the political, geographical, and historical links between the various Latin American populations. It is culturally and racially neutral, but does not conform to United States government agencies collecting data. It would be better to ask respondents how they wish to be labeled but this would produce discrepancies in the data.

Hispanic – Hispanic refers to a person of Mexican, Puerto Rican, Cuban, Central or South American, or of other Spanish culture origin regardless of race (Marin & Marin, 1991). The term "Hispanic" comes from the Directive 15 of the Office of Management and Budget issued in 1978 to increase the availability of data on persons of Hispanic origin. To be consistent with data reporting organizations, the quantitative part of this

study used the term Hispanic. CSAP tests given to students in Colorado use this term to record ethnicity.

Mexican Americans – An individual of Mexican origin who now resides in the United States. Origins can be from modern day Mexico or the Southwest United States that was formerly Mexico (Marin & Marin, 1991). The purpose of my research was to look more closely at Mexican Americans, the majority of Hispanic students. Mexican Americans make up the largest group of Hispanics in the United States at nearly 60%.

Socio-economic status (SES) – Low-socioeconomic class is defined by the National Assessment Educational Progress (NAEP) and Colorado Student Assessment Program (CSAP) as those who qualify for free or reduced lunch.

Study Limitations

One of the limitations to this study was the difficulty of finding a school to participate in this study. This school district, as well as other districts in the state, requires students with lower reading scores to take additional reading courses. These students do not have science during their school year. Therefore, a comparison of learning environments for fifth grade students was not possible between schools since not all of the fifth grade students had science. The school that participated in the study had a special situation in that the teacher adapted the curriculum so that all students could participate in science.

Another limitation to this study was the difficulty of acquiring socioeconomic data for students. This is obtained from school records for students that are eligible for free or reduced lunch, a measure of poverty that the state uses to provide support for students that do not have financial means for school lunches. This measure is a common

indicator, and schools use this data in many ways. The human subjects' protocol requested this information from the schools but they were not able to give out the information due to school privacy acts.

Delimitations

This study confined itself to data collection at one school for the quantitative data collection and two schools for the qualitative data collection. The second school was added in phase two as a question emerged regarding the number of experiences that students have at the outdoor learning center. The first school attends the outdoor learning center five times and the added school only participates once during the school year. The students from these two schools closely represent the demographics of the students of the school district. Due to the small sample size, the ability to generalize the results was limited.

Researcher's Perspective

I have been an educator for 27 years and, throughout these years, I have had an opportunity to work with very diverse student populations. In addition, I have been involved in curriculum, professional development, and diversity education. My own teaching and professional development experiences have shown me that the use of good instructional methods, especially strategies that engage students and are valuing of students from diverse backgrounds, are more effective than traditional didactic approaches. In addition, because I teach science and natural resources, I have frequent opportunities to teach in a natural environment where students have hands-on experiences with the knowledge and skills of the lesson. I believe that all students can be successful

when science incorporates field experience that is culturally relevant and provides inquiry and a sense of place or a connection to their environment.

My past experiences include working on Indian reservations with American Indians. Although I am not of Hispanic or American Indian descent, I hope to contribute some of my experience and knowledge to this field of study to help minimize differences in achievement for mainstream and non-mainstream students. Current school reform initiatives can benefit from more evidence that science achievement improves with field experience, especially for Hispanic and low socioeconomic class students. I believe all students regardless of culture, gender, race, or socioeconomic status are capable of understanding and doing science.

CHAPTER 2: LITERATURE REVIEW

This chapter provides an introduction to learning environment research and the theoretical framework guiding this study. The second part of this chapter presents existing research that demonstrates the effect of field experience on students' perceptions of learning environments and their attitude toward science. In addition, research will be presented that focuses on data differences of attitude and perceptions by ethnicity and socioeconomic class. The final section will summarize the literature review, support the need for this study, and provide rationale for further research.

Theoretical Framework

Socio-constructivist Theory

The theoretical framework for this study comes from two disciplines, the socio-constructivist theory and an ecological theory. The first one discussed is the social-constructivist theory. Social constructivism is a type of cognitive constructivism that emphasizes the collaborative nature of learning. Social constructivism was developed by post-revolutionary Soviet psychologist Lev Vygotsky. He rejected the assumption made by cognitivists that it was possible to separate learning from its social context. He argued that all cognitive functions originate in, and must therefore be explained as products of social interactions. He believed that learning was not simply the assimilation and accommodation of new knowledge by learners but was the process by which learners were integrated into a knowledge community. He took some of his beliefs from the behavioral approach of Dewey (1938) and Piaget (1969), but focused his study on the

social context of constructing knowledge and the fact that the learning environment greatly influences how, when, and why learning occurs.

Vygotsky emphasized the critical importance of culture and the importance of the social context for cognitive development. Much of this research centered on a phenomenon he coined as "the Zone of Proximal Development" or ZPD. According to Vygotsky, the ZPD "is the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978). More simply put, the ZPD is the gap between what a learner can accomplish independently and what a learner cannot do, even with assistance. This concept applies four principles:

> 1. Learning and development is a social, collaborative activity.
> 2. The Zone of Proximal Development can serve as a guide for curricular and lesson planning.
> 3. School learning should occur in a meaningful context and not be separated from learning and knowledge that children develop in the "real world."
> 4. Out-of-school experiences should be related to the child's school experience (p. 198).

For Vygotsky, the culture gives the child the cognitive tools needed for development and encourages room for a more active and involved teacher.

There are many parallels between constructivism and environmental education. For examples, the major goals described by Ernst von Glaserfeld (1987) are: 1) introduction of real life problem, 2) student centered instruction facilitated by the teachers, 3) productive group interaction during the learning process, and 4) authentic assessment and demonstration of student progress. In addition, one of the many

definitions for environmental education is "to assist learners of any age in developing awareness, knowledge, and commitment to result in informed decisions , responsible behavior, and constructive actions concerning wildlife and the environment upon which all life depends "(Klein & Merritt, 1994). Components of constructivism are present in most environmental education.

Ecological Theory

An ecological model emphasizes the embeddedness of human societies and culture within the physical community. This model describes a range of ecological, socio-cultural and technical influences that influence educators' interpretations of curriculum (Zandvliet, Brown, & Fraser, 2006). Focused learning within the context of the physical community improves the quality of life within whole communities and at the same time assists in developing a sense of place within students. The author believes that "the concept of an ecological model lies at the nexus between a "science education" that emphasizes a particular form of knowledge construction conceived of and implemented outside of "authentic" communities informed by socio-constructivist ideas" (Zandvliet et al., 2006). This theory merges with elements of the experiential learning cycle as a socially mediated process and 1) allows the use of information in meaningful ways, 2) adapts to ones own changing experiences, and 3) the role of the learner is not passive; the role of the teacher is to guide experience with personal construction of meaning (Von Glaserfeld, 1995). The ecological framework explains learning as a result of the factors in the environment that you are studying. The ecological theory and the social constructivist theory both suit this study as it looks at the engagement of students in a field environment

that values individuals and guides them and their experiences forward to the next level of educational discovery.

Learning Environment Research

Learning environment research proposes a model that includes the social, physical, psychological, and pedagogical contexts in which learning occurs and affects student achievement and attitudes (Fraser, 1998 p.7). Foundations for classroom environment research were laid more than 60 years ago when the work of Lewin (1936) and Murray (1938) introduced the formula B = f (P, E) to describe human behavior (B) as a function of two interdependent influences, the Person (P) and the Environment (E) (Henderson, Fisher, & Fraser, 1987).

Wahlberg (1974) later began to ask the question of how social and psychological forces influence social environment of the classroom and affect learning. Moos and Wahlberg (1981) furthered this science with the study of learning environments and the development of tools to measure this. They believed that the student's perspective on learning environment greatly influences students learning. They also studied the difference between what the teacher perceived as occurring and compared it with the students' perspectives and what actually occurs.

Moos (1979) proposed three dimensions on which most of learning assessment is based today. The three dimensions are: 1) relationships, 2) personal growth, and 3) system maintenance. Relationship dimensions are concerned with the nature and intensity of personal relationships while personal dimensions focus on opportunities for personal development and self-enhancement. System maintenance assesses the extent to which the

environment is orderly, clear in expectations, and is responsive to change (Moos, 1979). These constructs can serve as a basis for socio-psychological diagnosis and educational inventions. The social environment has effects on student's satisfaction, learning, and personal growth. A major use of this information about the social environment of learning is the comparison of different educational settings. A rapid growth of innovative learning environments has increased the need for more accurate descriptions of learning environment and teacher perceptions compared with student perceptions.

Walhberg (1981, 1984) looked at the socio-psychological characteristics of the learning environment using the Learning Environment Inventory (LEI) scale in the Harvard Project Physics curriculum. He established that there are nine factors that contribute to variance in students cognitive and affective outcomes of the environment. The first set of factors is student attributes: ability, age, and motivation. The second set relates to instruction: the quantity and quality of instruction. The third set of factors relates to the psychological environment: the psychological climate of the home, classroom, social group, and the peer group outside of the classroom (Reynolds & Wahlberg, 1992). All of these factors contribute to a student's success in the classroom. The testing of this model has confirmed its validity in showing that student attitude and achievement are influenced by a number of factors and classroom and school environment factors are particularly important. Students express greater satisfaction in classrooms characterized by high student involvement, personal student – teacher relationship, and innovative teaching methods (Wahlberg, 1981).

In the past 25 years, Moo's work has influenced the development and use of instruments to assess the qualities of the classroom learning environment from the

perspective of the students (Fraser, 1994, 1986; Fraser & Wahlberg, 1991). Examples of these classroom environmental instruments include: the Learning Environment Inventory (LEI; Fraser et al., 1982); Classroom Environment Scale (CES; Moos and Tricket, 1987); My Class Inventory (MCI; Fraser et al., 1982); College and University Classroom Environment Inventory (CUCEI; Fraser et al., 1986); Individualized Classroom Environment Questionnaire (ICEQ; Fraser, 1990); Science Laboratory Environment Inventory (SLEI; McRobbie & Fraser, 1993); and Constructivist Learning Environment Survey (CLES; Taylor et al., 1995).

Most school effects research has concentrated on academic achievement that uses standardized tests that may not be culturally sensitive or accurately cover the material. Statistical techniques alone do not hold the key to clearer understanding of questions concerning the effectiveness of school (Riddell, 1993). A call for mixed methods studies that include quantitative and qualitative approaches are needed to address the methodological issues. Dependence on achievement-test scores as outcome criteria led to the investigation to focus on other outcome measures such as attitude and student perceptions. Learning environment survey tools focus on attitudes toward science and students perceptions of different classroom environments are especially useful in science education.

Assessment of a laboratory class environment provided a comparison of a traditional class setting with a more active laboratory environment. Fraser, McRobbie, and Giddings (1993) used the Students Lab Environment Inventory (SLEI) to assess student perceptions of the psychosocial environment of science. This inventory is based on the Moos original scale also utilizing the Quality of Teaching interaction (QTI) scale.

The sample consisted of 489 students, grades 11 and 12, from Tasmania, Australia. The students completed modified forms of SLEI and TOSRA with a two column answer sheet for actual and preferred learning environment. This study was unique in that it looked at three categories of student outcomes: attitudes, achievement, and practical performance. Results showed that a closer match between students' actual and preferred environment leads to higher student outcomes, including student perceptions of laboratory environment in the school (Fraser et al., 1993).

Henderson, Fisher, and Fraser (1987) conducted the first use of classroom learning environment questionnaires involving students in high school environmental science classes. The three objectives of the study were to: 1) measure students' perceptions of the science classroom using the Environmental Science Learning Environments Inventory (ESLEI), 2) investigate associations between students' perceptions of the learning environment and their attitudinal outcomes, and 3) investigate the difference in student perceptions based on gender. The sample was composed of two secondary classes (grades 11 and 12) in Tasmania, Australia. Of the five aspects of environmental science student learning environments measured in this study, student cohesion, involvement, and task orientation were found to be most strongly associated with positive attitudinal outcomes ($p< 0.01$). Integration and material environment did not show statistical significance. The gender related differences indicated that male and female students perceive aspects of their learning environment in different ways. This has important implications for teachers wishing to make changes in specific aspects of their classroom environment in order to optimize student outcomes (Henderson, Fisher, & Fraser, 1987). These findings are also significant because they identify a subgroup of

students in a science class who would benefit from interventions that encourage positive perceptions and attitudes.

The "What is Happening in This Class Inventory" (WIHIC) was developed by Fraser et al. (1996) to bring economy to the field of learning environments by combining the most salient scales from the existing questionnaires with additional aspects of learning environments and dimensions to assess dimensions of the classroom environment. A cross-cultural study of classroom learning environments in Australia and Taiwan was completed by Aldridge and Fraser (1999). This is one of the first cross-cultural studies in science education that used multiple research paradigms. The (WIHIC) questionnaire was administered to 1081 students in 50 junior high science classes in Australia and 1879 students also in junior high in 50 classes in Taiwan. The study used an interpretative framework that was guided by constructivist and critical theory (the examination and critique of society and culture) paradigms. A greater variation of interest was provided by using a sample drawn from multiple countries. This allowed the researcher to question familiar educational practices. Students in Australia viewed their classroom environment more favorably than students in Taiwan ($p < .05$) but students from Taiwan had a more positive attitude toward science than did students in Australia ($p < .01$) (Aldridge & Fraser, 1999). The qualitative data collection helped the researchers make meaningful interpretations taking into account the background, culture, and situation of individuals provided a starting point for the collection of data from observations and interviews.

Another cultural use of the WIHIC questionnaire was completed by Koul & Fisher (2005) and involved the association between students' cultural backgrounds and

their perceptions of their teachers' interpersonal behavior and classroom learning environment. A sample of 1021 students from 31 classes in Jammu, India, showed that the Kashmiri students perceived their classroom more positively and had statistically significantly higher means ($p < .05$) than those from four other cultural groups identified in the study. This study demonstrated to teachers with students of different cultural backgrounds that they should not interact with them as a homogenous group but rather take cultural difference into account when interacting with different students (Koul & Fisher, 2005).

In yet another study, associations between classroom environment and academic efficacy was investigated. Academic efficacy is defined as the importance of fostering self-belief, and self-regulatory capabilities in students (Zimmerman, 1995). "Personal judgments of one's capabilities to organize and execute courses of action to attain designated types of educational performance are correlated to academic motivation, persistence, memory performance, and academic performance" (embedded in Dorman, 2001, p.243). An analysis of the classroom psychosocial environment included a sample of 1055 students from Australian secondary schools using the WIHIC and CLES survey. Simple and multiple correlation analyses revealed statistically significant correlations ($p < 0.001$) and effect sizes (r) between classroom environment dimensions and academic efficacy.

In a study presented at the America Education Research Association (AERA) in New York in March 2008, Zaragoza & Fraser (2008) compared student perceptions of the environments with attitudes among elementary students in traditional science and field study classrooms. Using the WIHIC and TOSRA scales, a sample of 765 students

supported the effectiveness of the field studies classroom in terms of both learning environment and student attitudes. In a study by Zandvliet (2007), environmental and place-based education programs were described as providing rich and extensive learning environments. This study incorporated quantitative and qualitative methods to show how these settings can be characterized and how they differ from other types of learning in a classroom-based setting. In general, "there are many ways that environmental education may affect the learner: cognitive structure may be altered, attitudes may be modified and further, the general learning environment which develops around these programs may enrich or stimulate further learning and action around environmental issues" (Zandvliet, 2007). In addition, Fisher & Waldrip (1999, p.83), recommend the development of more culturally sensitive instruments to meet the needs of diverse student populations because "science can be viewed as a cultural artifact and is embedded in and influenced by society and culture." Teachers can use teaching practices that may inadvertently conflict with students previous learning patterns so there is an increasing need to be sensitive to the cultural environment that teaching is placed.

To weigh instructional effectiveness, Nix, Fraser, and Ledbetter (2005) conducted a science education project in Australia with randomly chosen 7th graders to look at the students' perceptions of alternative instructional materials. An Integrated Science Learning Environment (ISLE) program was offered to one group of students and the control group did not receive the program. The teachers participating in the workshop were shown how to modify introductory physics courses to help students acquire a good conceptual foundation in physics, apply this knowledge effectively in addressing problems of the real world, and develop the science-process abilities that scientists use in

their real world work (Nix et al. 2005). Tested curriculum materials were provided along with a learning framework to incorporate the curriculum. The study found that the LEI inventory is a good predictor of students' cognitive and affective learning outcomes. This study provides an example of the use of learning environment to measure variables in the evaluation of specific education programs. Differences between the science classroom learning environments of ISLE and non-ISLE teachers are statistically significant ($p < 0.01$) for personal relevance and uncertainty of science, meaning that they understand science as something unpredictable. Although effect sizes are not large, with one-tenth of a standard deviation for uncertainty of science (0.13) to one fifth of a standard deviation for personal relevance (0.20), results still suggest that the ISLE program could be effective for improving the learning environment which is something that teachers can control. The survey form incorporated an innovative side by side representation to measure students' perceptions of the psychosocial factors taught by teachers on a field trip versus in school classrooms.

The availability of instruments such as the WIHIC and the TOSRA make it possible for teachers to obtain convenient and reliable feedback information about the climate of their own classroom, especially as perceived by students. This information can be used to implement classroom strategies aimed at aligning the actual environment more closely with students' preferred environment to improve achievement. These tools, if administered after the intervention is applied, can also be used to determine if the interventions are successful (Fraser & Pearse, 1982).

Field Experience

Introduction

Learning in a hands-on field setting is one of the best ways to reinforce topics learned in the classroom, integrate academic and experiential learning, and demonstrate the interrelationships of science disciplines (Knapp, 2005). What is considered field experience? A" field trip" is a trip arranged by the school undertaken for education purposes where students go to places where the materials of instruction may be observed and studied directly in their functional setting (Krepel & Duvall, 1981). In contrast, field experience is embedded in the curriculum and usually takes place more than once in the school year. Many different types of field experiences have been described, including the development of environmental study areas, development of nature trails, extended field studies, and activities for students at outdoor education centers. Other familiar terms, such as environmental education, outdoor education, service learning, or experiential education, have been used to describe field experiences (Knapp, 2003). Experiential education, which is the process of actively engaging students in an authentic experience, is at the core of older educational theories (Louv, 2005). Place-based education, appearing only recently in the education literature, usually includes conventional outdoor education methodologies to help students connect with their particular corners of the world (Woodhouse & Knapp, 2000).

Background

Field-based instruction is not new. Educators can trace the idea of direct learning outside the school back to John Dewey's 19th century lab school that was an early experiment in linking students' interests to neighborhood with contextual learning. Even

earlier, Comenius (1592 – 1670), an educational reformer born in the Moravia, stated: "We should learn as much as possible, not from books, but from the great book of nature, from the heaven and earth, from oaks and beeches" (Quick, 1890 p. 139). Throughout history, school trips have been conducted with various labels, but all include a common theme of teaching outdoors and engaging students with first-hand experience.

More evidence is needed to convince science teachers to transform their teaching practices and incorporate field-based experience into traditional science classrooms. The literature in the field highlights some of the efforts that have been made in the last decade, not only in reforming science education in the nation's school system but promoting science outside of the classroom (Cronin-Jones, 2000). Furthermore, field experience has been demonstrated to not only affect white middle-class student's science achievement, but make a change in minority and low-socioeconomic class students. The following studies show that field experience increases students' behavior and motivation, increases achievement in science as well as other disciplines, and improves student attitudes toward science, which has been shown to have an important effect on science achievement.

Outcomes

Behavior and Motivation

A great deal of research on the subject of field experience has focused on the effect it has on environmental behavior and motivation. McKinnon, Sinclair & Nolan (1997) created a project in New Zealand connecting students to land and water issues in their community. They found that if teachers are to change their practice, they must first change the way they think about the practice. With students, their project created

environments that encouraged them to learn in new ways and develop positive attitudes toward learning. An inquiry-based method was used by teachers and students to investigate a range of real-world problems requiring an across the disciplines approach, the gathering of data in the field, and the writing of reports. Students began the integrated studies project with a bicultural journey and advanced to projects that involved planning and organizing a "journey" - studying not only the natural environment but the Maori culture as well.

Using an embedded case study methodology, data were collected over three years from three cohorts of students. An attitude development survey, the school wide exam and interview data were used to compare the three different cohorts of students. For the attitude survey, mean scores increased from 19.3 to 20.1 to 21.2 during the involvement in the program. Students who elected to be involved in the program had more positive attitudes and enjoyment for out of class activities and were less alienated from schoolwork than their peers in the traditional program. Analysis of themes from student interviews revealed more feelings of empowerment and optimism, enjoyment of school, and they appeared to be less critical of their teacher. Overall, the research demonstrated that the approach had significant positive effects on students' motivation to learn and their educational performance.

Barnett, Lord, Strauss, Rosa, Langford, & Chavez (2006) used the study of urban ecology to increase minority and low-income student participation in real-world science in an urban setting. Students surveyed their local community and developed projects to improve their school grounds and develop nearby natural areas. Students that participated in the study developed a better understanding of scientific methodologies and an

improved sense of environmental stewardship compared with students that received traditional science instruction. The incorporation of an environmental education program into the sixth grade curriculum by Legault (2000) showed positive effects on students' environmental knowledge, attitudes, motivations, and behaviors. Participation in a citizen science project sponsored by Cornell University resulted in increased knowledge of biology and an increased understanding of scientific inquiry (Brossard, Lewenstein, & Bonney, 2005). All three of these studies demonstrated that field experience can improve the engagement, science knowledge, behaviors, and attitudes of students in the majority and minority culture.

Achievement

In spite of the evidence, environmental education and field experience remain optional when administrators are burdened with reports struggling to meet accountability requirements. However, students, teachers, and school are evaluated based on standardized tests so the reality is that this tool for measuring achievement will not go away anytime soon. The first comprehensive study linking field experience with student achievement, especially using standardized tests is "Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning" (EIC) by Lieberman & Hoody (1998). They define an environmental framework for education that is interdisciplinary, collaborative, student-centered, hands-on, and engaging. The study, which has been implemented in 40 different high schools across the nation, focused on the environment and developed environmental awareness using natural areas and the community as a framework. The observed benefits of EIC programs include better performance on standardized measures of academic achievement in reading, writing, mathematics,

science, and social studies. Fourteen schools from the study were statistically analyzed using comparative analysis and 92% percent of these schools academically outperformed their peers in traditional programs. Teachers and administrators reported increased knowledge and understanding of science concepts, better ability to apply science to real-world situations, and great enthusiasm and interest in learning science (Lieberman & Hoody, 1998).

The State Environmental Education Roundtable (SEER) report on this project is also significant in that it compared student achievement from participants with non-participants and included a large population of schools from 12 different states. Evidence was obtained from site visits, interviews, and survey results. Statistical analysis was done on both gain and standardized test scores and GPA's. These studies reveal important results for science educators that can guide them in making science relevant and more meaningful for all students. Although this report was issued in 2002, it has been ignored by the educational institutions (Louv, 2005). More work is needed and hurdles, such as policy changes and funding from school administration, need to be overcome to convince schools and teachers that using the environment to teach science and other disciplines is beneficial.

Since the SEER study was released, another comprehensive analysis involving multiple studies was undertaken by Pacific Education Institute in Washington State that has involved multiple studies. This new study has taken further steps to support the value of field experience and link it to standardized assessment tests. To obtain evidence for the reliability and validity of scores from the Washington Assessment of Student Learning Tests (WASL), a study was first conducted to establish a relationship between the

performance on integrated, which is environmental education that is embedded in the curriculum, and environment-based assessments and student achievement on standardized tests (Taylor, Smith, Tudor, Ferguson, & Bartosh, 2003). Scores were compared for fifth and eighth grade students and confirmed that there is a relationship between the performance of students on state standards tests and environmental education instruction (EE) that incorporates the outdoor environment. The results indicated that there is a significant difference in mathematics, reading, writing, and listening on WASL tests. Schools that have integrated environmental education perform better than non- EE schools. In the second stage, the external school ratings and demographic and socioeconomic criteria were analyzed and 77 pairs of school were selected. The teaching and learning environment was then assessed using a questionnaire. Finally, achievement was compared using data from the WASL test and quantitative analysis used to evaluate the impact of the EE programs. Bartosh (2004) concluded that Washington schools with environmental education programs have consistently higher test scores on state standardized tests. The study results indicate a pattern between student achievement and the level of implementation of environmental education in the curriculum and that learning about the environment is one factor that improves students learning and overall higher academic performance at a school building level.

Longitudinal analysis showed that not only does "the integration of an EE program in the curriculum improve environmental knowledge but it can also be used as an engaging context for teaching and learning and provide opportunities to improve student performance in traditional disciplines" (Bartosh, Ferguson, Tudor, & Taylor, 2006). The study also showed that teachers that integrated EE into their curriculum use

natural areas more frequently, have professional training, and receive support from parents and the community and administrators. The authors believe that this exploratory research shows a trend between the level of implementation of EE and student achievement and they call for more in-depth studies to investigate the cause-effect relationship.

Quality and Quantity of Experiences

Research has also looked at the quality and quantity of field experience in the curriculum. Riggs (2004) stated that more attention should be paid to the value of recurring visits to the same location. Orion & Hofstein (1991) studied the effects of "one-time visits" and recommend that students have previous acquaintance with the field trip location and previous knowledge of the concept being taught to improve performance. An Office of Superintendent of Public Instruction (OSPI) project, called Model Links (Yapp, 1998) was designed to improve the integration of environmental education into the school curriculum in Washington State. With eight pairs of schools, Yap (1998), established a correlation between student achievement and the level of EE implementation. The summative study included an analysis of student-test results and analysis of surveys given to teachers and administrators. The author claims that schools that have a higher level of implementation of EE in their curriculum had higher results on the standardized tests.

Peacock (2006) studied the value of multiple visits to a single site, a natural area in England, by studying the effects of a program called Guardianship, to evaluate whether school children's learning about their local environment would influence the

way they treat it, how they behave, and the life choices they make. These findings were revealed:

1) School trips are vital for children to connect with nature.
2) Schools trips influence lives.
3) Community spirit is developed from school trips.
4) School trips help bond families.
5) School trips improve student learning. (p.144)

The overall purpose of the research was to raise awareness and understanding of the benefits of multiple experiences and out-of-classroom learning to attract support to improve the quality of schools and provide opportunities for as many children as possible.

In addition to the number of experiences that students have in the field, the quality of the experience is sometimes overlooked. Factors that influence learning ability during a scientific field trip in a natural environment were studied by Orion & Hofstein (1991). They found that the learning performance of students acquainted with the field trip location is significantly better than those not so familiar. Previous knowledge of concepts relevant to the field, previous outdoor experiences, and previous acquaintance with the location all contributed to higher learning performance. The theoretical and empirical framework developed and tested by Orion & Hofstein (1991) showed that for outdoor learning to be a truly effective education environment, and for field trips to succeed at being more than a social experience for students or a day free of regular classroom work, teachers and curriculum designers must deliberately reduce the novelty factor. Findings indicated that the preparedness of students has a significant influence on learning ability. The ability of students to conduct cognitive tasks during a field trip depended on the novelty of the field trip setting.

Field experience incorporates three key characteristics of effective science education: 1) the use of inquiry, 2) culturally relevant instruction, and 3) place-based education. The reason that field experience increases engagement is because it is inquiry based and connects students to their community. Teaching minority and low-income students in the outdoors gives students a sense of belonging and enables them to make connections with science concepts. It is also more memorable because all of the students are engaged in the lesson.

Inquiry

One of the most widely accepted ideas in the science community is "inquiry" or "inquiry-based instruction." Developing an inquiry-based science program is the central tenet of the National Science Education Standards and Project 2061s Benchmarks for Science literacy discusses scientific inquiry throughout. "For more than 30 years, the literature in science education has documented increased achievement and improved retention of science concepts when students are taught using curriculum materials that have an inquiry approach" (BSCS, 2006, p. 5). There are many different definitions for inquiry. Colburn (2000) defines inquiry-based instruction as "the creation of a classroom where students are engaged in essentially open-ended, student-centered hands-on activities." This is simplistic in its definition compared to the text in the National Science Education Standards (NRC, 1996) which challenges us to consider three perspectives of inquiry: the teaching strategies that support student inquiry, the abilities necessary to do scientific inquiry, and the understandings about scientific inquiry. To shift to a more inquiry-oriented classroom, five essential features are identified in *Inquiry and the*

National Science Education Standards: A Guide for Teaching and Learning (NRC, 2000):

> 1) Learner engages in scientifically oriented questions,
> 2) Learner gives priority to evidence in responding to questions,
> 3) Learner formulates explanations from evidence,
> 4) Learner connects explanations to scientific knowledge and
> 5) Learner communicates and justifies explanations. (p. 5)

"Inquiry when applied to field experience is powerful and allows students to acquire and retain an in-depth understanding of science by being directly involved in the concepts and skills that they are learning" (BSCS, 2001, p.5). "For children, another important part of learning science is learning about its nature and organization. Children should learn about the nature of science through their experience, which can happen in a field study setting" (Carin & Bass, 2001, p. 17).

Barnett et al. (2006), created an inquiry project that incorporated field experience. They designed a field-based urban ecology science program (UESFP) to increase participation by urban students, especially traditionally underrepresented groups, such as minorities and women in real-world science. Urban ecology is a subject around which inquiry-based science activities can be built by critically examining the science standards and constructing scientific experience that address both the content and the inquiry processes described in those standards. The UESFP program offered an integrated curriculum that combined the power of science with the direct impact of active learning about the local community and it emphasized both process and content. Field visits and lectures, curriculum materials, and ongoing afternoon workshops supported the teachers and provided a network for them to share ideas and collaborate on projects. This helped teachers to move away from the "survey of the sciences" approach often found in

traditional classrooms and textbooks, which often saps the excitement and curiosity from many urban students (Barnett et al. 2006).

Students who participated in the field studies program were representative of the students that attend Boston Public Schools, grades nine – twelve, where there is a large population of low income and minority students like other urban districts. Survey and interview protocols included 63 questions designed to measure students' interests in science and their understanding of scientific investigative methodologies. Results from the pretest and posttest were analyzed using a modified scientific attitude inventory (Moore & Foy, 1997). The experimental group that participated in UEFSP scored statistically higher on "I want to be a scientist," "science methodology," and the "ecological mindset."

Using a mixed method evaluation, involvement in UESFP improved students' sense of environmental stewardship when compared with students experiencing traditional science instruction over the course of an academic year. Students developed a better understanding of scientific methodologies and showed an improved sense of environmental stewardship when compared with students experiencing traditional science instruction over the course of the year. These findings indicate a more generalized perception that traditional school science experiences do not facilitate the belief that students can be caretakers of the environment. (Gough, 2002, Hudson, 2001, embedded in Barnett et al. 2006).

In spite of the popularity of inquiry as a teaching technique, teachers are reluctant to incorporate it into their classroom. Some of the reasons teachers gave for not using inquiry included: 1) confusion about the meaning, 2) inquiry only works with high ability

students, 3) teachers are inadequately prepared, and the most common reason is that, 4) students will be difficult to manage.

Place-Based Education

"Place-based education encourages teachers and students to use the schoolyard, community, public lands, and other special places as resources, turning communities into classrooms. Project-focused and inherently tailored by local people to local realities, place-based education is equally relevant in small towns and big cities, equally effective for kindergartners and high school students" (Duffin, Phillips, & Tremblay, 2006, p.6). The place-based education collaborative has instituted individual and cross program evaluations in six place-based education programs representing 100 schools covering 12 states. The evidence reflects over 800 educator interviews or focus group participants, 200 student interviews, 750 educator surveys, 20,000 students' surveys, extensive documentation and review, and dozens of on-site interviews. The findings show that place-based education fosters a student's connection to place and creates vibrant partnerships between schools and communities. It boosts student achievement and improves environmental, social, and economic vitality (Duffin et al., 2006).

In the United States, a place-based education study compared first graders who had a teacher that employed a strong place-based education model with students in a traditional classroom. The Beebe School in Maldern, Massachusetts, used local resources to integrate science into the curriculum and has used this model since 1999. Since 2000, Beebe's students have out paced their peers in the school district on Massachusetts Comprehensive Assessment System (MCAS) suggesting a correlation between place-based education and academic performance. Overall, the analysis provided moderate

support for the relationship between exposure to the CO-SEED program and achievement at Beebe School. Specifically, the Beebe CO-SEED program appears to be having some positive effect on later-grade student achievement in the content areas of math and science (Duffin et al. 2006).

Fusco (2001) investigated a new way of looking at science by incorporating a community-based field experience into the community in New York City. Teenagers in a low-income after-school program created an urban planning and community gardening project on a vacant lot and Fusco demonstrated that it is not just what they learn, but how they learn. A practicing culture of science learning is very different than traditional textbook science classes. Opportunities to participate in real world activities alone do not guarantee that young people will find school or science more relevant. How young people are involved in these activities is critical. The science project was created from participants' concerns, interests, and experiences inside and outside of science. It included an ongoing process of research and then enacting ideas and was situated with the broader community. Fusco determined that the potential for change occurs at many levels, between youth, community and science, and affects change at a personal level, the environment at the physical and social level and, the culture of science and science education. The students' engagement in science included access to practical knowledge and the opportunity to participate in action research that served a purpose within community.

Gruenewald (2003) argues for a conscious synthesis that blends critical pedagogy and place-based education into one framework. The current education reform era of standards and testing that began nearly 20 years ago with the publication of a Nation at

Risk (1983) is perhaps reaching a climax in the No Child Left behind Act of 2001. One of the results of the new federal mandates for accountability is an increasing emphasis on standards, testing, and classroom pedagogies that "teach to the test" while denying students and teachers' opportunities to experience critical or place-based education (Gruenewald, 2003)

Culturally Relevant Curriculum

"Teachers have moved beyond the classroom walls and are providing their students with culturally relevant, real-world experiences" (Gutstein, Lipman, Hernandez, & Reyes, 1997). The children, in turn, are the direct beneficiaries of their teacher's evolving connection with the natural world. Going outdoors is immediate and real; it sparks question; it offers avenues of exploration and investigation; and it is available, at little or no expense, to everyone" (Bourne, 2000). Culturally responsive teaching incorporates culturally relevant curriculum. In Riggs (2004) review of science education research on field experience with indigenous peoples found that science experiences in the field needed to be tied with cultural ways of knowing for there to be an increase in science achievement. Culturally relevant pedagogy and curriculum advocates for science experiences that include these cultural connections.

Culturally relevant curriculum (CRC) is a tool of culturally relevant teaching and a part of a multicultural approach to education. A culturally relevant or multicultural curriculum is curriculum that is culturally diverse and focuses on inclusion. It includes the cultures of various ethnic groups and supports a notion that the history of all groups should be taught in school. One of the major premises behind culturally relevant curriculum is that culture is at the heart of all we do, including curriculum development,

instruction, administration, or evaluation. Although called by different names, culturally relevant, congruent, sensitive, or responsive, why it is important and how it is done is virtually identical. Culturally based curriculum is misunderstood as being "exotic" or not relevant to the "rest of us. Since all curriculum is culturally based, the question is, whose culture is it based on? Oftentimes, it is based on mainstream society and large-scale publishers who dominate the marketplace (Lipka, Yanez, & Andrew-Ihrke, 2006).

In recent years, the science community worldwide has come to understand the need to increase gender, racial, and ethnic diversity in academic ranks. This has led to an increase in funding and support for science education research into the nature and structure of cultural barriers. Native Americans are of particular concern for environmental science educators as an under-represented group. They manage a large land base and teaching styles common to science are not automatically compatible with many of the indigenous cultures. In western cultures, the scientist is perceived as a controller, manipulator, or exploiter of the natural world. To remove these barriers, science should be carefully presented in the classroom as just another portion of students' everyday lives rather than some foreign body of thought and knowledge.

Riggs (2004) completed a review of the theoretical and empirical science education research around field experience for indigenous people and provided an analysis of the common field based elements and an explanation for the success of this design based on field based learning. Successful earth science curricula for indigenous learners share in common an emphasis on outdoor education, a place and problem base structure, and inclusion of traditional indigenous knowledge in the instruction (Riggs, 2004). Programs that share these elements have proven successful for other cultures in

the United States. "The key is that science must be shown to be congruent with common ways of logical thinking that students recognize from within their own cultures, using everyday experience to illuminate and provide content for scientific instruction" (Riggs, 2004). Gay (2000, p. 14) emphasizes that "it is imperative for our schools today that teaching in the field uses the cultural knowledge, prior experiences, and learning styles of ethnically diverse students to make learning more relevant and effective for them."

Attitude Toward Science

Attitude is defined as the favorable or unfavorable response to things, peoples, place, events or ideas (Simpson & Oliver, 1990). Attitudes are important outcomes as many studies conducted during the last half century show students' increasing alienation from science and opting out of rigorous courses during adolescent years (Wahlberg, 1981). Early efforts to link attitude with science focused on defining attitude. It is important to differentiate between scientific attitudes, which have a cognitive orientation, and attitudes toward science, which is predominately an affective domain. This study is looking at students' attitude toward science. Attitude represents the emotional orientation of an individual to the topic at hand (Brandwien, Watson and Blackwood, 1958, embedded in Freedman, 1996).

Attitudes, as originally described by Klopfer (1971), were used to develop the Test of Science Related Attitudes (TOSRA), the measurement tool used in this study. The TOSRA inventory was based on these affective aims for science education as delineated in Table 1.

Table 1. Scale Name, Klopfer's Classification, and Sample Item for TOSRA Scale (Scibeci & Riley, 1986).

Scale Name	Klopfer's Classification	Sample item
Social implications of science	h.1 manifestation of favorable attitudes toward science and scientists	Scientific discoveries are doing more harm than good
Normality of scientists		Scientists usually like to go to their laboratories when they have a day off
Attitude toward scientific inquiry	H. 2. Acceptance of scientific inquiry as a way of thought	I would prefer to find out why something happens by doing an experiment than by being told
Adoption of Scientific attitudes	H. 3. Adoption of scientific attitudes	I like to listen to people whose opinions are different from mine.
Enjoyment of science lessons	H.4. Enjoyment of science learning experiences	Science lessons bore me.
Leisure interest in science	H. 5. Development of interest in science and science-related activities.	I dislike reading newspaper articles about science.
Career interest in science	H.6. Development of interest in pursuing a career in science	I would like to be a scientist when I leave school.

Haertel, Walberg, & Haertel (1981) examined Indonesian students' perceptions of the psycho social characteristics using an alternative approach. One of the purposes of this study was to extend a mediated effects model to consider not only achievement but also attitudes as outcomes. The sample included 734 correlations from 12 studies on 823 classes in eight subject areas from four nations. The results showed that prior science attitude and achievement have significant and direct effects on science attitude according

to pre-test and post-test (b = .60) scores that were relatively high. In this study, researchers found that achievement more likely causes positive attitudes rather than the reverse. Interdependence among different factors suggests that efforts to improve students' achievement and attitude may have a greater success because changing one factor simultaneously affects the other factor. Research is beginning to document the impact of achievement on attitude redevelopment (perception of ability) leading to greater interest in particular subjects such as science.

Freedman (1996) investigated the use of a hands-on lab program. Lab activities that were related to the science concepts were developed to involve the students cooperatively as a means of improving student's attitude toward science and increase student achievement levels in science knowledge. Using a post-test only control group design, an examination measured student achievement and a post-test survey looked at students' attitude to science. Findings showed that students who had regular lab instruction scored higher ($p < .01$) on an objective exam than those who had no lab instruction and exhibited a moderate, positive correlation (r = .406) between attitude toward science and achievement. Freedman (1996) believes that "instruction that makes science more exciting and encourages students has a positive influence on student toward science and their achievement."

Simpson & Oliver (1990) & Bloom (1976) suggest that 25% of the variance in school achievement could be attributed to how students feel about what they are studying, their school environment, and their concept of self. Osborne, Driver & Simon (1998) carried out some major work on attitudes toward science in the United Kingdom over several years. They found that attitudes toward school science appear to peak on or

before the age of 11 and decline thereafter and influenced by the student ethnic and home background. "Good teaching, in this study, was characterized by teachers being enthusiastic about their subject, setting it in everyday contexts and running well-ordered and stimulating science lessons" (Osborne et al. 1998).

Papanastaiou & Zembylas (2004) proposed to explain the attitude achievement relationship at the late high school level. Students from schools from Australia, Cyprus, and the United States provided important variations in attitudes toward science and the relationship between these attitudes and science achievement. They found that the "locality," the location where relationship between attitude and achievement develops, was important.There was a unique opportunity to investigate student backgrounds and relation to science achievement using data from Trends in International Math and Science Study (TIMSS). Results showed that the United States was the only country (of three countries) to demonstrate a reciprocal relationship between attitude toward science and science achievement.

Differences in Achievement of Science

Achievement gap research looks at the differences in achievement between mainstream and non-mainstream students. This definition takes into consideration the assimilation of ethnic minorities and their ability to acquire the standard language and shared culture of the dominant culture in the United States. In addition to this being deficit language, which focuses attention on the shortcomings of people, this may not be the best way to attempt to minimize differences in achievement or attitude. In order for minority achievement and low socioeconomic class achievement to improve, we must incorporate strategies that teach all students along with a belief that there is equity and

cooperation in the classroom to create an environment for all students to progress. The fact that all students come into the classroom from a variety of experiences emphasizes the importance of Vygotsky's zone of proximal development.

According to a National Study Group (2004):

> "We cannot overlook the essential need to focus on improving the learning opportunities and academic achievement of minority and low-income students. Demographic shifts in our nation's population mandate that we attend specifically to these students' achievement if we expect as a nation to maintain our standard of living, our level of prosperity, and our place in the global economy. Simply put, we need the knowledge and contributions of students of color-together with the knowledge and contributions of all our students and all our adults – to maintain our democracy....A systemic approach to closing achievement gaps and improving learning for all students necessitates access to a combination of educational interventions in the classroom, school, and community. High levels of academic ability can be obtained for all students by applying proven pedagogical practices and adopting policies that are within our reach" (Bennett et al. 2004, p. 24).

Fisher and Waldrip (1999) developed and validated an instrument to assess culturally sensitive factors of science learning environments because many school students come from communities with widely differing cultural practices. Teaching strategies adopted in the classroom can be perceived as being in conflict with students' previous learning patterns, home environment, and values. With a sample of over 3,500 students, the analysis indicated the most consistent predictors of attitudes were equity, competition, deference, modeling ($p<0.01$) and congruence ($p<0.05$). The Cultural Learning Environment Questionnaire (CLEQ) found the highest correlation occurred with attitude toward science when students perceived greater levels of congruence and equity in the classrooms. This information shows that teachers can use the cultural expectations of their students to better match the teaching strategies they select.

Achievement Gap Research

There are problems with the use of deficit or negative language when discussing achievement gaps. Despite the intense focus on the achievement gap that exists between students of color and their white counterparts, Gloria Ladson-Billings (2007) believes that the achievement gap discourse keeps us locked in a deficit paradigm. "Looking at current educational problems as an achievement gap forces us to look to the year-to-year progress on various standardized test measures and allows us to conclude that the problem lies solely with the realm of scholastic disparity" (Ladson-Billings, 2007, p. 3). The first concern is regarding the use of the term "achievement gap" to define educational problems. This terminology assumes that high performing students will stand still so that the minority students can "catch-up." A student's academic performance is not static and those who are performing well are not waiting for those that are lagging behind.

Another concern with using achievement gap terminology was the assumption that it is only a matter of student achievement. Issues like the inequity of school funding have occurred over centuries and contribute to educational problems. Ladson–Billings (2007) believes that, "to isolate the "achievement gap" in the midst of all of other disparities seems wrong-headed and disingenuous" (Ladson-Billings, 2007). The final problem with the achievement gap discourse is in understanding that this is not a new phenomenon. Cultural deficit theories in the 1950's and 1960's tried to explain that children of color were victims of pathological lifestyles that hindered their ability to benefit from schooling (Bereiter & Engleman, 1966). In 2007, you can still walk into a school and hear misconceptions about minority students and their academic failure. Some of the comments are:

1. The parents don't care.
2. Theses children don't have enough life experience.
3. These children aren't ready for school.
4. Their families don't value education.
5. They are coming from a culture of poverty. (p.3)

These misconceptions about students are problematic in that they create a separate society by assuming that poor children are different and cannot be treated with dignity and respect. Ladson–Billings (2007) believes that "if we can control the discourse then we can control the thinking." The achievement gap discourse constructs students as defective and lacking and reminds us that we are engaged in unethical and immoral treatment of our underserved populations.

Another problem with achievement gap research is the problem of changing terminology to refer to people of Hispanic descent in the United States. This has caused conflict and confusion and is still a point of contention for people that are Hispanic. According to the President's Advisory Commission on Educational Excellence for Hispanic Americans (2003), the country's Hispanic population is "much more complex than commonly recognized" and aggregate data does not provide an accurate picture of Hispanic student achievement. According to the 2006 U.S. Census, the Hispanic population includes many groups and is a percent of the total group referred to as "Hispanic" by the United States Government (Table 2).

Table 2. Population of Hispanic Population by Origin and Percent of the Total

Hispanic origin by type – 2006		
Type of origin	Number	Percent
Total	44,252,278	100.0
Mexican	**28,339,354**	**64.0**
Puerto Rican	3,987,947	9.0
Central American	3,372,090	7.6
South American	2,421,297	5.5
Cuban	1,520,276	3.4
Dominican	1,217,225	2.8
Other Hispanic	3,394,089	7.7
Source: US Census Bureau, 2006, American Community Survey		

The data cannot accurately tell the story of minority achievement. Ethnicity is self-perceived. Not only can people belong to more than one ethnic group, they can and do change their ethnic affiliations, both over time and in different contexts (Marin & Marin, 1991). In addition, standardized tests and present data recording methods employed by government agencies do not take into account different levels of acculturation. Because Mexican Americans were the highest population of minority students at the school chosen for this study, most of the focus will be on this ethnic group. The terms Hispanic and the Latino/a were used interchangeably especially when quoting original sources.

Ethnicity - Hispanic Students

Hispanic students are making gains but are still behind the gains of other groups (Chew, 2004). For Hispanic student populations, particularly Mexican Americans, the largest group of Hispanics, the need to understand their culture is particularly urgent for three reasons. First, at the start of the millennium, Hispanics were the largest minority

group in the United States at 20 percent of the student population. Second, they have a disproportionate, chronic record of underachievement and high drop-out rates in U.S. schools. Third, Hispanic underachievement places the social and economic welfare of the nation at risk (Griego-Jones & Fuller, 2003).

Gutstein, Lipman, Hernández, & Reyes (1997) examined mathematics instruction and its intersection with culturally relevant teaching in a Hispanic community. A curriculum was developed to help teachers use what they know about their student's culture to improve students' learning of mathematics. This project addresses three issues affecting schools: 1) the failure of schools to support the academic success of students of color, 2) mathematics as a "sense' making experience, and 3) the importance of developing tools for active participation in public life. This study took place in a community that consisted of 99% Latino and 99% low-income students.

The project worked with teachers to develop math curriculum that was relevant to the student's culture. Using qualitative research methods, field notes, interviews, and observations, researchers collected ethnographic data on the role of culture in the curriculum and the importance of the incorporation of the Mathematics in Context (MiC) curriculum. Although no quantitative data was collected, the results of this study created a model for teachers that: a) builds on student's informal knowledge and cultural experience, b) develops tools of critical thinking about knowledge in general, and c) orients to students' culture and experience. It is important that teachers build on the richness of students' experience and culture to make learning more meaningful. Teachers should present authentic real-life examples to students, make content information culturally relevant, and use the instructional strategies that promote the learning styles of

Hispanic children (Menchaca, 2001). "The richness of the culture and language that Hispanic migrant students bring with them to the classroom is invaluable. Teachers can build on these students' strengths by embracing and incorporating their experiences in the lessons. However, since most teachers do not know the kinds of experiences that Hispanic students have been engaged in, it is best to have the students write or tell about their adventures" (Menchaca, 2001, p.15).

Mexican Americans are the largest growing population in the United States. Currently, Hispanic students make up more than 20% of the U.S. school population and in 23 of the 50 states (U. S. Census Bureau, 2006). Hispanic students outnumber African American and Asian students. Since the 1990s, progress in the academic achievement of Hispanic students has virtually stopped. According to information provided by the National Center for Educational Statistics (NCES) one of the statements about the gap in the academic achievement of Hispanic or Latino students is: "at all levels, the average achievement-test scores of Hispanic students are lower than White students. By the end of high school, Hispanic students' reading and mathematical skills are comparable to those of White 13 year olds" (National Center Educational Statistics, [NCES] 2003).

According to information provided by the National Center for Educational Statistics (NCES), the gap in the academic achievement of Hispanic or Latino students at all levels, and the average achievement-test scores of Hispanic students, is lower than White students. By the end of high school, Hispanic students' reading and mathematical skills are comparable to those of White 13-year olds (NCES, 2003).

According to the U. S. Census Bureau (2006), by the year 2050, 49% of the population will be non-white , with Hispanics becoming the largest ethnic minority

population by 2010 and the U.S. Department of Education (2002) found that the number of students who spoke a language other than English at home rose from 6.3 million in 1979 to 13.7 million in 1999. Cultural diversity in U.S. schools is growing. These demographic trends present new challenges for teachers, as many teachers feel unprepared to teach a diverse student population (Holloway, 2003) and historically, ethnic minority students, with the exceptions of Asians, have been underserved by U.S. education. "As with all students, Hispanic students are most successful when school honors and values them" (Rodriquez, 2005). It is important that teachers have some knowledge of the Hispanic culture to help Hispanic children embrace the rich and authentic characters in the books. When students can relate to the information being presented, they are more likely to understand academic concepts and experience success in school" (Menchaca, 2001).

Socioeconomic Class

In "A Framework for Understanding Poverty," Ruby Payne (1998) discusses the factors that relate to poverty and contribute to low achievement. These factors are closely correlated with lack of resources, and numerous studies have documented the correlation between low socioeconomic status and low academic achievement. Students that come from low socioeconomic class also have less positive attitudes toward science and science achievement. Low socioeconomic class is defined by the National Assessment Educational Progress (NAEP) and Colorado Student Assessment Program (CSAP) as those that qualify for free or reduced lunch. Young people represent 25% of the population at large, but over 40% of those are classified as low income. Most of the

children and youth classified as low income are African-Americans (43%) or Hispanic (40%) and most live in large urban areas (US. Department of Education, 2002).

Kruse (1996) conducted a study to determine if students from low socioeconomic environments have lower academic achievement compared to the academic achievement of students from higher socioeconomic environments. The sample consisted of 66 sixth grade science students at Travis Middle School in Temple, Texas. There was a statistically significant difference between the academic achievement of students from low socioeconomic environments compared to that of students from higher socioeconomic environments ($p = .01$).

Evans (2004) suggests that socioeconomic differences affect children due to physical challenges such as health risks and poor housing, social environment challenges such as fewer educational materials at home, and other school and classroom environmental challenges. Schools that have greater portions of low income children are more likely to have lower per pupil expenditures, lower teacher quality, less rigorous curriculum, lower expectations for academic performance, and less involvement from parents as far as volunteering in school, attending school functions, and assistance with homework. Dahl and Lochner (2005) found that an income increase of $1,000 was associated with an increase in mathematics scores of 2.1% of a standard deviation (SD) and in reading test scores of 3.6% of a standard deviation (SD). A review of five studies showed similar results and recommended more rigorous course work, higher expectations from teachers, curriculum aligned with standards, and more parent involvement as practices to mitigate these problems.

California schools (Williams, Kirst, Wody, Levin, Perry & Haertel, 2005) undertook a large scale survey of elementary schools serving low income and poverty status students. A regression analysis was done using the correlates of student achievement in schools that have between 65% and 75% of students characterized as low income. Two hundred fifty-seven schools in 145 districts participated; 5,500 teachers and 257 principals responded to surveys. Even though the correlation of low income and low achievement can be positively correlated, there were other interesting results. Strong participation rates provided statistically significant results using regression analysis to isolate distinct correlations between schools test scores and several related independent variables. There was as much as a 250 point difference between schools that had similarly challenging student populations. The range of Academic Performance Index (API) suggest that while socio-economic class is one predictor of academic achievement, it is not the sole predicator. The four domains that scored the highest were implementing a standards based instructional program, standard deviation (SD: 17.6), availability of resources (SD: 16.9), using assessment data to improve student achievement (SD: 16.7), and prioritizing student achievement (SD: 16.3). Enforcing high expectations for student behavior, teacher collaboration and support from parent were important and scored 12.3, 11.0 and 9.9 SD respectively (Williams et al. 2005). To increase achievement for low income students, this study advocated for implementing a coherent, standards-based curriculum and instructional program school wide, and instruction guided by state academic standards. Other conclusions from the study recommend that more research is necessary that looks at both class and ethnicity.

"The true discrimination that comes out of poverty is lack of cognitive strategies. The lack of these unseen attributes handicap every aspect of life when the individual does not have them. Another key is creating relationships. In nine out of ten cases of students that were asked how they made the journey from poverty to middle class - it had to do with a positive relationship" (Payne, 1996, p. 23).

Summary

Teaching in a natural setting provides a learning environment that accepts and engages all students regardless of color, academic ability, or class. Field experience provides a place for investigation and inquiry to occur and connects students to the community giving them a sense of place. It is difficult to draw definitive conclusions about the effectiveness of field experience on science achievement due to the limitations in standardized testing procedures.

Based on a summary of existing literature, there is considerable evidence to support the incorporation of field experience into the curriculum. Thus the literature supports research that focuses on a comparison of learning environments in a field study environment and a traditional science classroom. This study will enrich the existing studies and continue the trend to compare learning environments in terms of students' perceptions and attitudes toward science and is unique in that it will differentiate results for Hispanic students and low socioeconomic class students.

CHAPTER 3: METHODOLOGY

This comparative study used a mixed method research design to investigate two different learning environments: a traditional science classroom and a field-study classroom. This approach involved collecting data that is both numeric and textual so the final database represents quantitative and qualitative information (Creswell, 2003). Both of these forms of data were collected from students who participate in both learning environments which is a repeated measures design with no control group. The intent in using this design was to bring together the different strengths and non-overlapping weaknesses of quantitative methods with those of qualitative methods.

The Research Design

The mixed methods sequential explanatory design consists of two distinct phases: quantitative followed by qualitative (Creswell & Plano Clark, 2007). In this design, a researcher first collects and analyzes the quantitative (numeric) data. The qualitative (text) data collected and analyzed second in the next sequence helps explain, or elaborate on, the quantitative results obtained in the first phase. The rationale for this approach was that the quantitative data and their subsequent analysis provide a general understanding of the research problem and the qualitative data and analysis refine and explain those statistical results by exploring participants' views in depth (Rossman & Wilson, 1985; Tashakkori & Teddlie, 1998; in Creswell, 2003).

In this sequential explanatory study, the results of a modified version of the What is Happening in this Classroom (WIHIC) (Fraser, 1998) questionnaire and the Test of Science Related Attitudes (TOSRA) (Fraser, 1981) questionnaire was used to compare the two environments and the students' attitudes toward science. Following the quantitative data collection, researcher observations and scientific notebooks explored how field experience affects science attitudes and student perceptions of the two learning environments. Figure 1 shows the model for this sequential explanatory research design.

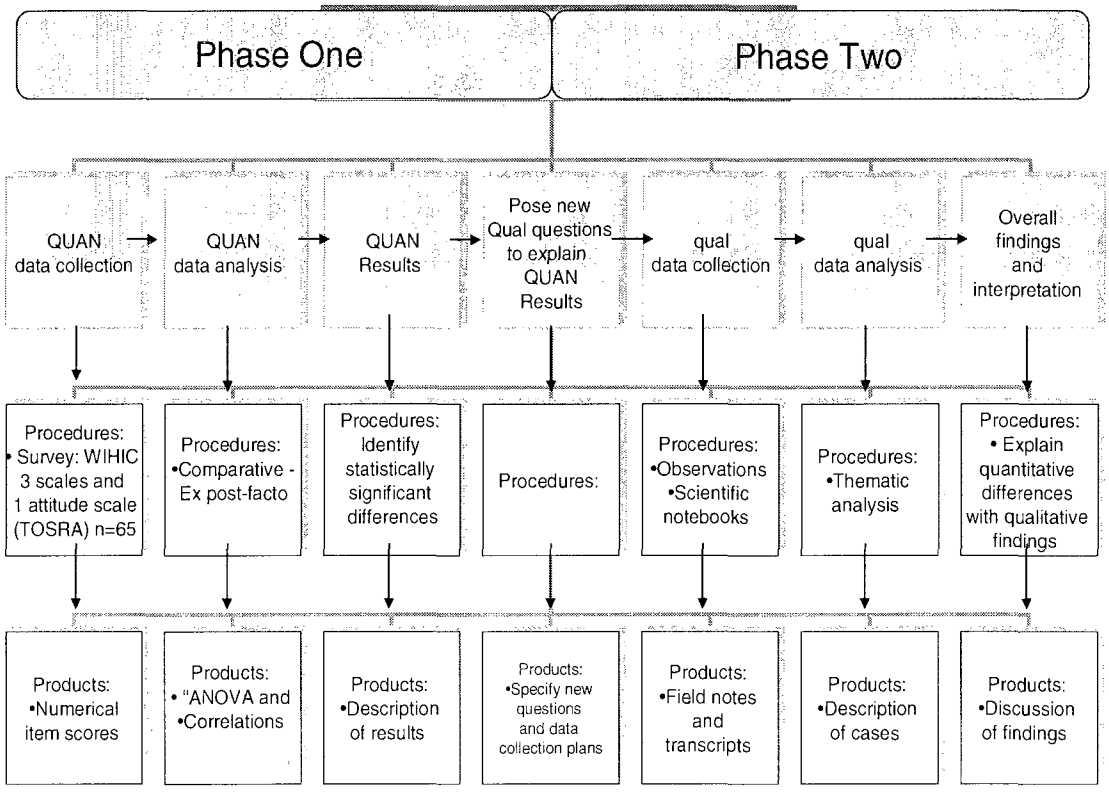

Figure 1. Sequential Explanatory Design

This research represents a blending of two different worldviews or philosophical assumptions in quantitative research; the intent is to see how data provided by participants fits an existing theory. On the other hand, in qualitative research, the intent is to learn participant's

views about a particular phenomenon in greater depth than quantitative data can provide. This study began (phase one) with a post positivist worldview making a claim for knowledge based on cause and effect thinking – a top down approach. Phase two helped to understand the phenomena by pursuing a constructivist worldview shaped by participants' social interaction and personal histories - a bottom-up approach.

Rationale for the Research Design

Mixed methods best addressed the research problem for two reasons. First, one approach to the research, quantitative or qualitative, is inadequate to address the research problem and that the combination of both quantitative and qualitative data gives a more complete picture by providing in-depth knowledge of participants' perspectives. Second, there is the need to explain the quantitative results. In this case, the data provided from the WIHIC and TOSRA survey may not provide a complete picture of the two learning environments. Student's perspectives provided through observation and science notebooks, which include the actual words of participants, will further interpret the results.

Green & Caracalla (1997) believe that "adding qualitative flesh to the quantitative bones is a good strategy to overcoming some of the problems of one method." Among the purposes for mixed-method evaluation design, Green & Caracalla highlight some of the ways a mixed method study might enhance the evaluation as follows:

> 1) Triangulation tests the consistency of findings obtained through different instruments. In this study, triangulation increased chances to control, or at least assess, some of the threats, such as researcher bias, influencing our results.
>
> 2) Complimentarily clarifies and illustrates results from one method with the use of another method. In this case, observations and the assessment of science notebooks added information about the learning process and will qualify the scores and statistics.

> 3) Initiation stimulates new research questions or challenges results obtained through one method. In this case, observations and analysis of student's scientific notebooks provided new insights on how the program has been perceived and valued.
>
> 4) Expansion provides richness and detail to the study exploring specific features of each method. In this case, integration of procedures mentioned above expanded the breadth of the study and likely enlightened the more general debate on the achievement gap in science for minority populations. (p. 5)

In sum, the explanation of this study demonstrates that a research strategy integrating different methods likely produced better results in terms of quality and scope. In addition, it encourages us to probe the underlying issues assumed by a mixed-method research design.

Setting

The opportunity to examine differences in learning environments and students' attitudes toward science arise from the existing arrangement of a school that attends an environmental learning center five times throughout the school year. This school was within walking distance of the outdoor education center and has opportunity to use the environmental learning center more often than other schools since the school does not have to pay for transportation. This school was also appropriate for this study because the teachers embedded the field experience in the curriculum and wrote all five field experiences using a model for student-based inquiry. Finally, the demographics of this school, specifically the ethnicity and socioeconomic class of the student population, were representative of the whole school district. An attempt to compare this school with other schools in the district was difficult because of the inability to control for confounding factors such as curriculum, teaching quality, and number of field experiences.

One school was added in phase two due to the common curriculum and demographics of the students. This second school did allow all students to participate in a single field experience in spite of the school district policy for additional reading requirements for

students scoring at a certain level. The second school was similar to the overall demographics of the school district and the first school in the study and had a similar field trip curriculum which was tied to Foss Kits and science standards for fifth grade students.

Participants

The theoretical population for the study was fifth graders in the United States who have an opportunity to participate in field experience as part of their school curriculum. The accessible population was fifth grade students who attend Winona Elementary School and participated in five inquiry-based field experiences embedded in the curriculum at the environmental learning center. Looking at the demographics of the students in the school district, 56% of the student population in the district was classified as minority and 53% of these minority students were classified as Hispanic. According to the state report for free and reduced hot lunch guidelines, 46% of the students in this district were classified as low-income. In phase one; the actual sample consisted of students from two fifth grade classes that are representative of the demographics in the school district as far as socioeconomic class and ethnicity (Table 3). In phase two, the sample of participants was from this school as well from the second school mentioned above with similar demographics, a similar field trip program based on science standards and Foss Science kits from the same school district.

Table 3. Class Size, Ethnicity, and Economic Status of the Fifth Grade Class Compared with the School District.

Demographics	School data	School district data
Free and reduced hot lunch	58%	52.56%
Ethnicity:		
White	41%	44.66%
Hispanic	58%	52.31%
Other	1%	3.02%

In a sequential

explanatory design, the same individuals can be included in the quantitative data collection for phase one and the qualitative data collection for phase two. The participants for phase two are selected that will best provide detail about the quantitative results. For example, if the data show a difference in attitude toward science for students from the non-mainstream culture, then the sample for phase two can purposefully include students in the sample to be from this group. This can be a smaller sample of students as the study design calls for further explaining the data rather than comparing the data. This unequal sample size is not an issue in sequential designs (Creswell & Plano Clark, 2007).

Pilot Tests

Quantitative

A pilot-test was conducted with two sixth grade classes from a local elementary school that had participated in a three day overnight field experience. Questions from modified versions of the WIHIC and TOSRA were given to these two classes. The pilot-test helped to gauge the comprehension level of the questions and the relevance of the constructs. The original version of the WIHIC included the construct involvement. Some of the questions from that scale seemed to overlap with other questions and the survey seemed too long for the sixth grade attention span. The WIHIC was then modified to include just the three constructs: equity, investigation and cooperation. In addition, the TOSRA scale had a series of questions focused on investigation. To eliminate duplication with a survey question in the WIHIC scale, the TOSRA was modified to include only the enjoyment of science scale.

Qualitative

A pilot-test was also done with fifth graders that participated in field study at the Poudre Learning Center using two of the three qualitative questions. These three classes are in the same school district and closely represented the demographics of the other schools and that district. By asking the two questions to the pilot group of students, I was able to identify the time needed to survey the students, to explain the directions for the short constructed response questions and then look at the themes that started to emerge to gauge the appropriateness of the questions that should be used with the sample population. The wording was then changed to reflect a more open ended question.

Another result of the pilot-test was the decision to add another school to phase two of the study to see if there would be different results. The original research methodology called for a comparison of schools but later it was determined that schools could not be compared, especially for ethnicity and socioeconomic class, due to a district policy that required a minimum score on reading to participate in science classes. That made it difficult to compare students' perceptions of science in two learning environments when only some of the students had a science in their curriculum. The school selected for phase one was unique and all students participated in science. For phase two, the situation was different. I was only asking students that participated in field experience about their experience so it seemed important at this point to be able to compare two different schools – one that participated in field experience five times and one school that only participated on one field experience.

Data Collection

The data collection procedure for this study was designed to address the research questions and match the type of mixed method design being used. A sequential form of data

collection involves the collection of one type of data followed by analysis prior to a second data collection. Quantitative and qualitative procedures must address the sampling procedure, permissions needed, information to be collected, recoding of the data, and administration of the data collection (Figure 2).

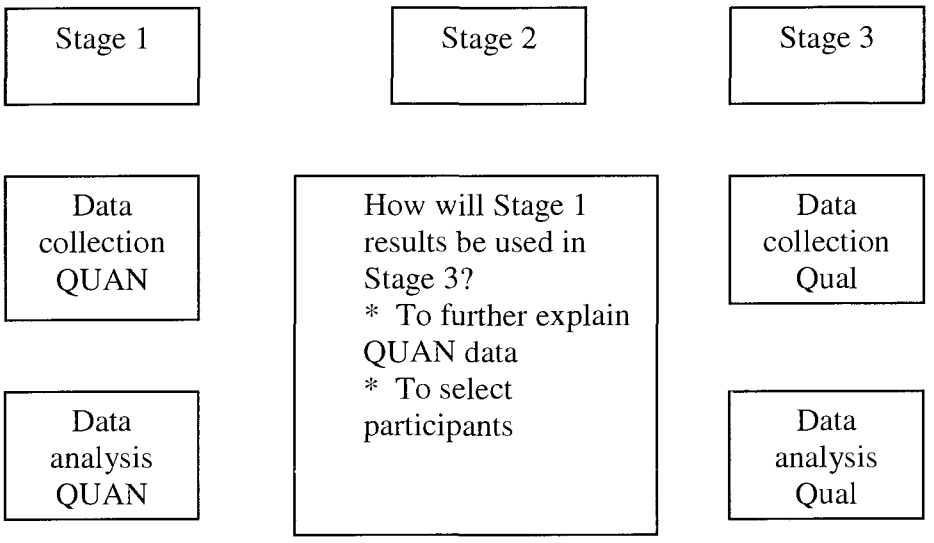

Figure 2. Sequential Explanatory Form of Mixed Methods Data Collection. (Creswell, 2003, p. 200).

Stage One: For stage one of the data collection, students were asked to complete a survey regarding their perceptions of a field-based learning environment and a traditional classroom environment. This survey was administered after the students' third field trip to the outdoor learning center. By administering the survey after three field experiences, the study yields more significant results because, by this time, students are comfortable with the setting, schedule, and learning activities in which they were engaged. Orion & Hofstein (1994) recommend eliminating the amount of "novelty space" to increase the amount a student is able to learn on a given field trip. When students are first exposed to a new geographical setting, it becomes a social experience and students are not as

engaged in the learning, but react to the new experience. The higher the novelty levels, the less likely it is that the student will have a meaningful learning experience. The students answered seven questions from three of the seven scales on the WIHIC and seven questions from one scale of the TOSRA. Both of these survey tools have been extensively field tested and provide high reliability and validity. In addition, on the same survey form, students self-identified their socioeconomic class based on their eligibility for free or reduced hot lunch. Ethnicity was obtained from the school reporting system. After the data was collected, the results of the survey were statistically analyzed.

Stage Two: The results of stage one were used to help select the participants and guide the development of the questions and observation protocol in stage two. The following criteria used to guide this stage were statistically significant results, statistically non-significant results, variables that distinguish between groups, and distinguishing demographic characteristics. Instead of purposefully sampling specific students for phase two of the study, the same students ($N = 60$) used in phase one were chosen for phase two for three questions. A fourth question was developed that required the comparison of another school, so in phase two, questions two and three, were given to another school ($N = 60$).

Stage Three: In stage three of the data collection stage, science notebooks and field observation notes were used to further explore the difference in student's perceptions of the two learning environments. The questions developed from analysis of stage one data were answered by coding for themes and describing cases. Observation protocol for the outdoor field experience science and a rubric for science notebooks

guided the qualitative data collection. These data were then analyzed and yielded specific quotes from individuals, codes that the researcher generated, and themes that consisted of groups of codes (Creswell & Plano Clark, 2007).

The data collection schedule was dependent on the students' school schedule and was as follows:

Data Collection Schedule
Fall 2008
- Gain access to site
  - a. University human subject approval
  - b. School district human subject approval
- Develop relationships with students for study
- Pilot – survey and observation protocol

Winter 2008
- Administer WIHIC/TOSRA questionnaire
- Analyze quantitative data
- Determine further direction – qualitative sample and questions

Spring 2009
- Collect qualitative data from:
  - a. Science notebooks
  - b. Observations
- Transcribe qualitative data
- Code for themes

Summer/Fall 2009
- Analysis
- Write-up results

Methods of Data Analysis

Quantitative and qualitative data analyses involves similar steps: data preparation, data exploration, data analysis, representation of the analysis, and data validation. According to Creswell & Plano Clark (2007), there are several guidelines that apply to the sequential mixed methods data analysis:

1. The purpose is to use the information from the analysis of the first database to inform the second database.

2. The sequential analysis is used to address the mixed methods questions. For this explanatory design, the mixed methods questions are generally: In what ways do the qualitative data help to explain the quantitative results? Which cases provide the best insights in to the quantitative results?
3. The first stage is to analyze the first database, review the information in stage two, and then make decisions about what information is most useful for stage three. (p. 146)

The methods of data analyses used for this study are shown in Figure 3.

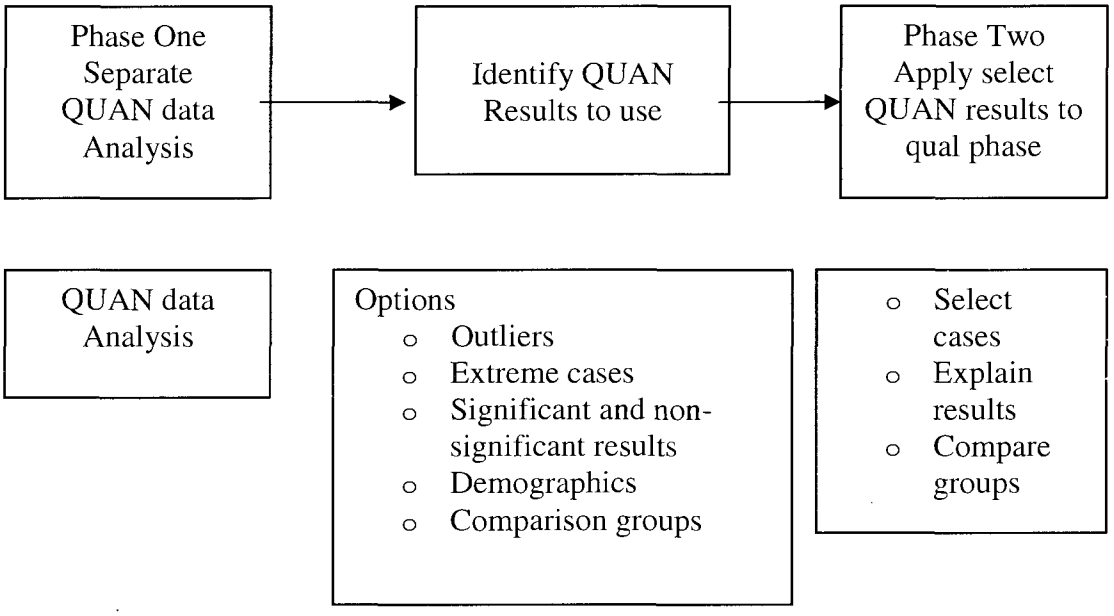

Figure 3. Sequential Explanatory Data Analysis

Phase One - Quantitative

In this particular study, there were three types of questions: difference, association and interaction (Table 4). The specific research questions for the quantitative data phase are:

1. Are there differences between the traditional public school science class and the field study class in terms of:
   a) learning environment
   b) attitudes toward science.

2. In terms of learning environment and attitudes toward science, is the field study class differentially effective for:
    a) students from a high or low socioeconomic class.
    b) Hispanic students and other students.
3. Are there associations between the learning environment and students' attitudes toward science?
4. Are there interactions between the ethnic group and the socioeconomic class?

Table 4. Research Questions, Statistic, and Result.

Research Questions – Phase One	Statistic	Effect Size
1. Are there differences between the traditional public school Science class experience and the field study class experience in terms of: (within subjects/repeated measures design) a) learning environment, and b) attitudes toward science.	Paired *t*– test	*d*
2. In terms of learning environment and attitudes toward science, is the field study class differentially effective for: a) students from a high or low socioeconomic class, and b) Hispanic students and other students.	Independent *t*–test	*d*
3. Are there associations between the learning environment and students' attitudes toward science?	Correlation	*r*
4. Are there interactions between the ethnic group and the socioeconomic class?	Factorial ANOVA	*Eta*

Question number one was analyzed using a paired samples *t*- test within subjects design with no control group to compare the field and classroom learning environment for four different constructs from the survey tools – WIHIC and TOSRA. The assumptions of this test are that the individual variable is normally distributed in the two conditions. In question number one, student's perceptions of the learning environment

field and class, will be compared. In addition, to a comparison of means, the *t*- test and probability, statistical significance, and the effect size was calculated to determine if the difference is small, medium or large according to Cohen (1988).

Question two was analyzed using an independent samples *t-test* for between groups. This test is used on two independent groups when investigating the difference on an approximately normal dependent variable. This test is appropriate when the following assumptions are not markedly violated: (a) the variance in the two populations (of the dependent variable) are equal, (b) the dependent variable is normally distributed, and (c) the data are independent (scores of one participant are not related systematically to scored of the others). This assumption is often addressed during design and data collection. The results of the survey were disaggregated by ethnicity and class. The first assumption is tested with the Levene's test for equal variance. If the *F* is not significant then the assumption that the variances of two groups are equal is not violated and the equal variables assumed line can be read. Effect sizes again are estimated to determine the size of the difference. If the *t* score is not statistically significant then it can be assumed that there is a difference between ethnicity and class as far as students' perceptions of the learning environment.

The third question is an association question and shows a correlation between each of the four variables. The third question is: Are there associations between the learning environment and students' attitudes toward science? Pearson product moment correlations were computed to examine correlations between the variables. And the fourth question is: Are there interactions between the ethnic group and the socioeconomic class?

This question was analyzed using a factorial analysis of variance (ANOVA) comparing groups based on two individual variances (two different individual variables with a between subjects design). The general linear model (GLM) programs provide a measure of effect size, means and plots the interactions, tests of between subjects effects and the interaction of the *F* (class and ethnicity) to see if it is statistically significant $F(1.7) = .337$, $p = .563$). The Statistical Package for the Social Sciences (SPSS) version 16 was used to perform the statistical analysis for this study (Morgan, Leech, Gloeckner, & Barrett, 2007).

Phase Two – Qualitative

Once the survey was completed, qualitative data was collected from students through observations and science notebooks to explore questions raised from the results of the quantitative surveys. The following questions guided the development of phase two of the study and were used to develop and refine the scientific notebook and observation protocol:

> How do educational experiences, in terms of investigation, cooperation, equity, and enjoyment of science that happen in field based environments compare to experiences in traditional classroom environments?

Theoretical propositions about causal relations, answers to "how and "why" questions, were useful in guiding phase two of the study. As results were analyzed from phase one of the study, more specific questions emerged.

Qualitative research questions:

Question One: How was learning at the Poudre Learning Center different than learning science in your school classroom? After coding this question the next two questions were developed.

Question Two: Did you enjoy learning science at the Poudre learning center? Yes or no. Give three reasons.

Question Three: What did you learn about the environment that you live in while learning science at the Poudre learning center? When the results from question one were initially coded new questions arose so a second school was added. Question two and three were then given to the original school (Winona) and the school that was added (Camaro). Winona participated in field experience five times and Camaro participated in field experience once.

At this point, the fourth question developed was: Were there differences in responses for students that attended field experience five times with students that attended field experience once?

Research Reliability and Validity

Phase One – Quantitative

Two basic questions pertaining to collected data must be answered to establish validity and reliability of the study (Tashakkori & Teddlie 1998). The first of these is "Am I truly measuring what I intend to measure?" (validity) and the other one is "Is my measurement without error?" (reliability). Overall research validity of the study consists of measurement reliability, internal validity, measurement validity of the constructs, and external validity (Morgan et al. 2007). Figure 4 shows the overall research validity of the study. It is important to distinguish between the merits of the study as a whole as opposed to the equality of the measurement of each separate variable.

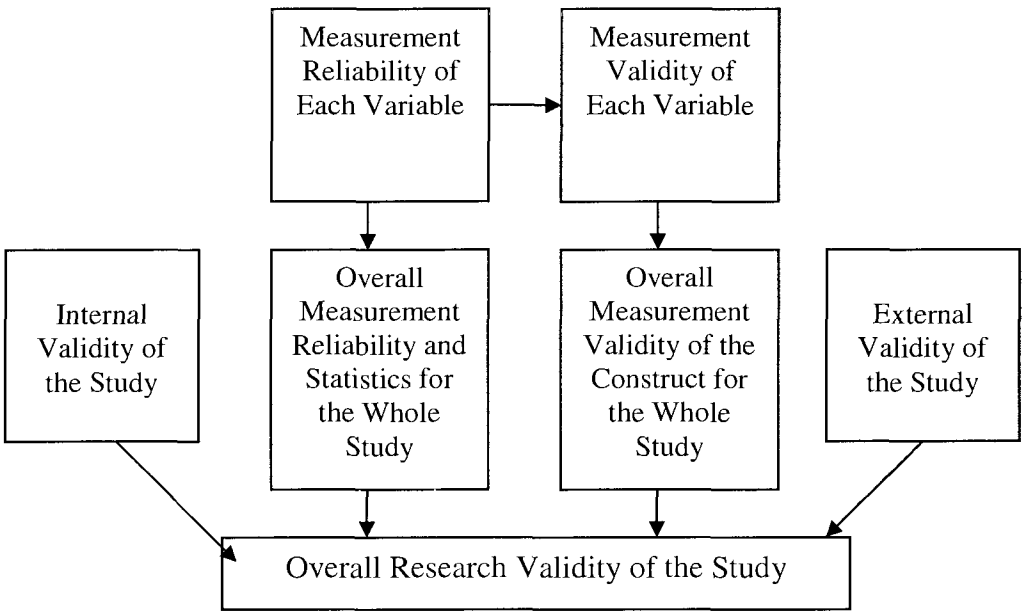

Figure 4. Overall Research Validity of the Study

The WIHIC test has been found to have high internal consistency across all content area and grade levels (Cronbach's alpha range between .88 and .93) and is scalable across years (Fraser, 1987). The TOSRA test has been found to have high internal consistency across all content area and grade levels 2008, Zaragoza & Fraser, found satisfactory factorial validity in a study with fifth graders in a field study learning environment and traditional classroom. The internal consistency reliability ranged from .80 to .89 for the same three scales of the WIHIC and the internal consistency reliability for the enjoyment of science scale from the TOSRA ranged from .88 to .92. The Cronbach alpha coefficient was used as the index of internal consistency and was estimated from a student sample of 765 fifth grade students. The mean correlation of one WIHIC scale with two other WIHIC scales varied

between .67 and .70 for the home school science class and .50 to .58 for the field study class (Zaragoza & Fraser, 2008).

Trustworthiness Criteria

Phase Two – Qualitative

Tashakkori & Teddlie (1998) discuss the lack of consensus when it comes to qualitative reliability and validity. "Trustworthiness" is the global concept introduced by Lincoln and Guba (1985) as a substitute for many of the measurement quality issues. They introduced four criteria: creditability, transferability, dependability, and confirmability. Credibility was established by: 1) prolonged engagement, 2) persistent observation, 3) use of triangulation techniques, 4) peer debriefing, 5) negative case analysis referential adequacy, and 7) member checks. Transferability was established by 8) thick description. Dependability was checked by a 9) dependability audit, and confirmability is checked by 10) confirm ability audit, and 11) reflexive journaling.

In data analyses procedures and data collection procedures, mixed methods present certain problems. Table 5 shows the issues and recommendations for minimizing potential threats to the validity of sequential designs in mixed methods research.

Table 5. Potential Threats to the Validity of Sequential Designs in Mixed Methods Research (Creswell & Plano Clark, 2003).

Sequential Explanatory Design	Minimizing the Threat
Data collection issues 1. Selecting the same or different individuals for the qualitative and quantitative data collection 2. Not choosing participants for the follow-up who help explain significant results 3. Not designing an instrument with sound validity and reliability.	1. Select the same individuals for an explanatory design 2. Choose same individuals for the qualitative follow-up and the quantitative in the first phase 3. Use rigorous procedures for developing and validating the new instrument
Data analysis issues 1. Choosing weak quantitative results follow up on qualitatively 2. Not addressing validity issues	1. Choose significant results or strong predictors to follow-up on 2. Use major themes as the basis for the qualitative follow-up 3. Address both quantitative and qualitative validity

By following the above protocol for minimizing threats to the validity and reliability in data collection and analysis, this mixed method research study maintained as high a level of confidence as possible.

Template analysis was used to analyze the qualitative results. Quality checks of template analysis are 1) independent scrutiny of analysis, 2) creating an audit trail, 3) respondent feedback (the teachers) and 4) reflexivity (a graduate student). Independent scrutiny is using members of the research team, an outside "expert" selected on the basis of knowledge of the methodology or defending your analytical decisions to an expert panel. The second quality check is creating an audit trail which involves documentary records of the stops you undertook and the decision you made to in going from the raw transcripts to your final interpretation of the data. The third quality check is respondent feedback a strategy for

evaluation the quality of the analysis by asking those who participated in the research to comment critically on the analysis. The combination of these three techniques for assuring quality all contribute to reflexivity which is the need to reflect on the nature of your involvement in the process and how that has shaped the outcome. One of the strengths of template analysis is to encourage the researcher to be more explicit about the analytical decisions you make, and to ground them in the tests you are analyzing and facilitating reflexivity (King, 1998).

In addition, it is important to recognize the role of culture in evaluation. The following advice is given by Lee (2007): "1) Set aside time and resources to deliberately learn about the cultures of the stakeholders, 2) Focus on the social identity and group member shop dimension, 3) Expand and deepen their knowledge about the dynamics of privilege and power is evaluation, and finally 4) Be intentional about your reporting to ensure cultural competency at every stage of the evaluation."

CHAPTER IV: RESULTS

A mixed method sequential explanatory design was used so that the quantitative data collected could be further explained by the qualitative data in phase two. Data were collected throughout the 2008-2009 school year. For phase one, the quantitative part of the study, a pilot-test was designed to establish the appropriateness of the instrument language, level of student comprehension and an appropriate number of concepts to measure. In phase two, another pilot-test was conducted to determine the validity of the way the short constructed response questions were asked. In both cases, small changes were made to the assessment tools to improve data collection.

Phase One – Quantitative

The two research tools used to collect quantitative data were the What is Happening in this Classroom (WIHIC) and the Test of Science Related Attitudes (TOSRA) survey. A modified version of the WIHIC was used because it is better suited to fifth grade students and the objectives of this study. The four constructs surveyed were investigation, cooperation, equity, and enjoyment of science. Investigation is described as the use of inquiry in instruction. An example of the type of question used to measure this construct is: "I find out answers to questions by doing investigations?" Cooperation can be described as the extent to which students cooperate rather than compete with one another on learning tasks. A sample item is: "I learn from other students in this class?" Equity is the extent to which students are treated equally by the teacher. A sample item is:

"I get the same opportunity to answer questions as other students?" The second survey tool was a modified version of the TOSRA that used seven questions from the enjoyment of science scale. A sample item from the enjoyment of science scale is: "I really enjoy going to science lessons" (Table 6). See appendix A for a copy of the instrument.

Table 6. The Scale, Construct and Sample Questions from WIHIC and TOSRA.

Instrument	Construct	Sample Question from each Construct
WIHIC	Investigation	I find out answers to questions by doing investigations.
WIHIC	Cooperation	I learn from other students in this class.
WIHIC	Equity	I get the same opportunity to answer questions as other students.
TOSRA	Enjoyment of science	I really enjoy going to science lessons.

WIHIC is a five point likert scale. One – I almost never feel this way in class, two – I seldom feel this way in class, three – I sometimes feel this way in class, four – I often feel this way in class, and five – I almost always feel this way in class. Students were asked to identify how they feel today regarding 24 questions. In the TOSRA, students were asked what they thought of seven statements using a similar five point scale. Students responded: one (SD) – if you strongly disagree with this statement, two (D) – if you disagree with this statement, three (N) – if you are not sure, four (A) – if you agree with this statement, and five (SA) – if you strongly agree with this statement (see Appendix 8 for a complete copy of this instrument).

Description of the Sample

The study took place in a school district located in Northeastern Colorado. The district serves 18,500 students, kindergarten through 12th grades, at 35 schools. The ethnicity of this school district is 52.31 % Hispanic, 44.66% white, 1.07 % Asian, 1.24% African American, and .71% Native American. Of the total number of students in the school district, 52.36% are eligible for free and reduced lunch under federal poverty guidelines. The school

chosen for this study was selected for two reasons. First, the demographics of the school, especially ethnicity and socioeconomic class, are representative of the ethnicity and class of the school district as a whole. Second, a school district policy requires that students score a certain level on Colorado State Assessment Placement-test to participate in a science class. Those scoring below the minimum score take reading courses to improve their reading level. This school does, however, incorporate science into the curriculum so that all students get science as well as additional reading if needed.

The elementary school has 298 students, of which 61 students are in the fifth grade. Of the 61 students, 27 are Hispanic and 33 are white. The school is 49.39% percent Hispanic, which is very close to the school district average. There are two classes of fifth graders at this school are both taught science by the same teacher, thus allowing for a consistent variable for study purposes. This is the only school that was used for the quantitative data collection.

Learning Environments in Science

The first research question asked: Are there differences between the traditional public school science class and the field study class in terms of: (a) learning environment and (b) attitudes toward science? In this study, data show that both the classroom and the outdoor field experience, as far as the four constructs of investigation, cooperation, equity, and enjoyment of science, are enjoyed by students.

The question sought to compare students' rankings of two different learning environments (class and field) for four constructs: investigation, cooperation, equity, and enjoyment of science, and was statistically analyzed using a paired samples *t*- test. The student ranking of investigation had a mean score of $M = 3.78$ for field and $M = 4.02$ for class; the difference of the means was statistically significant ($p < .005$). The effect size was

medium (d = .462) according to Cohen (1988) and showed that students prefer the classroom for investigation. The second comparison included field cooperation and cooperation in the classroom. The mean difference between cooperation in the field (M = 4.3) and cooperation in the classroom (M = 4.4) was not statistically significant. The third correlated t- test had a mean of (M = 4.07) for field equity and (M = 4.035) for class equity and was not statistically significant. The final pair compared the enjoyment of science in the field (M = 3.07) with the enjoyment of science in the classroom (M = 2.97). The effect size was small (d = .312; $p <$ .05) according to Cohen (1988). The within subjects design shows a preference for students' enjoyment of science in the field (Table 7).

Table 7. The Difference between the Traditional Science Class and the Field Study Class for Learning Environment and Attitude Toward Science.

Constructs	*M*	*SD*	*p*	*d*
Pair One			0.005	0.462
Field Investigation	3.780	5.250		
Class Investigation	4.020	0.540		
Pair Two			0.111	0.206
Field Cooperation	4.300	0.570		
Class Cooperation	4.400	0.510		
Pair Three			0.795	0.036
Field Equity	4.070	1.090		
Class Equity	4.035	0.910		
Pair Four			0.035	0.312
Field Enjoy Science	3.070	0.300		
Class Enjoy Science	2.970	0.340		

Ethnicity and Socioeconomic Class

The second research question asked: In terms of learning environment and attitudes toward science, are the field study class and traditional public school science class differentially effective for (a) students from a high or low socioeconomic class and (b) Hispanic students and other students? For this question number, the data was disaggregated by socioeconomic class and ethnicity. Table 4.2 shows the results of the statistical analyses using an independent samples *t*- test for between group designs. For each of the four constructs, the results of the students' perceptions were analyzed separately for Hispanic and white students. Although not a statistically significant difference ($p = .171$), Hispanic students preferred the field ($M = 3.9$) to white students ($M = 3.7$). The effect size was small to medium ($d = .411$) according to Cohen (1988). Cooperation was not statistically significant ($p = .831$), but it does suggest that cooperation in the class was preferred by white students ($t = -0.87$; $d = -0.277$), which was a small effect size (Cohen, 1988). Student perceptions of equity in the field and in the classroom was not statistically significant, but Hispanic students perceive the field environment to have more equity ($d = 0.34$), which is a small to medium effect size (Cohen, 1988). Enjoyment of science in the field and enjoyment of science in the classroom was not statistically significant ($p = 0.199$ and $p = 0.42$), and both had small effect sizes. White students preference for the field environment had a medium effect size ($d = -.383$) and the effect size for white students' enjoyment of science in the classroom was small ($d = -0.239$) (Table 8).

Table 8. Comparison of Hispanic Students and White Students in Field and Class Environment for Four Constructs (N = 60).

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Field Investigation			1.30	45	0.171	0.411
Hispanic	3.90	0.50				
White	3.70	0.52				
Class Investigation			-0.548	45	0.586	-0.161
Hispanic	3.93	0.67				
White	4.02	0.48				
Field Cooperation			-0.215	45	0.831	-0.063
Hispanic	4.29	0.67				
White	4.32	0.49				
Class Cooperation			**-0.87	28.37	0.392	-0.277
Hispanic	4.31	0.65				
White	4.45	0.38				
Field Equity			1.17	46	0.249	0.340
Hispanic	4.30	1.49				
White	3.92	0.64				
Class Equity			**-0.45	46	0.652	-0.132
Hispanic	3.95	1.05				
White	4.07	0.80				
Field Enjoyment of Science			-1.30	45	0.199	-0.384
Hispanic	3.01	0.27				
White	3.12	0.32				
Class Enjoyment of Science			-0.82	46	0.420	-0.239
Hispanic	2.97	0.26				
White	3.03	0.29				

**Adjusted for Levene's variance

Part two of question two used the same four constructs, and the data were disaggregated by socioeconomic class, as self-identified by students that qualified for free or reduced lunch. There was no statistically significant difference for students that do not qualify for free or reduced lunch for investigation in the field or in the classroom, but students that are classified as low income prefer investigation in the classroom with a

small to medium effect size (d = -0.373) according to Cohen (1988). For students' perceptions of cooperation in the field versus cooperation in the classroom, t (60) = -2.02, p = .049, d = .618, and there was a medium effect size (Cohen, 1988). More students who are low socioeconomic class ranked cooperation higher in the field than students that do not qualify. And, the difference between students' perceptions of cooperation in the classroom when comparing those that qualify to those that do not qualify for lunch rank was not statistically significant, but the effect size is small to medium for students that qualify (d = .416) (Cohen, 1988). Regarding equity in the field, the differences between students of low socioeconomic class and others was not statistically significant (p = .18), but there is a small to medium effect size (d = .408) for low income students and a small effect size (d = .20) for free and reduced lunch students' perception of equity in the classroom (according to Cohen , 1988). The fourth and last comparison was the enjoyment of science in the field and classroom for low socioeconomic class students and again, although the difference was not statistically significant (p = .285 and p = .825 respectively), there was a medium effect size indicating that students that do not qualify for free lunch enjoy field science although the means differ by only one tenth of a point (M = 3.1, M = 3.0) (Table 9).

Table 9. Comparison of Students that do not Qualify for Free or Reduced Hot Lunch with Students that do Qualify in Field and Class Environment for Four Constructs (N = 60).

Variable	*M*	*SD*	*T*	*df*	*p*	*d*
Field Investigation			-0.22	46	0.828	0.067
No Free lunch	3.76	0.53				
Free/reduced lunch	3.80	0.52				
Class Investigation			1.21	46	0.230	-0.373
No Free lunch	4.07	0.53				
Free/reduced lunch	3.86	0.64				
Field Cooperation			-2.02	46	0.049	0.618
No Free lunch	4.18	0.61				
Free/reduced lunch	4.52	0.42				
Class Cooperation			-1.36	46	0.181	0.416
No Free lunch	4.33	0.49				
Free/reduced lunch	4.55	0.54				
Field Equity			-1.36	47	0.180	0.408
No Free lunch	3.91	0.73				
Free/reduced lunch	4.36	1.55				
Class Equity			-0.66	47	0.510	0.199
No Free lunch	3.97	0.99				
Free/reduced lunch	4.15	0.74				
Field Enjoy of Science			1.08	46	0.285	-0.331
No Free lunch	3.10	0.28				
Free/reduced lunch	3.00	0.33				
Class Enjoy of Science			0.22	47	0.825	-0.067
No Free lunch	2.99	0.34				
Free/reduced lunch	2.96	0.33				

Obviously, differences in students' perceptions of learning environment and enjoyment of science are difficult to show, as students are on different levels of assimilation into the mainstream culture. Data analyses are also limited because many of the students that did not return parent consent forms to participate in the study are from low-socioeconomic classes. Students in this situation are in need of a system that

provides more support for family involvement and awareness of school projects and their value.

Correlations between the Four Constructs – Investigation, Cooperation, Equity, and Enjoyment of Science

The third research question asked: Are there associations between the learning environment and students' attitudes toward science in terms of the four constructs: cooperation, investigation, equity, and enjoyment of science? Pearson correlations were computed to examine correlations between the variables (Table 10). Results showed that there were statistically significant correlations between many of the four constructs in the field and in the classroom. Significant correlations were found for the association between cooperation in the field and investigation in the field ($r = .650$, $p < .001$); field equity and field investigation and field cooperation($r = .363$ and $r = 477$ respectively; $p < .001$); class investigation and field investigation and field equity($r = .405$ and $r = .370$,respectively; $p < .001$), and class cooperation with field cooperation, field equity, and class investigation($r = .614$, $r = .358$, $r = .435$, respectively; $p = < .001$. Additionally, class equity was statistically correlated with field cooperation, field equity, class investigation, and class cooperation ($r = .481$, $r = .530$, $r = .415$, $r = .590$, $p < .001$) respectively. Correlations between cooperation, investigation, equity, and enjoyment have small effect sizes but one may conclude that an environment values students would show correlations between cooperation and enjoyment as well as the other constructs.

Table 10. Correlations, Means, and Standard Deviations for the Four Constructs (N = 60).

Variable	1	2	3	4	5	6	7	8	*M*	*SD*
1. Field Investigation	1	.650**	.363**	.405**	0.287	0.25	0.199	0.236	*3.77*	*0.53*
		0	0.013	0.005	0.053	0.093	0.184	0.115		
2. Field Cooperation	**.650****	1	.477**	0.226	.614**	.481**	0.067	0.077	*4.28*	*0.58*
	0		0.001	0.131	0	0.001	0.656	0.61		
3. Field Equity	**.363****	**.477****	1	.370*	.358*	.530**	-0.047	0.005	*4.11*	*1.1*
	0.013	**0.001**		0.011	0.014	0	0.756	0.973		
4. Class Investigation	**.405****	**0.226**	**.370****	1	.435**	.415**	0.06	0.029	*4.02*	*0.55*
	0.005	**0.131**	**0.011**		0.003	0.004	0.692	0.85		
5. Class Cooperation	**0.287**	**.614****	**.358***	**.435****	1	.590**	-0.036	-0.173	*4.4*	*0.52*
	0.053	**0**	**0.014**	**0.003**		0	0.814	0.25		
6. Class Equity	**0.25**	**.481****	**.530****	**.415****	**.590****	1	0.005	-0.077	*4.06*	*0.91*
	0.093	**0.001**	**0**	**0.004**	**0**		0.976	0.611		
7. Field Enjoy Science	**0.199**	**0.067**	**-0.05**	**0.06**	**-0.04**	**0.005**	1	.504**	*3.08*	*0.31*
	0.184	**0.656**	**0.756**	**0.692**	**0.814**	**0.976**		0		
8. Class Enjoy Science	**0.236**	**0.077**	**0.005**	**0.029**	**-0.173**	**-0.077**	**.504****	1	*3*	*0.34*
	0.115	**0.61**	**0.973**	**0.85**	**0.25**	**0.611**	**0**			

* $p = < .05$, ** $p = < .001$

Interactions between Ethnicity and Class

The fourth research question asked: Are there interactions between ethnic group and socioeconomic class? A factorial ANOVA based was used based on two individual variables (ethnicity and class) with a between groups design. The means and standard deviations for enjoyment of science for class and ethnicity in table 11 shows there was not a significant interaction between field enjoyment of science ($p = .563$). The interaction between ethnicity and class using the general linear model (GLM) programs provides a measure of effect size, means, and interaction F (Class * Ethnicity) $F(1, 7) = .337$, $p = .563$ (Table 12).

Table 11. Interaction Between Ethnicity and Class on TOSRA in Field and Class.

TOSRA – Enjoyment Field								
	No free lunch			Free or reduced lunch			Total	
Ethnicity	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Hispanic	10	3.0	.286	10	3.03	.271	3.015	.272
White	21	3.17	.26	6	2.966	.450	3.129	.316
Total	32	3.106	.283	16	3.006	.3356	3.073	.302
TOSRA – Enjoyment Class								
	No free lunch			Free or reduced lunch			Total	
Ethnicity	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Hispanic	10	2.89	.277	11	3.045	.225	2.97	.257
White	21	3.100	.184	6	2.82	.466	3.04	.287
Total	32	2.99	.343	17	2.96	.335	2.97	.337

Table 12. Sum of the Means for Interaction of Ethnicity and Class on TOSRA Class and Field.

TOSRA - Enjoyment Class				
Variable and source	*df*	*MS*	*F*	*ń2*
Ethnicity	2	.939	13.93 *	.388
Class	1	.040	.599	.013
Ethnicity * class	1	.475	7.05 *	.138

TOSRA - Enjoyment field				
Variable and source	*df*	*MS*	*F*	*ń2*
Ethnicity	2	.091	1.030	.046
Class	1	.078	.882	.020
Ethnicity * class	1	.138	1.570	.035

* $p < .001$

Summary

The quantitative results from phase one led to few statistically significant results but helped with further exploration in phase two. A statistically significant outcome does not give information about the strength or size of the outcome. Effect size is defined as the strength of the relationship between the independent variable and the dependent variable (Morgan, Leech, Gloeckner, and Barrett, 2007) learning environment and enjoyment of science. There were some small to medium effects that showed that students' rankings of investigation were higher in the classroom and students' ranking of enjoyment of science were higher in the field. Hispanic students ranked investigation and equity higher in the field, and students from a low socioeconomic background ranked investigation and equity higher in the classroom. Hispanic students also ranked cooperation in the field higher than in the classroom learning environment. Again, although these responses were not all statistically significant and sometimes the

difference was in the opposite direction than hypothesized, it lead the researcher to questions the differences that exist between these learning environments and why?

Phase Two – Qualitative

The second phase of this study involved the collection and interpretation of qualitative data using an approach referred to as "template analysis." Template analysis provided a guide to analyze the qualitative responses from three short constructed responses (SCR) of 120 students from two classes and two schools that participated in the field study in science.

Template Analysis

The template analysis approach involves making judgments about particular themes and includes deductive and inductive coding. The initial template consisted of the four constructs from the survey tools used on phase one of the study (Figure 5).

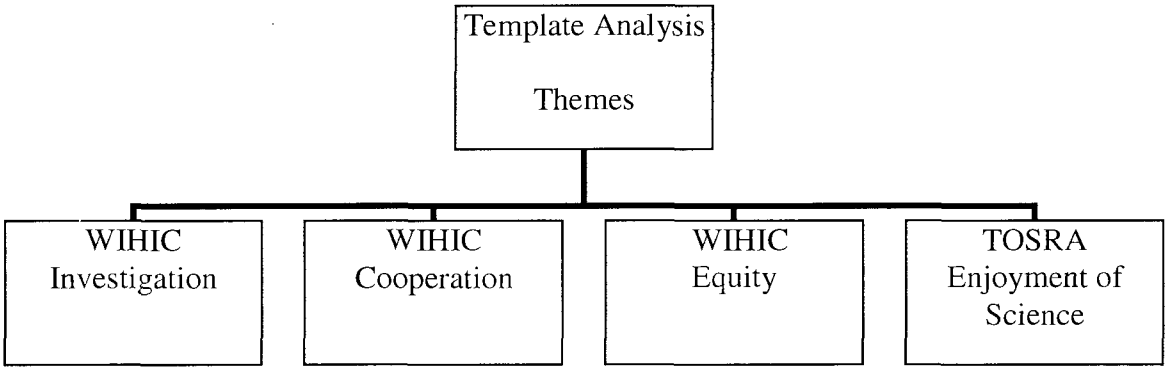

Figure 5. Initial Template.

After coding students' responses to an exploratory question developed from the quantitative data collection, the initial template was expanded to include three themes that emerged: activity or engagement, skills, and sense of place. This modified template was

then used to code the short constructed responses to questions regarding their enjoyment of science and awareness of environment (Figure 6).

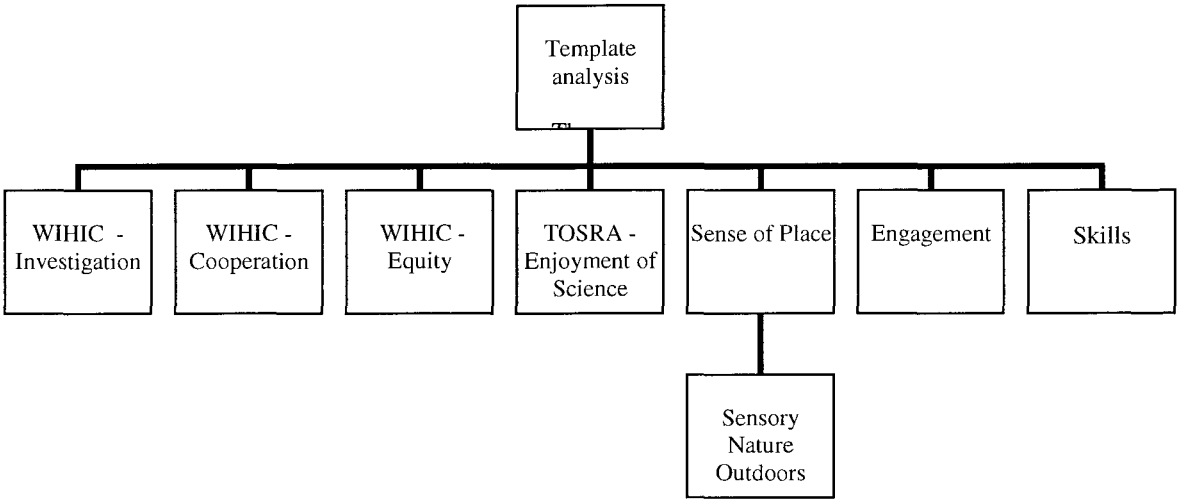

Figure 6. Modified Template

To triangulate the data and provide another source of information, the four constructs from the initial template were used to develop a classroom observation form and both school and outdoor classrooms were observed at two schools. The results from the classroom observations provided further validation of the results of this study and showed that students were more engaged in learning outdoors and because of the engagement, they developed a sense of place or awareness of the community that they live in.

Description of the Sample

The same school used for the quantitative data collection was also used for the second phase, qualitative data collection. Additionally, some differences began to arise that warranted further investigation and the addition of a second sample school. The original

school in the study attended the outdoor learning center five times and the activities were embedded in their science curriculum, in this case supplemented with Foss kits. A second school was added to compare frequency of visits. The second school also used Foss kits for their science curriculum, but only attended the outdoor learning center one time in the spring. This allowed for a comparison of responses from students from two different schools. The second school demographics included 425 students, from Kindergarten through six grades. Of the fifth grade students, 83.4% qualified for free or reduced lunch in 2004 - 2005, 79.2% in 2005 – 2006, and 85.6% in 2006 - 2007. Compared with the first school, 49.7%, 48.7%, and 48% of the students qualified for free or reduced lunch in the same years.

Comparison of Learning Environments - Question One

After collecting and analyzing the data from the survey tools described in phase one of this study, the first question that emerged asked students to describe in their own words the difference between the two learning environments. This question was also designed to tease out additional themes for further qualitative data collection. The question: "How was learning at the Poudre Learning Center different than learning science in your school classroom – give three reasons", was given to two classes. Both classes had the same teacher and participated in the field experience that was embedded in the curriculum five times throughout the school year.

Template analysis was used to analyze the responses from the students. The template consisted of the four constructs from the survey tools used in phase one of the study: cooperation, investigation, equity, and enjoyment of science. All four were used to code the responses from the questions using NVivo, version 8.

Enjoyment of Science - Question Two

The responses from question one led to the need to further explain the differences between the two learning environments. The question that arose was: "Did you enjoy learning science at the Poudre learning center? Yes or no. Give three reasons." Although there were a few no answers to this question, possibly due to tired, cold, or hot students, most enjoyed the field experience at the outdoor learning center. Their responses were again coded using template analysis and deductive coding. Three other themes emerged: sense of place, activity or engagement, and skills. These themes were developed inductively and used along with the four constructs to code the responses from the two schools (Table 5). The number of references was obtained from manually coding phrases from student responses. More than one phrase per question may have been coded in more than one theme so it is not matched to each individual student. Number of references was used for comparison in this study but percent coverage, the percentage of a source that is coded at a node, was also created by the software and listed in some tables as an additional reference (http://www.qsrinternational.com retrieved on August 1, 2009) (Table 13).

Table 13. Number of References from Two Schools for Question Two – Enjoyment of Science.

Themes	School	References	Percent Coverage
Deductive Codes – Initial Template			
Investigation	Cam 1	1	1.62
	Wino 1	17	18.87
	Wino 2	3	0.71
Cooperation	Cam 1	1	2.36
	Cam 2	3	4.54
	Wino 1	1	.87
	Wino 2	10	11.54
Equity	Cam 2	1	
	Wino 2	1	
Enjoyment	**Cam 1**	**42**	**40.58**
	Cam 2	**42**	**53.98**
	Wino 1	**50**	**69.98**
	Wino 2	**43**	**60.89**
Inductive Codes – Revised Template			
Activity	Cam 1	2	1.60
	Cam 2	5	6.13
	Wino 1	8	9.08
	Wino 2	8	6.51
Sense of Place			
- Outside	Cam 1	8	7.40
	Cam 2	10	12.78
	Wino 1	**22**	**25.60**
	Wino 2	12	14.68
- Sensory	Cam 1	3	1.82
	Cam 2	9	10.02
	Wino 1	22	20.53
	Wino 2	6	8.55
- Nature	**Cam 1**	**35**	**31.09**
	Cam 2	**33**	**40.54**
	Wino 1	14	19.02
	Wino 2	12	14.52
Skills	Cam 1	10	9.62
	Cam 2	15	16.46
	Wino 1	11	15.97
	Wino 2	9	11.70

Sense of Place – Question Three

The third question was: "What did you learn about the environment that you live in while learning science at the Poudre Learning Center?" This question was developed to explain the large number of student references in question two to the outdoor environment. Inductive and deductive coding of the responses about enjoyment of science in the field revealed comments regarding the sense of community or understanding of the community around them that they find when they are learning outdoors. Responses were again coded using NVivo and the initial and modified template and the theme sense of place was further divided into three additional themes: nature, environment, and sensory (Table 14).

Table 14. Number of References from Two Schools for Question Three – Sense of Place.

Themes	School	References	Percent Coverage
Deductive Codes – Initial template			
Investigation	Cam 2	1	3.55
	Wino 1	1	1.47
Cooperation	Wino 1	1	0.69
Equity	None		
Enjoyment	Cam 2	4	3.66
	Wino 1	2	1.20
	Wino 2	3	3.03
Inductive Codes – Revised Template			
Sense of Place			
- Outside	Cam 2	3	4.60
	Wino 2	1	0.85
- Sensory	Cam 1	4	6.10
	Cam 2	3	7.14
	Wino 1	6	8.22
	Wino 2	5	3.07
- Nature	**Cam 1**	**35**	**65.73**
	Cam 2	**33**	**58.29**
	Wino 1	**24**	**26.73**
	Wino 2	**40**	**39.88**
Skills	Cam 1	13	18.48
	Cam 2	13	17.84
	Wino 1	**25**	**33.57**
	Wino 2	**24**	**23.79**

Once the NVivo results were analyzed, individual quotes were studied to explain what was happening and if there were any additional patterns that emerged.

Investigation

The construct investigation was referenced 21 times by three classes – two from Winona and one from Camaro. Seventeen of these references and 18.87 % coverage were from Winona one - question two and include some of the following quotes:

"You get to physically do the experiment"	Wino1
"The PLC is the best place to do science experiments in the outdoor, you will be able to understand it a little better"	Wino1
And, "I always have a good time getting to the experiments up close"	Wino 1
"When we are the PLC you get to learn how things, work, grow or run"	Wino 1
"We experiment on the real thing we are learning about"	Wino 1

Cooperation

The second construct was cooperation. Four classes made a total of 15 references and Winona two had 10 references with 11.54 % coverage. Some of the quotes from these students were:

"I had a wonderful time because I get to be with my friends"	Cam 1
"We got to use teamwork"	Cam 2
"I get to learn about the outdoors and enjoy nature with other people"	Wino 1
"You get to be in groups to make it a lot more fun"	Wino 2
"I get to be with the whole fifth grade"	Wino 2
"...and we work in bigger groups"	Wino 2
"You get to have the experience with your girlfriends"	Wino 2

Equity

The third construct was equity. This question was not addressed by the short constructed responses but appeared later in the classroom observations. One of the

observations was: "all of the people at the Poudre learning center are very respectful to us and were patient with all of the students."

Enjoyment of Science

The fourth construct from the initial template is enjoyment of science and this one had the highest number of responses. All four classes responded to this question with references that included the words liked, loved, enjoyed, and it was fun. There were 84 references from Camaro and 93 references from Winona.

"It was fun and messy"	Cam 1
" Yes, because I was able to do and see things I never thought I would see or do"	Cam 1
"I liked it because it was outside and we actually got to do it"	Cam 2
" It is fun to actually see the real things we are lerning about"	Wino 1
"I always have a good time getting to do the experiments up close and I like looking at different kinds of things"	Wino 1
"I enjoy learning at the Poudre because it gives me a real life demonstration of whatever I may be learning about natural environments"	Wino 1
"We get to get down and dirty with our hands with dirt and other things"	Wino 1
" I like it because I got to eat a bug"	Wino 2

The next three themes added were activity, sense of place and skill attainment. For activity or engagement, there were 23 activity responses – 16 from Winona and seven from Camaro. The students from Camaro students take a bus and Winona students walk to the field experience. Both schools do a lot of walking during the day once they get there.

"When we were walking we see a lot"	Cam 2
"I enjoy learning because I get more exercise in an environment where I walk and run in one which I sit most of the day"	Wino 1

"It's better than sitting down for three hours" Wino 2

Sense of place was divided into nature, senses, and environment. The first and most prevalent response was related to components of the natural environment: nature. All four classes had multiple responses to the things that they had experienced in their natural environment. Eighty-four responses were coded - 68 from Camaro and 26 from Winona. They saw insects; different types of soil, wildlife; rivers, lakes, and ponds, dirty and clean water; habitats; landforms; hawks and nests; edible plants; the mark or print of an animal; grasses, different kinds of soil, rocks, pebbles, sand; and mud and dirt; and "how the Poudre River was made."

The students made numerous comments about experiencing nature with their senses. Forty responses involved seeing, hearing, touching, and feeling.

Sensory experience:

"I learn more out there because I can see what I'm learning about" Wino 1
We touched a lot of stuff, like how the soil feels" Cam 2
"You see wat it realy look like not like the 1892 picers" Wino 1
"That you can make a getter grade at gest looking at it live" Wino 1
"Also, you can see the actual thing instead of fake models" Wino 2

Students most enjoyed being in a natural environment and mentioned this most often (44 responses were made about the outdoor environment).

"You get to learn science in an outdoor environment PLC give more room to work" Wino 1
"You are not in the in a hot classroom but by the trees, grass and wildlife" Wino 1
"Instead of being crowded in the room you learn outside" Wino 2
"You can have an adventure and get to explore science in a new way instead of being in the classroom" Wino 2

"Outside, the environment, it is nice not to be school for 8 hours" Cam 1

Because they not only get to touch and see what they are learning about and work in an outdoor environment, but they also learn outdoor skills; therefore, the last category is skills. Thirty-six students' responses referred to skills, application of concepts learned in the classroom, and an increased sense of environmental awareness.

"Poot what you take and poot it back" Cam 1
"...use a compass" Cam 2
"...lerned what was safe and unsafe" Cam 1
"..:how to protect the environment" Cam 1
"How to survive in the wild" Cam 2
"What to do when a wild animal approaches" Cam 2
"How to tell if the water is clean in a river or a lake" Cam 2
"Learned many things that would take all day to list but only take a second to do" Wino 1
"That we can all help this world. We can help recycling or even picking up trash on a Saturday. We can tune into the news and learn about the problems earth faces and FIX IT. I also learned that we help reproduce plants so the earths natural beauty can restored every year. We can keep the earth beautiful by simply walking through and enjoying nature. We should treat bugs, animals and plants equally to use" Wino 1

To conclude with one student's response that seemed extremely meaningful:

"And another thing I suggest is that all grades can go on the trip so they can learn and feel good about themselves" Wino 1

A few students did not enjoy the PLC. The following comments were made: "we had to walk everywhere," "it was boring and really hot outside," "we had to write down notes and had to keep stopping," and "I never have room for anything in my backpack."

A Comparison of Two Schools - Fourth Question

Were there differences between a school that had one field experience and a school that participated in field experience five times? A comparison of the responses of students from two schools' responses found that they both experienced sense of place and had responses regarding the components of nature. The school that made five visits made more responses (26 versus 49) about skills that they learned at the field experience (Table 15.

Table 15. Number of References Comparing Two Schools – Camaro and Winona.

Themes	School	References	Percent Coverage
Camaro			
Deductive Codes – Initial Template			
Investigation	Cam 2	1	3.55
Enjoyment	Cam 2	4	3.66
Inductive Codes – Revised Template			
Sense of Place			
- Outside	Cam 2	3	4.60
- Sensory	Cam 1	4	6.10
	Cam 2	3	7.14
- Nature	**Cam 1**	**35**	**65.73**
	Cam 2	**33**	**58.29**
Skills	Cam 1	13	18.48
	Cam 2	13	17.84
Winona			
Deductive Codes – Initial Template			
Investigation	Wino 1	1	1.47
Enjoyment	Wino 1	2	1.20
	Wino 2	3	3.03
Cooperation	Wino 1	1	0.69
Inductive Codes – Revised Template			
Sense of Place			
- Outside	Wino 2	1	0.85
- Sensory	Wino 1	6	8.22
	Wino 2	5	3.07
- Nature	**Wino 1**	**24**	**26.73**
	Wino 2	**40**	**39.88**
Skills	**Wino 1**	**25**	**33.57**
	Wino 2	**24**	**23.79**

Classroom Observations

To further explain the data collection and provide one more source of information, the same four constructs were used to develop a classroom observation form which can be found in the appendix (Appendix F). Both school and outdoor classrooms were observed at the two schools. The results from the classroom observation form supported and provided further validation of the results of this study. The form was divided into three sections: environment, students, and teachers. The first section evaluated how well the teacher provided an environment that included all of the constructs of phase one and phase two of the study, both in the school and outside of the classroom. The second evaluated students' interactions and participation in the class or field. The third section ranked the teacher's ability to treat students equally. The final section of the form included participant observer comments on the four constructs from the quantitative phase of the study. Table 18 summarizes the results from seven classroom and field observations from the two schools that participated in phase one of the study.

Table 18. Summary of Classroom Observations

Teacher	Class	Environment (25)	Students (70)	Teachers (60)	Total (150)
Winona	School	19	67	54	140
Winona	School	23	72	56	151
Winona	School	22	62	53	137
Winona	School/sub	18	52	41	111
Winona	Field	24	70	60	154
Camaro	Field	25	70	49	144
Dos Rios	Field	25	63	49	137

The classroom observation forms served to validate the quantitative and qualitative data gathered. I observed that the students showed a high enjoyment of science in both environments. This could account for their close ranking of cooperation,

investigation and equity in the surveys. Also, differences in class and ethnicity were small to medium in effect sizes and in classroom observations. According to my observations, the teacher clearly made a big difference in classroom environment and enjoyment of science. The teacher in this study did an excellent job of teaching, valuing students, making science enjoyable, and using inquiry in the classroom and outdoors. Second, the field environment was more enjoyable in both schools. And third, the classroom is more structured and provides less opportunity for movement and an active engaged discovery-based science lesson. The following are comments for the four constructs:

Winona - Classroom: (Four Classroom Observations)

Investigation: used jigsaw, asked students questions, students had to solve problems asked "why" questions to further investigate and students gave answers and responded positively to wrong answers and answered more questions after the lesson was done

Cooperation: worked as a team with other tables, all students were on task, had to work out their team organization on their own, students were sharing and working together, class cooperated, very engaged and involved in discussion

Equity: all students were engaged in the lesson, all students were asked questions and had the same wait time, used students responses equally everyone is looking at the teacher, and lots of positive encouragement – nice job, good use of vocabulary

Enjoyment: curious and excited, excited to hear about eating worms, smiling faces, hands raised, gave great examples, and students are laughing

Winona - Field:

Investigation: excellent use of inquiry and questions, predictions and conclusions at each station

Cooperation: great organization and great job of working together

Equity: no signs of gender, racial or class discrimination and all kids treated fairly

Enjoyment: definitely enjoying field day

Camaro - Field:

Investigation: lots of inquiry at each station and observed hypothesis and predictions

Cooperation: all students cooperated in partners, in groups of four, and in groups of 10 – 15

Equity: students ideas were all considered equally

Enjoyment: kids were engaged, laughing, and enjoying themselves and well organized field day with great students

Both schools experience in the field included investigation, cooperation, and equity. You could also tell that students really enjoyed learning science in this environment. These classroom observations, along with memos from each class and field visit, provided more data that were used to further explore the statistical results in phase one.

Summary

The use of a mixed method sequential explanatory design enhanced the understanding of these research questions and was integrated in two places. First, the results of the quantitative data analysis revealed minor differences between students' rankings of learning

environments and in some cases, preferred the classroom. The analysis from the WIHIC and TOSRA led to questions that were further explored with qualitative methods, in this case, students' short constructed responses and classroom observations by the researcher. The second time or place this occurs is at the conclusion of the qualitative data collection and analysis. The results of phase two explain why students enjoy field experience and what they can learn about the environment the live in. The constructs enjoyment and investigation were strong themes again in the qualitative data collection as students report that they learn from experiments and enjoy the Poudre Learning Center. The constructs of cooperation and equity were identified less often in their responses but are present in both the field and classroom observations. The themes that are added in this process of template analysis (sense of place, activity, and skills) tell a story about the experience that students get in the field that cannot be experienced in the classroom. The themes that emerged in phase two are tied to place-based education. Place-based education grounds learning in local phenomena and students' lived experiences. This is culturally relevant teaching without rewriting the curriculum or trying to adapt the curriculum for each individual student's experience.

The teacher that incorporates inquiry into the classroom or the field environment, treats students equally, gives students an opportunity to work together, and teaches science in an enjoyable way can do a good job in the classroom or the outdoor field environment with mainstream and non-mainstream students. What students get from the field experiences are a sense of place, an active learning environment, and the application of knowledge of science concepts to their environment.

CHAPTER V: DISCUSSION

The goal of this study was to explore students' perceptions of the learning environment in science by comparing the traditional science classroom with an outdoor field experience. A mixed methods design was best for this study because questions raised from the results of the quantitative phase were explained by the qualitative data collection and analysis. Sequential explanatory design was used because: (1) it provided an explanation for the results of the quantitative phase of the study better than one method would and (2) questions and themes emerged deductively and inductively as the study progressed. The outcome of using this design produced confounding yet strong results.

Learning Environments

Learning environment research provides us with many useful tools for examining student perceptions of learning environments that can influence student's attitude toward science. The issue of how learning environments impact students goes back to Dewey in 1916, "when cognitive development is appropriately nurtured by the learning environment the growing individual becomes capable of processing information from sensory inputs in fundamental different way from those that were characteristics of earlier stages of development" (embedded in Blocher, 1974, p. 25). The study of learning environments was looked at in phase one and phase two of the study. The results of the WIHIC and TOSRA survey did not provide major evidence for the classroom or field experience in terms of statistical significance, but there were small and medium effect sizes that are worth noting.

Quantitative – Phase One

First of all, according to the WIHIC, students prefer the classroom for investigation. The teacher in this study was very comfortable with the use of inquiry as a teaching strategy in the classroom and in the field. Investigation in the classroom may be preferred by students because students are exposed to the teaching strategy of inquiry throughout the school year in the classroom. Furthermore, the classroom is a more familiar environment for investigation than the field environment.

Second, for the constructs of cooperation and equity, non-statistically significant differences could be explained through the classroom observations. As a participant observer, it was clear to me that the students were treated equally in both learning environments. The teacher believes that all students can and will learn and holds all students to the same standard. She does this in a way that is respectful and valuing of their individual differences. Her teaching strategies involve a lot of collaborative learning, and students who are not accustomed to this teaching style quickly learn and seem to appreciate the cooperative atmosphere. There was no surprise that students ranked both environments high in equity and cooperation.

And last, the fourth pair of constructs compared enjoyment of science in the field with enjoyment of science in the classroom. The teacher, as observed in the field and the classroom, always made science fun and the students enjoyed science in both environments. There was a small effect size indicating that students enjoy science more in the field. This is supported in quotes that mention, ""I liked it because it was outside and we actually got to do it," "It is fun to actually see the real things we are lerning about," and "I always have a good time getting to do the experiments up close."

This study also looked at differences in the class and field learning environment with a correlation matrix of the four variables in question three: investigation, cooperation, equity and enjoyment. Student rankings of their perceptions of the field environment from the WIHIC survey tool were analyzed first. Investigation in the field was highly correlated with student perception of equity and cooperation in the field. The use of investigation or inquiry as a teaching technique incorporates cooperative learning strategies that build cooperation and equity in a class and provide for a more positive teaching environment. Cooperation in the field was correlated with classroom cooperation and equity because students are building relationships in the field and those relationships transfer to the classroom learning environment. And again, field equity was correlated with class equity because due to this teacher, students felt valued in both environments. Classroom and field observations supported these results.

The results from correlation of the same three constructs of the WIHIC for the classroom learning environment were similar. Investigation in the classroom was correlated with cooperation and equity in the classroom. The teacher promoted this equitable and cooperative atmosphere by valuing students and incorporating inquiry and collaborative learning in the classroom. Class cooperation was correlated with field cooperation and field equity. Again, students seem to transfer these constructs easily from one environment to the other. Additionally, class equity is correlated with field cooperation, field equity, class investigation, and class cooperation. I believe the teacher's use of inquiry contributed greatly to these correlations. Inquiry, when understood and implemented done properly, facilitates positive relationships with the students and they get a sense of cooperation and equity in both learning environments.

Finally, enjoyment of science in the field was compared to enjoyment of science in class. Interestingly, they were not correlated to any of the three constructs from the WIHIC, but they were related to each other (Table 17). As observed in classroom and field, the teacher was excellent and because of this, her students enjoyed science – in both the field and classroom. From my observations and the survey data, the teacher has a big influence a student's enjoyment and attitude toward science.

Table 17. Correlation Chart from Largest Correlation to Smallest ($p < .001$).

Variable 1	Variable 2	r	r^2	Effect size*
Field Investigation	Field Cooperation	.650	**.423**	**Medium**
Class Cooperation	Field Cooperation	.614	**.377**	**Medium**
Class Equity	Class Cooperation	.590	**.348**	**Medium**
Class Equity	Field Equity	.530	**.281**	**Small**
Class Enjoyment of Science	Field Enjoyment of Science	.504	**.254**	**Small**
Class Equity	Field Cooperation	.481	.231	Small
Field Equity	Field Cooperation	.477	.228	Small
Class Cooperation	Class Investigation	.435	.189	Small
Class Equity	Class Investigation	.415	.172	Small
Class Investigation	Field investigation	.405	.164	Small
Class Investigation	Field Equity	.370	.137	Small
Field Equity	Field Investigation	.363	.132	Small
Class Cooperation	Field Equity	.358	.128	Small

*According to Cohen (1988).

In conclusion, the largest correlations were between field investigation and field cooperation, field cooperation and class cooperation, and class cooperation and class equity. Two variable correlations that have a small effect size but seem to have very important results for this study are the enjoyment of science in class with enjoyment of science in the field. The three variables that had the smallest correlation were: field enjoyment of science with field equity ($r = - 0.05$) and classroom cooperation ($r = -0.04$), and class enjoyment of science with class cooperation ($r = -.173$) and class equity ($r = -.077$). These variables do not seem to have a relationship as perceived by students in their

rankings. Enjoyment of science in the class and in the field, again, is correlated with each other, but students do not make a connection between those variables and their attitude toward science.

Qualitative – Phase Two

Questions raised regarding students' perceptions of learning environments in phase one were used to develop the data collection in the second phase, or qualitative data collection, in the sequential explanatory design. The qualitative data collection answered questions such as: "If students can learn and enjoy science in both environments then what is the difference between learning in the classroom and the field?" The students wrote short constructed responses to three questions and the students' responses were coded to further explore this issue. In addition, classroom and field observations were conducted. The coded responses and observations produced interesting results.

The first question asked students about the differences in learning environments. Students did not address the constructs of investigation, cooperation, and equity. This could have been the result of the question design. The second question was more specific and asked students if they enjoyed the field and to give the reason why. When these responses were coded with the initial template using constructs from phase one, three additional themes inductively emerged. The new themes were activity, sense of place, and skills.

The first new theme, activity, described their physical engagement in learning. Students talked a lot about the exercise they got and "not sitting in chairs all day." Students seemed to get the connection between physical activity and cognition especially at the age of 10 and 11. This is an important link to consider with fifth-grade students. Students that are actively engaged in the learning environment (Table 19) is the first E of a framework for

inquiry based instruction. The five E's, incorporates five steps: engage, explore, explain, elaborate, and evaluate into a students school lesson. The first theme, activity, is what initially catches students' attention and engages them. Without this step, students do not learn.

Table 19. Total References and Percent Coverage for Question Two

Themes	Total References	Camaro	Winona
Investigation	21	1	20
Cooperation	15	4	11
Equity	2	1	1
Enjoyment	**177**	**84**	**93**
Activity	23	7	16
Sense of Place			
(Total)	**184**	**97**	**88**
- Outside	40	18	34
- Sensory	40	11	28
- Nature	94	68	26
Skills	45	25	20

Sense of place was the second theme that emerged from the student responses There was a total number of 154 references. This code was then divided into three secondary codes. The first code refers to students' references to sensory experiences that they have in the field: "seeing the 'real' thing," "touching the soil," and "getting dirty." The second code of sense of place is about their references to the components of nature that they observed. There were 132 references to birds, trees, water, soil, etc. (Table 21). The third code in sense of place was the many references made to the physical environment in which they were learning. By learning outside, students were seeing and learning about the community in which they live.

Table 21. Total References and Percent Coverage of Question Three

Themes	Total References	Camaro	Winona
Investigation	2	1	1
Cooperation	2	1	1
Enjoyment	9	4	5
Sense of Place			
(Total)	154	78	76
- Outside	4	3	1
- Sensory	18	7	11
- Nature	**132**	**58**	**64**
Skills	**75**	**26**	**49**

After coding sense of place and activity, many references remained that did not fit in the initial template or with the new themes. I found that differences emerged between two schools. The school that participated in field experience five times mentioned the skills and the application of what they learned 49 times compared to 26 references from the school that attended field experience once. Although it is difficult to make causal relationships or statements about learning in a quasi- experimental design, the references to skills and my class observations support evidence that students made more references to their ability to test water, use compasses, build shelters, take care of the earth, or the environment in which they live. In addition, the references student made demonstrated the application and integration of what they were learning. This can build self-efficacy in a student. Self-efficacy is the belief that one is capable of performing in a certain manner to attain certain goals (Bandura, 1997).

Another teaching model often incorporated in environment education is the awareness, knowledge, and application model. The ability of students to gain skills and apply what they have learned is a higher level of learning and creates self-efficacy. This

is certainly depicted in one student's quote, "I think all grades should get to go this outdoor learning center to learn and feel good about themselves."

A comparison of codes from two different schools– a school that attended field experience five times and a school that attended field experience once both made similar references to the components of nature that they observed and to a sense of place. The difference was that the students' responses from the school that attended field experience five times talked more about skills and an application of what they learned in the classroom. I believe that students that have a field experience more than once have a greater opportunity to develop a higher level of understanding and a sense of self-efficacy more than students who have a token field trip.

Integration of Quantitative and Qualitative Results

The results from the quantitative comparison of classroom and field environment showed students' preferences for the classroom for investigation. Other results showed a preference for enjoyment of science in the field. The results seem to be contradictory, but according to Nevo & Nevo (2009), there is an important distinction between conflicting and contradictory results. This study has conflicted findings however, they can be integrated into the study to make credible sense of different aspects of the results. In phase one, students' perceptions regarding cooperation and investigation were ranked high in the classroom. This does not mean that they do not enjoy the field experiences. Inconsistencies in the findings were further explored through the qualitative phase of the study. A complementary approach was useful in dealing with the conflicting results of this study. This approach gave the sequential explanatory design of this study more validity by using the qualitative data to explain the conflicting results.

According to Nevo & Nevo (2008), "the plausible explanation to observed gaps is that the two methods measure different entities and different aspects of social reality." This allows you to reach a fuller understanding of the phenomena under investigation and make credible sense of the conflicted findings. Scales measure performance and functioning objectively, whereas interviews reflect personal and subjective views. Two different aspects of a complex phenomenon were measured in this study. Inaccurately interpreting conflicting findings comes from basing major decisions on the results or the emphasis or rejection of one finding over another. In this study, the conflicted findings of students (ranking the classroom higher for some constructs but also ranking enjoyment in the field highly) complement this study. The quantitative data reported results and the qualitative data explained questions that arose from the data.

Ethnicity and Socioeconomic Class

The need to minimize differences in achievement in science for students based on ethnicity and class increases as the populations of minority students increases in our schools. Field experience can improve a student's attitude toward science because the outdoor environment is culturally relevant to all students. The differences between Hispanic and white students and low socioeconomic class students and students that do not qualify for reduced or free lunch emerged in the quantitative data collection and analysis.

Hispanic students preferred investigation in the field. Seeing and experiencing science in the field was engaging and relevant to students from diverse backgrounds compared with traditional, more didactic classroom practices such as lecture and note-taking. Teaching in the field is more relevant to their everyday life experiences. Cooperation in class was preferred by white students. This is not surprising as the classroom is the learning

environment most frequently used. Hispanic students perceive the field environment has more equity, so it may be that they are participating more evenly in the field. The classroom environment may be more intimidating to students from different cultures that do not learn best by lecture and teacher-centered methods. In enjoyment of science, there is no significant difference between white or Hispanic students and as stated before, due to the teacher, these students enjoy science in both environments.

The data were also disaggregated by differences in socioeconomic class and showed that small, but important differences exist. Unfortunately, socioeconomic data was difficult to obtain. The data was gathered from the students by asking them to self-identify their eligibility for free or reduced hot lunch. This was an inaccurate way to obtain the numbers, as students may not have understood the question after we explained it to them. Students also may not have been comfortable volunteering this information. The differences are still worth noting.

Low socioeconomic class students prefer investigation in the classroom. Again, this is the more commonly used and familiar teaching environment. I also noticed that some of the students did not have the cold weather clothing needed for the field experience. The teacher thoughtfully supplied any gear needed for all students, but it may have been embarrassing for students who did not own warm clothes and shoes for outdoor experiences. More low socioeconomic class students perceived cooperation in the field to be higher than in the classroom. It may be that an open environment is more inclusive of all students. Teamwork and cooperative learning strategies may allow them to gain confidence with group observations and answers to problems by giving them more anonymity if they do not know the answer. There was no notable difference between students that qualify or do not

qualify for lunch with regards to their ranking of equity in the field or the classroom, because, as observed, the teacher promoted an equitable learning environment in both class and field. I think all of the students felt valued and knew that the teacher believed in their ability to learn. The qualitative data in phase two were not disaggregated by ethnicity and class, so I was not able to further explain these quantitative results.

Sense of Place

The third area of this study emerged from the qualitative analysis of the students' responses in phase two. Students' mention of sensory experience in the field setting, the environment they were learning in, and observation of the components of nature were all categorized as sense of place. Students from both of the schools surveyed had the largest number of responses about observations of their environment and the major difference between the class environment and the field environment. This is how students develop a sense of place.

Sense of place is the main component of place-based education. What students learn with place-based education is closely tied to their own experience, connecting them more directly to their place and their community. "It validates the culture and experience of students' families unlike national curricula that concerned with the perpetuation of national rather than local knowledge" (Smith, 2002, p.). District and state curriculum mandates and textbooks are written for a national market and they tend to focus on general principles rather than on questions drawn from children's immediate experiences. This does little to teach children about their own place in the world (Smith, 2002).

"Students were able to investigate local natural phenomena and tap into an inborn curiosity about the physical world, which is rarely tapped or satisfied in schools" (Smith,

2002). Students' experience of the world is valued, and the school is embedded in their community rather isolated from it. Teachers who incorporate field experience into their curriculum get the benefits of getting students outside the classroom and to take advantage of their curiosity. This results in a breakdown of the boundary between the child's experience and what he or she encounters at school and it results in higher engagement and student achievement (Smith, 2002).

Taking students outdoors is a way of connecting students with the environment in which they live and teaching with relevance. This is the rationale for outdoor learning, as Dewey wrote:

> "From the standpoint of the child, the great waste in the school comes from an inability to utilize the experiences he gets outside school in any complete and free way within the school itself; while, on the other hand, he is unable to apply in daily life what he is learning at school. That is the isolation of the school, its isolation from life. When the child gets into the schoolroom he has to put out of his mind a large part of the ideas, interests, and activities that predominate in his home and neighborhood. So the school, being unable to utilize this everyday experience, sets painfully to work, on another tack and by a variety of means, to arouse in the child an interest in school studies."
>
> (Dewey, 1958, p.76-78).

Smith (2002) states that "the disconnect between children's life experience and school learning has only been exacerbated by our national preoccupation with standardized test scores." Nabhan (1994), in The Geography of Childhood, states "we need to turn to learning about the land by being on the land, or better by being in the thick of it" (p.38). Place-based education is by its nature specific to particular locales, so generic curricular models are inappropriate. Four themes that are common to the different models of place-based education were present in this curriculum: cultural studies, nature studies, real world problem solving, and an introduction to community.

The incorporation of field experience in this curriculum adapts to the unique characteristic of the students' backyard to help overcome a loss of connection that a student's school has with children's lives. During field experience: (1) teachers and students have an opportunity to learn about events around them, (2) students become the creators of knowledge rather than the receiver, (3) students' questions play a role in determining what is being studied and their ownership emerges, and (4) the wall between school and community is minimized. Students are allowed to engage in activities that are of service to the community and the place they live, which is especially beneficial for students from diverse backgrounds (Smith, 2002). I believe that the principles of place-based education were demonstrated in this study of learning environments and although good teaching can occur in both learning environments, the benefits of field experience are great and cannot be overlooked.

Significance of this Research

Field experience has been studied as a method for increasing achievement (Lieberman and Hoody, 1998) and behavior and motivation (McKinnon et al. 1997). Other studies have looked at the number and quality of field experiences (Orion & Hofstein, 1991; Peacock, 2006). In a more recent study, Zaragoza and Fraser (2008) studied learning environments and attitudes in Florida and differences in perceptions of learning environments for males and females and LEP and native English speakers. Zaragoza & Fraser (2008) established the validity of the modified WIHIC questionnaire with fifth grade students. The results suggested that the field class was a more favorable learning environment and that a more positive learning environment was linked to better attitudes toward science. My study used the same modified version of the WIHIC and TOSRA, as did

Zaragoza and Fraser (2008), but is unique in looking at learning environment and attitudes toward science with a focus on ethnicity and class. The results were different in that students did not rank the field environment significantly higher than the classroom and for a few variables, ranked the classroom environment higher. The disaggregated results for Hispanic and white students and students that qualify and do not qualify for free or reduced lunch programs were also not significant. What this study did was to use qualitative data to further explain the quantitative results. The qualitative results provided a different picture as well as answers to how field experience can improve attitudes in science for mainstream and non-mainstream students.

Implications for Practice

This study has major implications for teachers, administrators, and teacher educators. First, teachers can learn from the student perception of the three constructs in the two learning environments. Cooperation, equity, and investigation were ranked high by students in both environments. These three variables are extremely important when working with students from diverse cultural backgrounds. Inquiry as a teaching technique uses cooperative learning and is dominated by student-centered learning versus teacher-centered learning. These are strategies that build collaboration in the learning process and equity between students. Teachers can incorporate field experience into their curriculum to enhance their science class and build a sense of place in students. Students can see and touch what they are studying. They can also learn more about the community that they live in and develop a sense of confidence in the skills that they develop in the field. However, students are comfortable in the classroom and there is much that a teacher can do to connect science to

the everyday lives of students and to create an environment that supports cooperation and equity in the classroom.

Second, administrators should support field experiences for students so that they can experience a sense of place. Administrators should allow teachers planning time to organize quality field experiences that are integrated into the curriculum. Administrators should support a curriculum in which all students can have science and use science to apply and improve their reading skills. Additionally, funding should be built into the school budget for transportation or the construction of outdoor classrooms on the school grounds in order to minimize the achievement gap in all subjects but especially science.

Finally, pre-service teacher education should model and teach how to offer quality field experience for teachers that are preparing to become science teachers. A poorly facilitated field trip becomes a token or novelty outdoor experience in which the bus ride is the best part of the day. A well facilitated field trip, as seen in this study, may build equity and cooperation, utilizes investigation, and gives students a positive attitude and experience in science.

Limitations of Research

There were limitations to this study that made it difficult to provide more solid evidence to the research questions proposed in this study. Connections need to be made between achievement and attitude. Many administrators are under pressure to raise test scores and need to see more solid evidence for the relationship between attitude toward science, enjoyment of science, and science achievement. Some of the limitations to this study have to do with flaws in methodology, such as the use of a small sample size and only one school. Another factor that may have skewed the results was the lack of adequately sensitive

instruments in phase one and the wording of the questions in phase two. Additionally, when disaggregating data for ethnicity and class, the classification of ethnicity does not accurately reflect the different levels of acculturation into the mainstream culture and it is difficult to obtain data for socioeconomic classes. Studies involving different cultural groups must be more sensitive to these issues.

The last limitation to this study (the teacher effect) was, ironically, the strength of the study. The teacher used in this study was excellent. She made science enjoyable in the classroom and in the field and she used incorporated teaching strategies that encourage investigation, cooperation and equity. This perhaps skewed the results in a good way. She was able to engage the students and make science enjoyable in both learning environments. In addition, her use of inquiry and her ability to develop equity and cooperation with students allowed other themes to emerge such as: sense of place and application of skills. If all teachers were as enthusiastic and experienced as this teacher, I believe that the achievement gap would minimize between ethnicity and class.

Suggestions for Further Research

More evidence is needed to convince science teachers to transform their teaching practices to incorporate field-based experience into traditional science classrooms. Environmental behaviors and motivation could be measured the following year to learn the impact of field experience on their behaviors. A longitudinal study that tracked these students over the years may uncover if the students retain the information they learned in the field environment over time.

Studies linking attitude to achievement are difficult due to the nature of standardized testing, but Lieberman & Hoody (1998) have made some advances that have contributed to a

more valid comparisons of schools. As sense of place emerged as a construct in this study, it became apparent that a new instrument developed for sense of place by Zandvliet (2007) would further enrich the findings of this study as well as more in-depth qualitative data collection through the use of focus groups and student interviews.

Summary

Of all the learning environments in science teaching, the outdoor environment is the most neglected. With an increasing need to minimize the achievement gap in science and better educate diverse student populations, immersing students in their community and outdoor environment improves the cultural relevance of their curriculum, especially in science. Unfortunately, achievement gap data are based mostly on the scores from standardized tests that are not culturally relevant and classify students into categories that may not reflect their ethnicity. Although there were some medium to small effect sizes in students' perceptions of cooperation, investigation, equity, and enjoyment of science, this study reveals that a learning-centered environment can exist in the classroom and in the outdoors. Experiences that engage all students in learning and place learning in real-world experiences in the community help all students enjoy science.

Field experience is a teaching technique that combines investigation, cooperation, and equity, enables students to feel good, and connects students to their environment. School districts and teacher training programs should support and encourage future teachers to facilitate these experiences more often for mainstream and non-mainstream students. Whether a school goes to an outdoor learning center once or five times per year, seeing the "real" thing and exploring the environment takes students from where they are and moves them into the next level of learning (such as in Lev Vygotsky's zone of

proximal development). "One of the primary strengths of place-based education is that it can adapt to the unique characteristics of particular places, and in this way it can help overcome the disjuncture between school and children's lives that is found in too many classrooms" (Smith, 2002, p.48).

Whether in the classroom or outdoors, a major factor in learning is the ability of the teacher to engage all students, to treat them equally and to instill in them a love of science. A dynamic teacher incorporates instructional strategies that value all students and enables them to discover and experience science through the values and experiences that they come into the classroom with.

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Appendix A.

CONSENT TO PARTICIPATE IN A RESEARCH STUDY
COLORADO STATE UNIVERSITY

Title of Study: **Comparison of Learning Environments in Environmental Education**
Principal Investigator: **Dr. Gene Gloeckner, Colorado State University, 970-491-6835** Gene.Gloeckner@colostate.edu
Student: **Barbara Patterson, Doctoral Fellow, Center for Learning and Teaching in the West,** Colorado State University, 970-204-8310 or Barbara.patterson@frontrange.edu
Sponsor of Project: **National Science Foundation**

WHAT IS THE PURPOSE OF THE STUDY?
We want to learn about the effect of field experience on students' attitude toward science especially for Mexican American students and students that are of low socioeconomic class. We also want to explore students' ideas about field experience experiences at an outdoor learning center and how this educational intervention engages students.

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?
You are enrolled in fifth grade at Winograd Elementary School and participate in field study at the Poudre learning center.

WHO IS DOING THE RESEARCH?
Barbara Patterson is the primary person who will conduct most of the research. This research is being conducted by the Center for Learning and Teaching in the West, which is funded in part by the National Science Foundation.

WHAT WILL I BE ASKED TO DO?
You will be asked to complete a survey of your perceptions of the classroom learning environment and the field environment and questions regarding student attitudes toward science. You will not be identified by name in any of the data collection. The results of the surveys will be stored for five years after the study. After five years, the data will be destroyed.

Please initial below if you agree to participate in the survey.

_____ • **I am willing to participate in the survey.**

We would like to use the results from the survey at research meetings, during workshops, in other scholarly formats for education, and for other institutionally approved projects. Please initial below if we may use the results of the observations and surveys for these purposes. You may still participate in the study if you do not agree to use your data for institutionally approved projects.

_____ • **I <u>do</u> approve of my participation in surveys and class observations. The data may be used in research meetings, during workshops, in other scholarly formats for education, and for other institutionally approved projects.**

Demographic Questions
At the beginning of the survey, you will be given directsions for completing the survey. The survey will take approximately 30 minutes to complete. You will complete the questionnaire in a classroom or office setting.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?
There is no compensation for your participation in this study.

WHERE IS THE RESEARCH GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?
The survey will be administered at school as part of your classroom day. It will take approximately 30 minutes. Copies of the observations and survey results will be available to students to review and make comments.

ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS RESEARCH?
There are no reasons that you should not take part in the study.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?
Any potential risks are minimal.

1. **You may feel uncomfortable answering questions on the survey. But there are no right or wrong answers – it is simply a survey of your attitudes and perspectives. This risk is similar to what you might feel in a class situation during a class discussion.**

It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

WILL I BENEFIT FROM TAKING PART IN THIS STUDY?
There are no known benefits to you for participating in this study, but we hope to gain more knowledge about what students think about science. This knowledge may benefit educators of science classes who will be able to modify their curricula to address these ideas for all students.

DO I HAVE TO TAKE PART IN THE STUDY?
Your participation in this study is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

WHAT WILL IT COST ME TO PARTICIPATE?
There are no costs for you to participate in the study.

WHO WILL SEE THE INFORMATION THAT I GIVE?
We will keep private all research records that identify you, to the extent allowed by law.

Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish the results of this study; however, we will keep you name and other identifying information private.

When highlighting a specific participant in the case study, fictitious names, initials, or numbers will be used to protect your identity.

CAN MY TAKING PART IN THE STUDY END EARLY?
Your participation in the study may end early if you decide that you do not want to participate in the survey.

WHAT HAPPENS IF I AM INJURED BECAUSE OF THE RESEARCH?
The Colorado Governmental Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury.

WHAT IF I HAVE QUESTIONS?
Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Gene Gloeckner at 970-491-1101 or Gene.Gloeckner@colostate.edu or Barbara Patterson at 970-204-8310 or Barbara.patterson@frontrange.edu

If you have any questions about your rights as a volunteer in this research, contact Celia Walker, Director of Regulatory Compliance, at 970-491-1553. We will give you a copy of this consent form to take with you.

WHAT ELSE DO I NEED TO KNOW?
Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing _3__ pages.

_____ _____

Signature of person agreeing to take part in the study Date

_____

Printed name of person agreeing to take part in the study

_____ _____

Name of person providing information to participant Date

_____

Signature of Research Staff

PARENTAL SIGNATURE FOR MINOR

As parent or guardian, you authorize _____ (print name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to you by _____ and you are satisfied that proper precautions will be observed.

_____

Minor's date of birth

_____

Parent/Guardian name (printed)

_____ _____

Parent/Guardian signature Date

Appendix B.

Colorado State University Application for Human Research Review:

Model Assent for Children

Hi!

I'm a student at Colorado State University. I am studying science education. This is called research. My research is about what would help kids learn science better. I am asking you if it is OK for you to participate in a questionnaire regarding field-study at the outdoor learning center.

If you say it is OK, I'll ask you to answer a questionnaire about your background. Then I would like to ask you questions about your experience at the outdoor learning center. I will also ask questions about what you like about science. There isn't a right or wrong answer --- it is just about what you think. It will take approximately 30 minutes. I would also like to observe your classroom and read your science notebooks so that I can learn as much as possible about your experience. Your name won't be on the included, so no one will know how you answered your questions or what you did.

Agreeing to be in this project cannot hurt you. It won't help you, either. You won't get any gift for doing it. You don't have to do it. If you say "yes" now but later change your mind, you can stop being in the research any time by just telling me.

I will ask your parents if it is OK that you do this, too. If you want to be in this research, sign your name and write today's date on the line below.

_____ _____

Student Date

_____ _____

Researcher Date

Appendix C.

A Comparison of Learning Environments in Environmental Education
Letter of Agreement from Institution

Principle Investigator: Barbara Patterson
Supervisor of the Research: Dr. Gene Gloeckner

Please read the following information and, if you consent to participate, sign below. The purpose of this study is to 1) evaluate the effectiveness of field experience on students' attitudes toward science, 2) examine the differences for class and ethnicity 3) identify how and why field experiences engage students in science. Quantitative data will be collected and statistically analyzed from the WIHIC and TOSRA survey and disaggregated by number of field experiences to statistically significant. To answer the question of why and how field experience benefits students, qualitative data will be collected and analyzed from class observations and review of science notebooks. The benefits of this study will potentially result in an improved understanding of science teaching strategies that are effective for low-income and minority students.

The study is my dissertation for my PhD program at Colorado State University as part of a National Science Foundation Grant Project Center for Teaching and Learning in the West looking at the Achievement Gap in Minority Students for Math and Science. Informed parental consent will be required as the participants in this study are minors but there is a minimal risk to subjects. The quantitative data used for this study is obtained from these simple surveys that will be anonymously reviewed and will not cause an adverse effect on participants. The qualitative data will be collected from class observations and review of science notebooks. All discussions will be transcribed, reviewed with participants for accuracy and records will remain anonymous and kept on

campus in secure files. A human subjects application will be filed with both Colorado State University and the school district and all human subjects research protocol will be followed at all times.

I have read and understand the above information. I am confident that there will be little or no risk to subjects due to the anonymity and the fact that the study is using already existing test data. I understand that at any time if I feel uncomfortable, I have the right to end my participation with no negative consequences. If there are any questions please feel free to contact Barbara Patterson at Barbara.patterson@frontrange.edu or, the supervisor of the research Dr. Gene Gloeckner at Gene.Gloeckner@Colostate.edu or the Human Research Compliance Administrator at 970-491-1655.

Subject Signature: _____ Date: _____

Principle Investigator: _____ Date: _____

Appendix D.

What Is Happening In This Class? (WIHIC)

Learning Environment Questionnaire

Directions:

Identify how you feel today regarding the following statements using the scale below:

I almost never feel this way in class.
I seldom feel this way in class.
I sometimes feel this way in class.
I often feel this way in class.
I almost always feel this way in class.

Please use the answer sheet provided, remembering to supply information at the top of the form.

Describe how you feel today about this class....

A. Involvement
1. I discuss ideas in this class.
2. I give my opinions during class discussions.
3. The teacher asks me questions.
4. My ideas and suggestions are using during classroom discussions.
5. I ask the teacher question.
6. I explain my ideas to other students.
7. Students discuss with me how to go about solving problems.
8. I am asked to explain how I solve problems.

B. Investigation
9. I carry out investigations to test my ideas.
10. I am asked to think about the evidence for my statements.
11. I carry out investigations to answer questions coming from discussions.
12. I explain the meaning of statements, diagrams, and graphs.
13. I carry out investigations to answer questions that puzzle me.
14. I carry out investigations to answer teacher's questions.
15. I find out answers to questions by doing investigations.
16. I solve problems by using information obtained from my own investigations.

C. Cooperation
17. I cooperate with other students when doing assignment work.
18. I share my books and resources with other students when doing assignments.
19. When I work in groups in this class, there is teamwork.
20. I work with other students on projects in this class.

21. I learn from other students in this class.
22. I work with other students in this class.
23. I cooperate with other students on class activities.
24. Students work with me to achieve class goals.

D. Equity

25. The teacher gives as much attention to my questions as to other students' questions.
26. I get the same amount of help from the teacher as do other students.
27. I have the same amount of say in this class as other students to.
28. I am treated the same as other students in this class.
29. I receive the same encouragement from the teacher as other students do.
30. I get the same opportunity to contribute to class discussions as other students.
31. My work receives as much praise as other students' work.
32. I get the same opportunity to answer questions as other students.

Appendix E.

TOSRA

Test of Science Related Attitudes

Barry J. Fraser

Directions:

1. This test contains a number of statements about science. You will be asked what you yourself think about these statements. There is no right or wrong answers. Your opinion is what is wanted.

2. All answers should be given on the separate answer sheet. Please do not write on the question sheet.

3. For each statement, draw a circle around

SA	if you **strongly agree** with the statement
A	if you **agree** with the statement
N	if you are **not sure**
D	if you **disagree** with the statement
SD	if you **strongly disagree** with the statement.

1. I would prefer to find out why something happens by doing an experiment than by being told.
2. Science lessons are fun.
3. Doing experiments is not as good as finding out information from teachers.
4. I dislike science lessons.
5. I would prefer to do experiments than to read about them.
6. School should have more science lessons each week.
7. I would rather agree with other people than do an experiment to find out for myself.
8. Science lessons bore me.
9. I would prefer to do my own experiments than to find out information from a teacher.
10. Science is one of the most interesting school subjects.
11. I would rather find out about things by asking an expert than by doing an experiment.
12. Science lessons are a waste of time.
13. I would rather solve a problem by doing an experiment than be told the answer.
14. I really enjoy going to science lessons.
15. It is better to ask the teacher the answer than to find it out by doing experiments. The material covered in science lessons is uninteresting.

16. I would prefer to do an experiment on a topic than to read about it in science magazines.
17. I look forward to science lessons.
18. It is better to be told scientific fats than to find them out from experiments.
19. I would enjoy school more if there were no science lessons.

Correspondence per email 11/3/2008
Barbara - You are welcome to use the WIHIC and TOSRA. There is no charge.
Barry Fraser

Appendix F.

Science Classroom Observation Form

A. Demographic Information

1. Observer_____
2. Teacher Code _____
3. Date_____
4. Duration (minutes) _____
5. Grade level _____
6. Course _____
7. Size of Class _____
8. School and Location _____

If an item is not observable, circle 1.

B. Environment	NO				YES
1. Were materials, equipment, kits, live specimens, etc. in evidence?.....	1	2	3	4	5
2. Were there audio visual aids in the room? (E.G. tape recorder, film strip viewers, loop projectors, charts, film strips, etc.).....	1	2	3	4	5
3. The students worked as.....	A whole Class				Individually or in small groups
	1	2	3	4	5
4. Students mobility was.....	Fixed				Flexible
	1	2	3	4	5
5. The classroom environment was.....	Closed				Open
	1	2	3	4	5
C. Students					
6. Used a textbook.....	A little				A great deal
	1	2	3	4	5
7. Engaged in disruptive behavior	1	2	3	4	5
8. Engaged in organized group and/or class discussion	1	2	3	4	5
9. Asked questions (not counting simple requests for direction)	1	2	3	4	5
10. Appeared enthusiastic	1	2	3	4	5

11. Appeared responsive	1	2	3	4	5
12. Proposed alternative ideas, interpretations, theories	1	2	3	4	5
13. Touched, operated, and manipulated materials	1	2	3	4	5
14. Handled materials and specimens responsibly	1	2	3	4	5
15. Conducted experiments	1	2	3	4	5
16. Developed their own "conclusions"	1	2	3	4	5
17. Made choices of activity	1	2	3	4	5
18. Were curious and inquisitive	1	2	3	4	5
19. Engaged in making decisions about the lesson	1	2	3	4	5
20. Co-operated with each other	1	2	3	4	5
21. Showed competence in using apparatus	1	2	3	4	5
22. Interacted freely and purposefully with each other	1	2	3	4	5
23. Depended on the teacher for direction	1	2	3	4	5
24. Appeared to be just going through the motions	1	2	3	4	5

D. Teacher

25. Encouraged students to question, theorize, etc	1	2	3	4	5
26. Provided answers throughout the lesson (not teachable moment answer or IDP yes/no)	1	2	3	4	5
27. Responded in a neutral way to student responses	1	2	3	4	5
28. Stressed content (versus process)	1	2	3	4	5
29. Asks divergent questions (open-ended)	1	2	3	4	5
30. Used AV/TV equipment	1	2	3	4	5
31. Shows and tells	1	2	3	4	5

32. Said or implies "I don't know"	1	2	3	4	5
33. Was enthusiastic	1	2	3	4	5
34. Aroused curiosity and interest	1	2	3	4	5
35. Encouraged examination of how something was learned	1	2	3	4	5
36. Was approachable	1	2	3	4	5
37. Gave students time to think and ponder	1	2	3	4	5
38. Provided materials	1	2	3	4	5

Other Comments