EFFECT OF OUTDOOR EDUCATION METHODS AND STRATEGIES ON STUDENT ENGAGEMENT IN SCIENCE: A DESCRIPTIVE STUDY

by

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July 2012

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ABSTRACT

Keystone Science School (KSS) is a residential outdoor education facility set high in the Rocky Mountains of Colorado. Initially as a classroom teacher in a nearby town, I observed first-hand the positive impact of experiences had by my students at KSS on their attitudes toward learning science. This research was designed as a descriptive study to analyze how KSS uses outdoor methods and strategies to positively effect student attitudes toward learning science. Over the course of several weeks, participating students and teachers were surveyed about their experiences (typically 3-day/2-night) at Keystone Science School. Instructors and field groups were also observed on several occasions to analyze the degree to which particular methods and strategies were being employed, and their effectiveness on student interest and engagement in science. The results suggest that with an overwhelming positive view from students and teachers about the effectiveness of their outdoor learning experiences, student age, student gender, and instructor gender had some effect on these attitudes. Boys tended to be slightly more comfortable learning outdoors than girls, and younger students (ages 9-11) generally more comfortable than older students (ages 12-14) especially among girls. Students also reported being slightly more comfortable learning outdoors with male instructors, and tended to rate the abilities of male instructors slightly higher. The findings of this result support the conclusion that methods and strategies used in outdoor education are more effective at developing positive attitudes toward learning science than typical classroom experiences.

INTRODUCTION AND BACKGROUND

Background

Educational Philosophies

The age-old quandary in education: *depth* vs. *breadth*. Do we want our children to learn a lot about a little, or a little about a lot? My firm belief is that these options are not exclusive, and it is possible (and essential) for educators to provide opportunities for students to learn a lot *about* a lot. A teacher's job is to serve as a guide or coach as students develop critical thinking skills, not to profess their own understanding of specific topics as they emphasize retention of content knowledge. So much emphasis in modern education is placed on norm-based comparisons of student progress measured by standardized test achievement without much reflection of the context under which these concepts are studied or applied. It is more important for students to transfer their academic understanding and make personal connections (emotional or otherwise) with the content in order for them to learn.

By providing opportunities for students to experience our world first-hand and construct their own approaches to problems, students gain skills necessary to put them in the right mind-set to effectively learn. The basis for my Action Research stems from my continuing effort to find experiences that hold the most meaning; to find experiences that make students *want* to learn. A successful student does not ultimately rely on others to instruct them, but is able to find motivation for their own learning in an unquenchable thirst for understanding. By engaging in their own learning, it is my belief that students will not only become better students, but better citizens.

Throughout this report, the word “experience” may be used exhaustively, but for a simple reason: From my viewpoint, experience is the basis for all learning.

Personal Experience

My first official year as a middle school science teacher came in the autumn of 2007. Like many first-year teachers, I constructed a clear (and admittedly unrealistic) image of what my classroom would look like and how my lessons would feel: picture students spending afternoons alongside pristine mountain streams observing habitats, hiking along high alpine cirques to map past movements of extinct glaciers, or identifying wildflowers in vast alpine meadows.

Delusions of grandeur were quickly replaced by disappointing realities of modern classroom teaching. The bureaucratic nature of public education (in my experience) was stifling the feeling of ingenuity and creativity, and I felt extremely limited in my ability as an educator to provide what I consider meaningful experiences. It was not as if somebody went out of their way to explicitly limit learning opportunities, but the system seemed to require preoccupation with external pressures so that, by design, it discouraged innovative thinking. All I desired to do was provide quality learning opportunities that met the needs of students as individuals, and the cards seemed stacked against me.

One can imagine that in a small, economically stressed town of only two thousand residents (about 70% of students qualified for free-or-reduced lunch status), opportunities for local financial assistance was limited. My total annual classroom budget at the time was $300, and it cost more than that just to reserve in-district transportation for a single day field trip. Countless personal hours were spent writing grants and approaching local businesses to solicit donations. This, on top of the expected paperwork required by the school district in the name of "accountability," and I found myself struggling just to keep up with necessary and vital day-to-day tasks like lesson planning, meaningful assessment and feedback to students.

Scope of Study

Project Conception

During my tenure as an eighth grade science teacher, despite the minimal financial and professional moral support, I was able to find the means to take students outside of their typical classroom setting on occasion. Most notably among these experiences was an annual autumn trip to Keystone Science School, located in Keystone, Colorado, for a week of outdoor education. At the end of each school year students overwhelmingly cited their trip to Keystone Science School as the most important, influential, and memorable experience of eighth grade, and often times, of their entire middle school career. This observation served not only to validate the hardships invested in setting up quality educational programs, but inspired me to focus even more on providing deep and rich learning opportunities to as many students as possible.

In 2010, I was given the chance to become a full-time part of the Keystone Science School team as Assistant Director of Summer Programs. This position offered me an opportunity to take a closer look at reasons why programs at Keystone Science School seem to have so much more of a lasting impact on student's perception of science and education, as my previous eighth grade students had so frequently stated. Since beginning this Action Research, I have also accepted a position at The Peak School, a newly-formed, private middle school in near-by Breckenridge, Colorado. My role as Science, Technology, Engineering, and Math (STEM) teacher as well as Outdoor

Education Coordinator at The Peak School will be well-served by this research. My findings may perhaps become even more relevant to my situation as I attempt to harness the power of outdoor education methods and strategies on a more regular basis to enhance and enrich learning opportunities for my future students.

Project Purpose

The purpose of this Action Research is to investigate how outdoor education experiences are effective at engaging students in science, particularly compared to traditional classroom experiences. My background with Keystone Science School has provided me with an in-depth perspective on at least one organization involved in the industry of outdoor science education. This research was a descriptive study designed to analyze the effectiveness of outdoor education methods and strategies on student engagement in science, specifically at Keystone Science School. My goal was to gain valuable insight regarding effective approaches to science education, and improve my own abilities as a teacher and educational program coordinator. A secondary goal was to provide Keystone Science School with useful information to aid in the effective administration of current and future programming.

Focus Questions

The primary question for this descriptive research study is: What are the effects of outdoor education strategies on student engagement in science? Sub-questions served to strengthen my own understanding of the primary question, as well as provide tangible evidence to support the development and implementation of programs at Keystone Science School:

1. How are lessons taught at Keystone Science School effective at engaging students in science?
2. In what ways do students perceive that teaching methods and strategies at Keystone Science School differ from traditional classroom science lessons?
3. Why do teachers choose to have their students participate in programs at Keystone Science School?
4. What challenges do teachers face in organizing trips to visit Keystone Science School?

Project Setting

Keystone Science School (KSS) is an outdoor education facility set high in the Rocky Mountains in Keystone, Colorado. KSS is a subsidiary of The Keystone Center, a non-profit organization seeking to find solutions to society's most challenging environmental, energy, and public health issues. Founded in 1976 by famed adventurer and mountaineer Robert W. Craig, The Keystone Center uses the Keystone Science School to help develop critical thinking skills in our future leaders and policy-makers.

Primarily utilized as a residential facility, KSS has traditionally designed curriculum to challenge students through exploration of the natural environment. From June through August each year, KSS Summer Programs host students from all over the country in a wide variety of camp programs based on curriculum of different scientific themes. From September through May, KSS School Programs welcome school groups primarily from across Colorado, typically for three-to-five day programs. The curricula for these sessions are custom-designed with classroom teachers to meet the educational and social needs of each group. All themes are designed to meet national and state science standards through the use of current science concepts, scientific inquiry, and team-building.

Throughout my investigation, I received deep and varied support from numerous people. Fellow administrative staff at Keystone Science School assisted me early in the research process through development of purpose, questions, and ideas for research instruments to be implemented. Dave Miller, KSS School Programs Director, Patrick Nashleanas, Assistant School Programs Director, Ellen Reid, KSS Director, and Joel Egbert, KSS Summer Program Director, were integral in the development of research methods used in this project. The input from this group was used to ensure data instruments were not only beneficial to the research and overall program development, but was as least invasive to the day-to-day operations and goals of instructors as possible. The team of 12 KSS instructors helped a great deal during the development stages of research, as well as throughout the period of data collection. I would not have been able to collect as much useful data as I did without their help. Rebekah Jordan, founder and head of school for the Peak School, and fellow Peak School instructor Dana Karin, have been a tremendous resource during my analysis and interpretation of findings. They helped look for ways to use my observations to define and improve the educational community at The Peak School, and plan implementation of quality outdoor education opportunities for future Peak students. Finally, advice and guidance (and certainly patience!) continually provided by Walt Woolbaugh and Laurie Rugemer of the Masters of Science in Science Education program at Montana State University were critical to my progress throughout the research process.

CONCEPTUAL FRAMEWORK

There are many ways to describe “outdoor education.” The term itself implies a distinction in *location* from most educative settings, but, used by educators and authors as a very broad term, it encompasses several perspectives, approaches, and philosophies of education. "Outdoor education has been described as a place (natural environment), a subject (ecological processes), and a reason (resource stewardship) for learning. It has been called a method (experiential), a process (sensory), and a topic (relationships) of learning" (Gilbertson, Bates, McLaughlin, & Ewert, 2006, p. 4). In the framework for this study, I consider outdoor education in the context of how I observe Keystone Science School using outdoor education strategies and methods. Examples of current philosophies of education that intertwine or overlap with approaches to outdoor education at Keystone Science School include, among others, environmental education, experiential education, inquiry-based learning, place-based education, and cooperative learning. This framework is derived from a variety of sources pertaining to learning in and about the natural environment, and relevant educational philosophies.

The Importance of Outdoor Education

Outdoor education has become an increasingly major tenet of education in recent history for various reasons. One primary concern is the changing landscape of the childhood experience and apparent disconnection to nature. According to a report from The Kaiser Family Foundation, 8-18 year-olds today devote an average of 7 hours and 38 minutes per typical day to using entertainment media, equating to more than 53 hours a week. And because they spend so much of that time 'media multitasking' (using more than one medium at a time), they actually manage to pack a total of 10 hours and 45 minutes worth of media content into those 7.5 hours (Riedout, Foehr, & Roberts, 2010, p. 11). Obviously, this is time children are *not* using for essential physical activities, and can be a major contributing factor to a host of other issues observed in modern times.

Children growing up in modern generations seem to suffer from what Richard Louv (2005, 2006, 2007, 2011) has extensively described as *Nature-Deficit Disorder*.

In his book, *Last Child in the Woods*, Louv (2005) cites an array of research to highlight several consequences of deprived outdoor activity in children, and points toward direct exposure to nature as essential for physical and emotional health. For instance, according to a study published in 2004 linked to the Children's Hospital and Regional Medical Center in Seattle, "each hour of television watched per day by preschoolers increases by 10% the likelihood that they will develop concentration problems and other symptoms of attention-deficit disorders by age seven" (p. 102). In a 2003 study, the rate of prescriptions for antidepressants among American children reportedly doubled in five years, with the steepest increase (66%) amongst preschool children. While admittedly, these medicines do provide an obvious benefit to some children who suffer from severe illnesses and disorders, Louv offers evidence that using nature as a preventative, alternative, or supplementary treatment does have direct health benefits. Also, according to Louv, the Center for Disease Control (CDC) reports that between 1989 and 1999, the population of obese children between the ages two and five increased by almost 36 percent in the United States to about two of every ten – four times the percentage of childhood obesity reported in the late 1960's.

In addition to obvious health benefits of outdoor experiences, improved academic performance can be linked to outdoor education. According to Louv (2007), there is evidence that schools using outdoor classrooms and other forms of experiential education produce significant gains in social studies, science, language arts, and math. This may be partially attributed to a direct correlation between length of children's attention spans and direct experience in nature, increases in self-esteem, problem solving, and motivation to learn, as well as more creative and cooperative play with students who have experiences in unmanufactured “green areas” (para. 17).

Shrinking natural areas not only serve to limit students’ accessibility to open spaces, but eliminate natural habitats in which to observe local flora and fauna. According to the United Nations Population Fund, in 2008, for the first time in history, over half of the world’s population lived in towns and cities. By 2030, this number will likely reach 5 billion people, with most of this growth occurring in small cities and towns (Martine, 2007). For example, here in the United States, 53,000 acres of land are developed each year in the Chesapeake Bay watershed, a rate of about one acre every ten minutes. Similarly, 20 percent of forest cover in the area around Charlotte, North Carolina was lost in the period of two decades, from 1982 to 2002. The state lost 383 acres a day to urban development, increasing at a rate twice that of actual population growth (Louv, 2005). Because of urban expansion, it is increasingly difficult or, in some cases impossible, for students to experience certain natural ecosystems first-hand regardless of their desire to do so.

Support for environmental education through outdoor experiences can also be attributed in part to the need to directly address environmental issues that face our communities on both a local and global level. Saylan and Blumstein (2011) see environmental education as the vehicle to increase understanding about the complexities of natural systems, and lead to finding solutions to problems like resource overconsumption impacts on ecological systems by humans. They see classrooms as architecturally designed to isolate students from nature, creating barriers students in creating relevant and meaningful connections and transfer of understanding. By integrating outdoor education into standard curricula, Saylan and Blumstein feel these experiences will "stimulate critical thinking abilities and help students become better able to assimilate and apply knowledge from different disciplines" (p. 186). These experiences are important in developing love of nature on behalf of students, and, as a result, a sense of stewardship and reason for protection of natural resources.

Elements of Outdoor Education

While direct contact with nature is essential in the overall outdoor education experience, it is just as important to make sure these experiences have value to a student. "It is [the educator's] business to arrange for the kind of experiences which, while they do not repel the student, but rather engage his activities are, nevertheless, more than immediately enjoyable since they promote having desirable future experiences" (Dewey, 1938, p. 27). It becomes necessary for outdoor educators to devote time in both physical and mental preparation for outdoor experiences. Researchers Orion and Hofstein (1991) observed 256 high school students to analyze factors that influence learning abilities during a science-based field trip in a natural environment. To optimize the opportunity for learning, Orion and Hofstein suggest outdoor experiences be planned as part of an integrated curriculum as opposed to an isolated activity. These experiences should also be preceded by a short preparatory unit focused on maximizing physical and psychological readiness for an outdoor experience so students are able to devote their energies to the designed purpose of the experience. Through preparation, students can minimize their own anxieties, embrace the overall learning experience, gain confidence and comfort level in similar scenarios, and encourage future learning experiences.

"Experience" is not a concept devoted solely to the outdoor setting, but is nonetheless a central, if not *the* central, component of outdoor education. Keystone Science School offers academic programs dependent on students having direct experience. Dewey (1938) discusses at length how experience is to be used effectively in education. "It is not enough to insist upon the necessity of experience, nor even of activity in experience. Everything depends on the *quality* of the experience which is had" (p. 27). During a given session at Keystone Science School, the entire student experience, including meals, free-time, games, etc., is intentionally designed to center around learning, and attempt to help students gain a sense of transference for further experiences. Connectedness and continuity, as described by Dewey, is the crux of making experiences effective, thus increasing the likelihood that these experiences do lead to genuine learning (pp.37-38). Depending on the designed purpose of an experience, outdoor education may have different areas of focus, such as environmental/nature studies, physical skills, and interpersonal relationships (Gilbertson et al., 2006). Just as in a classroom, there are dangers with becoming too focused on development in one particular area as opposed to approaching an outdoor experience holistically. As Dewey (1938) points out, "a given experience may increase a person's automatic skill in a particular direction and yet tend to land him in a groove or rut; the effect again is to narrow the field of further experience" (p. 26).

Collaborative learning is a concept that Keystone Science School infuses into its outdoor education model at virtually all levels of programming. On their department website, Johnson and Johnson (n.d) of the Collaborative Learning Institute at the

University of Minnesota cite earlier research (Johnson & Johnson, 1989, 1999) to describe collaborative learning compared to other traditional learning methods:

> Cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning. It may be contrasted with competitive (students work against each other to achieve an academic goal such as a grade of "A" that only one or a few students can attain) and individualistic (students work by themselves to accomplish learning goals unrelated to those of the other students) learning (para. 5).

Some ways outdoor educators typically achieve group dynamics most conducive to cooperative learning is through activities like icebreakers, warm-up activities, initiative tasks, or adventure challenges (Johnston, 2007). By addressing challenges as a group, students have opportunities to develop positive interpersonal relationships, as well as intrapersonal and reflective skills. Observing first-year college students on a wilderness experience designed to introduce and prepare them for an upcoming college experience, professor Cheryl B. Torsney (2008), of West Virginia University reflects:

> Talk about bonding – together the students learn about the natural history of the area they're backpacking through, and simultaneously traverse the territory of their hearts. They form support groups that last. As a result, students who experience these outdoor adventures are retained from first to second year at a higher rate than students who do not go into the woods or on other nature adventures (p. 27).

Not only is student-student social interaction of great importance to the outdoor education experience, but also student-instructor social interaction is critical. "The principle that development of experience comes about through interaction means that education is essentially a social process…It is absurd to exclude the teacher from membership of [the] group" (Dewey, 1938, p. 58). By not distinguishing themselves from other members of the group, instructors have the opportunity to be viewed by the other group members (i.e. students) as a collaborator in learning, not a director of activities. In exploring methods to teach about power and privilege in society, Alison L. Neilson (2009) discusses the use of outdoor learning experiences in terms of both student-instructor relationship as well as transference of content:

> Taking the learning situation outdoors to a small urban park, the power dynamics change to allow teacher and students to become collaborative learners and together explore systems of oppression. Being outdoors we are bombarded with new stimuli, the presence of other people… as well as the sun and wind which provide opportunities for challenging the notion that students need to accept the oppression of the classroom (p. 136).

In a collaborative learning environment, Dewey (1938) states that instructors' learning plans must "be flexible enough to permit free play for individuality of experience, and yet firm enough to give direction towards continuous development" (p. 58). The importance of play in our society, and in education, is often overlooked as it may just look silly, frivolous, purposeless, or undirected, and may not lead to immediate "material" production in which to assess understanding of an intended concept. The consensus among scientists who research about how play affects the brain is that play is a central part of neurological growth and development, as it allows children to "build complex, skilled, responsive, socially adept and cognitively flexible brains" (Henig, 2007, n.p.).

While outdoor education is certainly not limited to learning science, I will use the term "outdoor education" in the context of this study to encompass Keystone Science School program objectives. These objectives center on a focused study in current scientific topics, using physical skill development and interpersonal growth as tools to enhance and enrich a student's overall experience.

METHODOLOGY

Project Design

To best answer my research questions, I have developed several methods of collecting data. Data collected directly from student participants, classroom teachers visiting with their students, and observations of Keystone Science School instructors all helped to identify reasons students seem more engaged in science while learning at Keystone Science School.

Initially I considered implementing pre-trip and post-trip assessments for participating groups. In the past, some school groups have brought a portion of their student population to Keystone Science School, but have a significant number of students *not* participating in the experience at Keystone Science School as well. If classroom teachers still held non-participating students responsible for learning similar content through alternative methods, participation in KSS programs itself would have been the treatment. Due to the variability of student participation, topics studied, school schedules, and other logistical difficulties, this type of research design proved to be impractical during the time of the study. Instead, the research was designed to focus on observational data obtained directly from participants.

As a descriptive study, no actual treatment was involved in this research. Instead, the majority of data was collected through participant response to items on the data instruments and direct observations. The importance of using a descriptive study in my case is that I was able to provide a) a summary of current observations, and b) a basis for future longitudinal studies. The structure resembles what McMillan and Schumacher (2010) defines as a "cross-sectional" study, or, in other words, assesses feedback from several groups at one time. In this type of study, participants respond to present circumstances, attitudes, and beliefs, and are essentially independent from each other. As one variable systematically changes with another variable, we are able to see a relationship between variables. The benefit for Keystone Science School is in how programs are set up to adapt or respond to particular variables to most positively benefit students. My data collection methods attempted to identify and correlate possible relationships among variables.

One of my professional goals for this research, as an administrator for programs at Keystone Science School, was to provide KSS with valuable information or insight to help with the overall improvement to programs offered to students. Certain items of the data instruments were not used directly in answering my specific research questions, but were valuable nonetheless. Keystone Science School had not previously employed a consistent method for obtaining student feedback about programs, staff, or facilities. One goal of the KSS administrative team was to develop such a tool to assess the impact of programs and offer concrete evidence to aid in their improving efficiency and effectiveness of programming, staff development, and facility maintenance. When attempting to use this type of assessment to set up longitudinal studies, valuable information can be obtained and analyzed over a much longer period of time. The student survey used in my data collection served as a “draft” of sorts to begin looking at how to obtain measurable and useful feedback directly from students.

During the course of this study, participating groups focused on one of two main content curricula: *Snow science* (Appendix A) and *Forest ecology* (Appendix B). Instructors used these curricula as the basis for planning and preparing lesson activities, experiences, and assessments. Participating groups were able to choose appropriate curricula based on their academic needs, but have their own individual learning or development goals as well. These are typically communicated with administrative staff prior to their KSS trip and reviewed with instructional staff during chaperone orientation upon arrival to KSS. Instructors are then more able to adapt their use of outdoor education methods and strategies to best fit the needs of individual groups and students.

Study Participants

During the six-week period of data collection, I obtained feedback from a total of 315 students from 9 participating school groups (one school brought three separate groups of students at different times, and were each counted as individual groups). With a nearly equal amount of participation from male and female students throughout the study (Table 1), students ranged from 4th grade through 8th grade, and ages 9 to 16.

Table 1

Distribution of Student Participants by Grade Level, Age, and Gender (N=315)

Age	Gender	Grade 4	5	6	7	8	U	Sum	TOTAL
9	boys	16					1	17	**31**
	girls	14						14	
10	boys	20	13				1	34	**61**
	girls	15	11	1				27	
11	boys		15					15	**32**
	girls		16		1			17	
12	boys		1		24			25	**74**
	girls			3	46			49	
13	boys				37	8		45	**85**
	girls			1	32	7		40	
14	boys				1	13		14	**27**
	girls				1	12		13	
15	boys							0	**1**
	girls					1		1	
16	boys					1		1	**1**
	girls							0	
U	boys		1				1	2	**3**
	girls				1			1	
Sum	boys	36	30	0	62	22	3	**153**	
	girls	29	27	5	81	20	0	**162**	
TOTAL (Grade)		**65**	**57**	**5**	**143**	**42**	**3**		**315**

Although I did not collect other demographic data from individual participants, student ethnic demographic statistics (Table 2) were obtained indirectly from each participating school through a teacher survey used by KSS. While the demographic surveys report participation by 318 students, I received voluntary feedback from 315 students, indicating about 99.1% participation by students in the study. Approximately 89% of all students attending Keystone Science School during the period of data collection were Caucasian, approximately 5% were reported as Asian American, approximately 3% were reported as African American, approximately 3% of Latino or

Hispanic origin, less than 1% Native American and less than 1% were reported as "other."

Table 2
Student Demographic Data (N=318)

School	Date	Topic	Ethnic Origin (No. of Students)					
			Caucasian	Native Amer.	Asian Amer.	African Amer.	Latin Amer./Hisp.	Other
Graland	2/9/12	Snow Science	57	1	5	1	1	0
Renaissance I	2/10/12	Forest Ecology	17	0	1	0	0	0
Kiowa	2/17/12	Snow Science	27	0	0	1	1	1
Elbert	2/17/12	Snow Science	25	0	1	0	0	0
Renaissance II	2/22/12	Forest Ecology	43	0	1	2	1	0
St. Anne's	2/24/12	Snow Science	30	0	3	4	3	0
Renaissance III	2/29/12	Forest Ecology	45	0	1	0	0	0
Most Precious Blood	3/12/12	Snow Science	24	0	0	1	2	0
Broomfield	3/14/12	Snow Science	16	0	3	0	0	0
Total			**284**	**1**	**15**	**9**	**8**	**1**

Data Collection Methods

Each group of participants was able to provide a unique perspective on student engagement while attending Keystone Science School. Several data instruments (Table 3) were designed to collect qualitative and quantitative data from participants with varying roles and perspectives about student engagement in science.

Table 3
Data Instrument Matrix

Focus Question	Data Instrument		
	Student Survey	Teacher Questionnaire	Instructor Observation
1. How are lessons taught at Keystone Science School effective at engaging students in science?	X	X	X
2. In what ways do students perceive that teaching methods and strategies at Keystone Science School differ from traditional classroom science lessons?	X	X	X
3. Why do teachers choose to have their students participate in programs at Keystone Science School?	X	X	X
4. What challenges do teachers face in organizing trips to visit Keystone Science School?	X	X	

Prior to implementing any data instrument for this study, approval from Dave Miller, School Programs Director at Keystone Science School was obtained (Appendix C). The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix D).

When any group arrives on the KSS campus, several events typically happen. First, students and chaperones are allowed a brief time to transport their luggage and belongings from buses to their overnight dormitory facilities. All females stay in one cabin, and all males in another. After settling in, students are brought to the main dining hall where KSS support staff go through general expectations with students. Meanwhile, teachers and chaperones attend a separate meeting with the KSS instruction staff. This was a critical time in my study, as this is when teachers were presented with the general purpose and scope of research, and granted verbal approval to collect data from their respective group. Without this consent, data collection for a group could not have proceeded.

Throughout the development and implementation of data collection methods, KSS staff was briefed on the purpose, focus, and context of each item. I relied heavily on staff to collect data, particularly the data obtained directly from students and teachers. Since each school group had a lead KSS instructor who took on the responsibility for collecting much of the data on my behalf, it was essential to have as much consistency as possible to minimize bias. Prior to data collection, KSS staff were debriefed on preferred data collection methods, and given a rehearsal demonstration so that they were able to see how I wished data to be collected and ask questions and provide input about data collection procedures.

Student Survey

Perhaps the most valuable data available for this research came directly from student participants. As one of the last activities before the departure of a school group, students are given several moments to voluntarily complete an anonymous survey (Appendix E). A great deal of discussion with KSS staff and my support team went into the timing of this survey administration. Before loading their buses to return home, all students gather in the dining hall and debrief about their KSS experiences. This debrief varied with the specific curriculum used for a group. In the past, students typically transitioned from the debrief into lunch and were treated with a slide-show of music and photos from their experiences over the past three days. Students were allowed to go to the school store, wrap up any curriculum items with their teachers, socialize, etc. and finally gather gear and load their buses. To create the least impact to the flow of the program, and to gain the most reliability in data, we decided the ideal time to administer the survey would be after the debrief and before lunch. The rationale behind this is that immediately after the debrief, students have a more holistic view of their total experience and can provide their overall opinions about the program, and also because these ideas are still fresh in their memories.

As I was not always the person to administer the survey, I spent time with staff before official research began to prepare a procedure for this to ensure as much consistency as possible. The introduction piece delivered to students highlights the importance to KSS in receiving feedback. We wanted to make the things we did well even better, and to fix the things that did not go as well so future participants will have the best experience possible. It was pointed out to students that KSS truly values their feedback, so it would only work if two criteria were met: a) student responses are *their* responses, not their neighbors, and b) student responses are honest. This was to be done with some levity, as the intent was for students to *want* to fill the survey out completely as opposed to feeling like they *had* to fill it out.

The format of the survey is also very intentional. In my experience, school assessments are often bland and official-looking, so I attempted to have the surveys not physically resemble these sorts of assessments. The surveys themselves were printed on soft-green-colored paper, and I gave as much space as possible for responses to allow students the freedom to express themselves. I tried to incorporate colorful imagery and "kid-friendly" language to make them more easily understood by a wider range of students. These designs were meant to increase student buy-in to the purpose of data collection and increase both depth and reliability of responses. Prior to the official survey, several "pilot" school groups provided data in a similar manner. Based on feedback from KSS staff and MSSE colleagues, both the format of the survey and the process of data collection were adjusted to ensure the most efficient and reliable data.

Teacher Questionnaire

The intent of the teacher questionnaire (Appendix F) was to gain a different perspective on student engagement in science. Teachers who spent time organizing trips to Keystone Science School for their students did so with some obvious intent. Through the questionnaire, I attempted to decipher specific parts of that reasoning and apply to the research questions (Table 3). The questionnaire items were intentionally broader and more open-ended than the student survey in the hopes of to yielding more "expressive" qualitative data.

Similar to the student survey, timing for the administration of the questionnaire was an important factor in data collection. After approving the data collection, teachers and chaperones were introduced to the questionnaire during the initial orientation. Teachers and chaperones have quite a different use of time while at Keystone Science School than students. The rationale was to give teachers the chance to look over the questionnaire items early in their experience, and have time to think and respond to those items as they found time to do so. There are typically several times, particularly during the evening academic or team-building programs, that teachers are present but not active in programs, and I saw this as an ideal time to fill the questionnaires out. As students completed their surveys on their final day, teachers could also use that time to reflect and include additions to their questionnaire before they submitted it along with the student surveys. Prior to the official data collection period, the teacher questionnaires were presented to "pilot" school groups and participating teachers provided data. Based on feedback from KSS staff, MSSE colleagues, and the teachers participating in the pilot study themselves, items on the questionnaire were adjusted and the process of data collection refined to ensure the greatest amount of reliability and validity.

Instructor Observation

A third component of data collection came from actual field observations. While using literature to identify and investigate specific outdoor education methods and strategies, observing KSS instructors use them in practice is important to analyze how these methods are truly affecting student engagement. From the perspective of a passive observer, I was able to accompany field groups on their lessons and record observations about specific aspects of their activities. In this way, the research remains much more specific to Keystone Science School, rather than to the outdoor education industry in general.

To correlate observations from lesson to lesson by different instructors, I adopted an instructor observation form (Appendix G) from Horizon Research Inc. (2005). On this form, I recorded the amount of time an instructor engaged students in particular types of activities. Prior to the actual study, I performed a pilot lesson observation. Feedback from teachers, chaperones, students, and KSS staff was then used to establish a procedure for field observation. This helped maintain my role as a passive observer, minimizing impact on the structure of the lesson and group dynamics and ensuring reliability and validity of data.

Before accompanying groups in the field, I met with respective field instructors to discuss the general scope and logistics of each planned lesson. We discussed activities that preceded outdoor lessons and activities that were scheduled to follow. By putting lessons in this sort of context, I was able to gain a more clear understanding of learning goals and objectives associated with each lesson. This also ensured that I would be observing lessons focused on academic/science content, and not specifically on physical skill development (e.g. snowshoeing, cross-country skiing, etc.). Providing my own transportation, I met groups at trailhead locations where instructors introduced me to the group and I briefly explained my role as an observer. Because the chaperones acted in a similar passive role in the field, I typically spent the majority of the lessons observing in the background with them. Through interactions with chaperones, my presence intentionally seemed more natural within the group, and subsequent conversation with chaperones allowed me to gain a deeper sense of each particular school's culture and background. During observations, I used a wristwatch to mark the time a certain type of activity commenced, marking when the format of the activity stopped or changed, and noting these times on the observation form (to the nearest minute).

While students were engaged in different activities throughout the lesson, I also recorded personal observations of student engagement in a field journal. The purpose of the field journal was to focus observations and describe reactions of students, chaperones, and instructors in response to different techniques. These personal reflections allowed me to relate understanding of outdoor education methods and strategies, their application in the field, and their effect on student engagement.

DATA AND ANALYSIS

The data instruments utilized in this study provided a great deal of qualitative and quantitative information to help answer the four focus questions. As previously stated, the format for this study was descriptive in nature and designed to provide a cross-sectional analysis. The objective of the data analysis is to identify correlations that exist as variables systematically change with one another (or groups of variables). For instance, as ages or genders of students change, do responses to certain items follow a trend. Taken as a snapshot in time, the results reveal several interesting patterns, offering a great deal of insight into how Keystone Science School effectively uses outdoor education methods and strategies.

Student Survey Results

A large amount of valuable information in this study came directly from student responses on a student survey (Appendix E). Each item on the survey served to identify particular variables and allowed correlation between students' responses and the context or conditions in which they participated. The first section of the survey collected basic demographic data from participants while maintaining anonymity. This data included school of origin, grade level, age, gender, and corresponding KSS instructor during academic sessions. The latter part of the survey collected information about students' perceptions and attitudes about their experience at Keystone Science School. To simplify data analysis, these questions were assigned a "question number" (Question 1 = Q1, Question 2 = Q2,…Question 14 = Q14).

I was also able to indirectly obtain other data for each student, such as topic studied (based on school surveys already used by KSS) and weather conditions during the time frame of each group's visit (according to www.weathersource.com, obtained from a weather recording station within a mile of Keystone, Colorado; Appendix H). The average maximum daily high temperature (tMax) during each student's experience was important to gain a general sense of environmental conditions in which students participated.

Being comfortable in the learning environment can be especially challenging in the outdoor setting, but was a key factor in gauging student attitudes toward learning science. In addition to academic content, Keystone Science School program objectives focus on putting students in a mindset conducive to positively approaching physical and emotional challenges, thus minimizing distracting factors and increasing enjoyment in the learning process. Various items on the student survey were helpful in determining factors of student comfort levels.

Question 3 (Q3) asked students directly if they felt more comfortable learning in a classroom environment or in the outdoors. An attitude scale from 0 to 10 was used, with "5" serving as the equal or impartial response, "classroom" preference skewing to the left and "outdoor" preference skewing to the right. It was implied by the use of graphics (See Appendix E) that a response farther from "5" indicated a greater preference for the given environment. Once data was obtained from all participants, the scale was adjusted by subtracting 5 from each response making "0" the value for an impartial response.

Positive values (maximum of 5) indicated outdoor preference and negative values (maximum of -5) indicated classroom preference, with the greater absolute value indicating greater preference for the respective learning environment. Approximately 66% of students surveyed (*n*=207) indicated a higher comfort level in an outdoor learning environment (Q3>0), 10% (*n*=32) a higher comfort level in a classroom environment (Q3<0), and 24% (*n*=76) remaining impartial toward their learning environment. Overall, the average score was 2.19 (*SD* = 2.68) on the adjusted scale. Plotting student responses to Q3 (Figure 1) revealed obvious differences in responses by different groups of students.

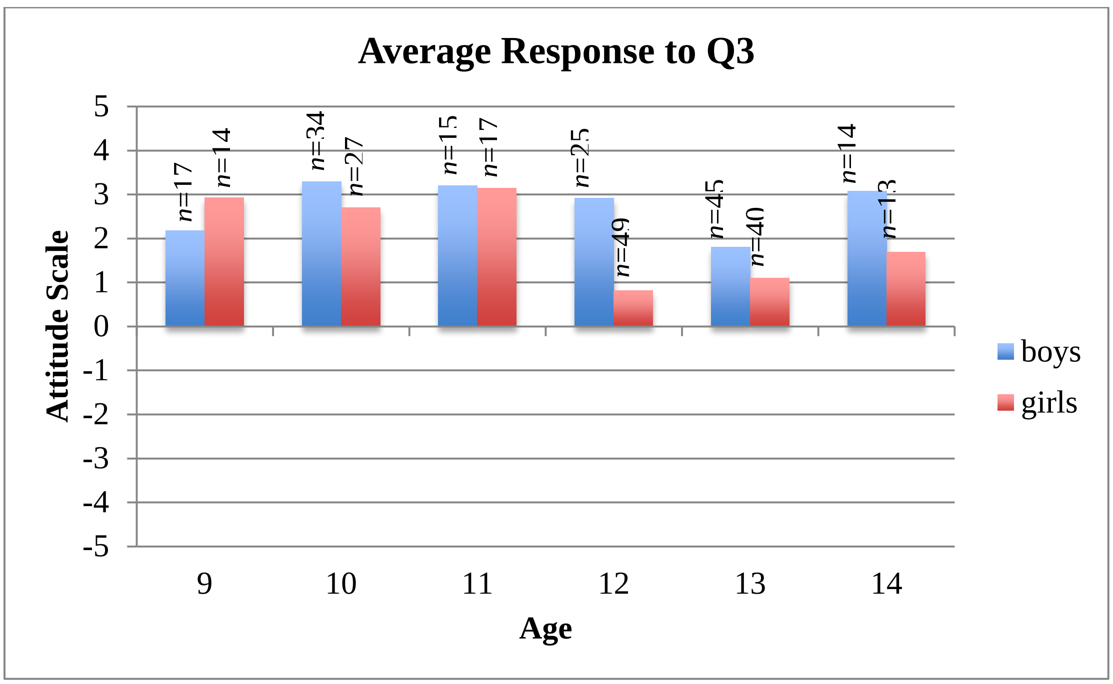

Figure 1. Average response to Q3 by age and gender, (*N* = 310).

Overall, boys (*n*=153) responded to Q3, regarding comfort level learning in the outdoors, with an average (adjusted) score of 2.67 (*sd* = 2.73), and girls (*n*=162) responded with an average score of 1.73 (*sd* = 2.45). Using a two-tailed independent (unpaired) t-test, a strong statistical significance for comfort level related to gender, $t(301) = 3.17$, $p = .002$, indicating boys typically felt more comfortable learning in the outdoors than girls. When asked (on the student survey) how learning science outdoors is different from learning in a classroom, examples of responses from boy participants regarding comfort learning in an outdoor setting included: “It was calmer and more wide open. We were not all crunched together;” “Outside: fresh air, sun, light breeze, fresh pine. School: hot, stuffy, boring;” “I find it different because the outdoors makes you very focused and relaxed. Being in a classroom can be very boring.”

Students were further categorized into age brackets of younger (ages 9 to 11) and older (ages 12 to 14); other ages were omitted due to small n-values. Younger students (n=124) responded with an average score of 2.94 (sd = 2.51) while older students (n=188) responded with an average score of 1.65 (sd = 2.66). There was a strong statistical significance relating reported comfort level to age, $t(274) = 4.32$, $p < .001$, with younger students reporting a higher comfort level learning outdoors than older students. In response to the student survey question regarding differences between outdoor science lessons and classroom science lessons, responses from younger students regarding comfort learning in an outdoor setting included: “Well, I think it is funner [*sic*] and it is not boring like the classroom where you just sit and listen;” “Well, when you’re in a classroom you’re stuffy and hot. But when you’re outside you’re free!”

Further comparing younger girls (n=58), who responded with an average of 2.89 (sd = 2.26) on Q3, to older girls (n=102), who responded with an average of 1.04 (sd = 2.33), also revealed a statistical significance for girls’ age to comfort level, $t(122) = 4.92$, $p < .001$, with a much higher comfort level among younger girls than older girls. This significance leads me to believe that comfort levels learning in the outdoor setting may be very dependent on both age and gender. Although not as obvious or apparent during my field observations, these observed trends help answer how outdoor lessons at KSS are ultimately effective at engaging students in science. In recognizing the difference in comfort levels for genders and ages, KSS staff can more effectively develop their instructional techniques and methods to better meet the needs of individual students and increase overall engagement for students of all ages and genders.

To further analyze the effect of gender on comfort levels, student genders were cross-referenced with genders of instructors (Table 4). Students were categorized by both their gender (boys, girls) and the corresponding genders of their instructors (male, female). Independent two-tailed t-tests were used to indicate statistical significance of responses from these groups of students.

Table 4
Student Survey Question Three (Q3) Analysis by Student and Instructor Genders (N=305)

Variable: Instructor Gender		**T-Test Result**
Boys w/ Male instructor *average response: 2.94* *n=35*	Boys w/ Female instructor *average response: 2.65* *n=114*	*t*(55) = 0.54 *p* = 0.595
Girls w/ Male instructor *average response: 2.46* *n=50*	Girls w/ Female instructor *average response: 1.50* *n=106*	*t*(107) = 2.45 *p* = 0.016

Variable: Student Gender		**T-Test Result**
Boys w/ Male instructor *average response: 2.94* *n=35*	Girls w/ Male instructor *average response: 2.46* *n=50*	*t*(60) = 0.84 *p* = 0.405
Boys w/ Female instructor *average response: 2.65* *n=114*	Girls w/ Female instructor *average response: 1.50* *n=106*	*t*(218) = 3.27 *p* = 0.001

Overall Comparison		**T-Test Result**
Same gender *average response: 1.86* *n=141*	Opposite gender *average response: 2.59* *n=164*	*t*(295) = 2.44 *p* = 0.015

These results indicate that girls comfort level while learning outdoors was strongly related to the gender of their instructor, indicating a much higher response with male instructors. Especially among those with male instructors, when asked what the best part of their KSS experience was, several students indicated their instructor: “Getting to meet my instructor, [*name*]. He is funny and a teacher who lets me learn through exploration;” “Having fun with friends and instructors;” “Skiing and seeing [*instructor’s name*]’s different pants;” “ It should also be noted that because average responses have a positive value, comfort levels are skewing towards the outdoor settings for all age and gender groups, just to varying degrees. As with recognizing gender and age of students, this data can be used by instructors to better understand their role and effect on student comfort level to develop into more responsive and effective educators and leaders.

In addition to age and gender, responses to Q3 were compared to the maximum daily temperature for each student. Prior to analysis, I predicted there would be a strong positive correlation between outside temperature and comfort levels learning in an outdoor setting (i.e. as temperatures decrease, so would comfort levels). Surprisingly, the tMax appeared to have little statistical significance for student comfort level ($t(59) = 0.26$, $p = 0.79$). One possible reason for this observation could be that students remained comfortable during even harsh conditions because they were adequately prepared for these challenges and were properly equipped to handle challenging environmental conditions.

Another indicator of how comfortable students were while learning outdoors came with Question 4 (Q4) of the student survey. This item used a 10-point attitude scale to assess in which environment (classroom or outdoors) students felt they were more able to learn science. The results of Q4 were adjusted in a similar fashion to Q3 so zero (0) became the neutral response, positive values showed preference toward the outdoor learning environment and negative values preference toward classroom learning. The absolute value of each (0 – 5) indicated the degree of preference. I use this item as an indicator of comfort level by directly correlating students' perceptions of their *ability* to learn and their positive *attitude* of learning. It is my assertion that students who perceived a greater sense of success learning in a particular setting were also comfortable and focused enough to have prevented emotional, psychological, or physical distractions from overpowering their cognitive and critical thinking abilities. 80% of students (n=251) surveyed indicated a greater ability to learn science in an outdoor setting (Q4>0), 9% (n=27) indicated greater ability to learn science in a classroom environment (Q4<0), and 12% (n=37) remaining impartial or neutral toward their learning environment. Overall, the average score was 3.01 (SD = 2.52) on the adjusted scale, in favor of an outdoor setting. On the student survey, when asked how learning science outdoors is different from learning science in a classroom, several students discussed the perceived effectiveness of their outdoor experience on learning: "You can interact more with things in their natural habitat [which] is much more useful to those who learn more visually;" "You get hands-on experience, and for me anyway, I seem to remember things better;" "It is more hands-on and memorable;" "In the outdoors you can see, smell, and touch. It's like textbooks coming to life!" Analyzing how several sub-groups of students (e.g. age, gender, etc.) responded to Q4 yielded no statistically significant relationships.

Student survey Question 10 (Q10) (Table 5) asked students "What was the hardest thing about coming to KSS?" while question eleven (Q11) (Table 6) asked students

"What was the best thing about coming to KSS?" Responses to these questions provide an opportunity to analyze factors contribute to comfort (or discomfort) levels from students' perspectives. These data serve to show what aspects of programming at Keystone Science School are effective at engaging students in the learning experience.

For the purpose of data analysis, student responses to Q10 and Q11were put into categories based on emergent trends and themes. Students frequently commented in multiple ways, so were therefore counted in multiple categories as appropriate. For instance, a student response to Q11 was "*learning how to ski and meeting lots of new faces*" and was counted in two categories: "Physical activities" and "Social aspect."

Table 5
Student Survey Question Ten (Q10) Response Summary (N=315)

Q10 Response Category	**Example Response**	**% Responding**
Missing family / homesickness	*"Leaving my family"*	20.00%
Physical activities	*"Cross-country skiing"*	19.68%
Weather/conditions	*"The cold weather"*	14.6%
Sleeping	*"Sleeping in a different bed"*	9.84%
Travel	*"Bus ride for 2 hrs."*	7.62%
Packing	*"Packing"*	6.67%
No electronics	*"The hardest thing was having no electronics"*	3.81%
Learning	*"Learning all the stuff"*	3.49%
Food	*"(Adjusting to) the food"*	0.32%
"Nothing"	*"Nothing"*	6.67%
Other	*"Little time in the shower"*	5.71%
No response		4.44%

Table 6
Student Survey Question Eleven (Q11) Response Summary (N=315)

Q11 Response Category	**Example Response**	**% Responding**
Physical activities	*"Snowshoeing"*	35.87%
Social aspect	*"Being with my friends"*	24.13%
Learning	*"We learned new things!"*	14.92%
"Fun"	*"It was fun"*	10.48%
Environment/Being outdoors	*"Spending time outside"*	8.89%
KSS Instructor(s)	*"Meeting my instructor"*	4.44%
Food	*"The food"*	3.17%
"Everything"	*"Everything!"*	5.71%
Other	*"Getting a souvenir"*	8.89%
No Response		2.54%

A relatively large portion of students, 35.87%, enjoyed the physical activities associated with their experience. 19.68% of students also described physical activities as the hardest part of their KSS experience, but not frequently in a negative tone. 24.13% cite the social aspect, along with another 4.44% of students stating their relationship with their instructors, as part of the cooperative learning communities formed at KSS as what they liked most about their experience. For many students (20%), leaving the comfort of home and family was the most difficult part of the KSS experience. This isn't to say these students were necessarily *un*-comfortable while at Keystone Science School, but it is important to note that these students recognized a challenge with being in an unfamiliar learning environment. Keystone Science School program objectives involve being upfront and intentional about addressing homesickness, leading to students having a positive personal growth and development experience, transferring to the associated academic content. Based on findings in my literature review, I predicted a significant population of students would have cited lack of access to electronics for the duration of their experience at KSS as one of the most difficult things they had to deal with. Surprisingly, only 3.81% of students surveyed responded to Q10 this way. This is indicative of "engagement" in the learning process, as students may not spend as much time or energy seeking out personal distractions they may be accustomed to, such as electronic devices (cell phones, mp3 players, etc.).

In addition to measuring student comfort levels and possible sources for those feelings, gauging student attitudes toward learning science can also be supported by analyzing how successful students felt in their learning process. While the student survey was not designed to measure content understanding directly, Question 1 (Q1) and Question 2 (Q2) asked students to measure their own sense of learning before (Q1) and after (Q2) their KSS experience. Students responded on a 10-point interval scale indicating the level of understanding of the topic at two points in time. The difference in responses to Q1 and Q2 qualitatively indicated the degree to which students felt they were able to learn (i.e. effectiveness of the KSS experience in their learning). My assertion is that if students express confidence in learning more about the subject studied, this can be correlated to generally more positive learning experiences, and therefore more positive science-learning attitudes. Overall, students indicated an average score of 4.49 (*SD*=2.10) for Q1 (understanding of the topic before the KSS experience) and 8.58 (*SD*=1.38) for Q2 (understanding of the topic after the KSS experience) with an average increase of 4.09 (*SD*=2.23) from Q1 to Q2. When comparing results among sub-groups of students (e.g. age, gender, tMax, etc.), no statistical significance of response tendency was observed. This tells me that overall, KSS outdoor experiences were ultimately effective at engaging students in learning science with the majority of participants.

Independent of their responses to Q1 and Q2, and perhaps more importantly from Q3 and Q4, Question 5 (Q5) asks students to describe how learning outdoors is different from learning in a classroom. Responses were extremely varied, but several trends became obvious during data collection and revealed insight into how methods and strategies were effective at engaging students in learning science. To analyze the qualitative data provided by results to Q5, I created categories to encompass a variety of responses (Table 7). While several categories encompass similar ideas, different categories were created to capture students' use of particular language and vocabulary. For instance, if a student's response included the term "hands-on" to describe learning outdoors, the response was recorded in the category "Outdoor learning is more 'hands-on.'" If a student used a form of the word "explore," the response was recorded in the category "Outdoor learning involves more exploration." Students frequently commented on aspects of outdoor learning versus classroom learning in multiple ways, so were therefore counted in multiple categories as appropriate. For instance, a student response to Q5 was "It is different because I feel trapped indoors and don't work as well. I feel more open and hands-on." This response was counted in two categories: "Outdoor learning has more open air / 'free space'" and "Outdoor learning is more hands-on." Also, when students referred to outdoor learning as being more sensory, many cited specific senses, so additional categories were used to account for these instances. This method of categorizing prevented comparison of overall percentages of responses, but allowed for students' personal responses to be more accurately categorized.

Table 7
Student Survey Question Five (Q5) Response Summary (N=315)

Q5 Response Category		**Example Response**	**% Responding**
1) Outdoor learning is more “hands-on”		*“It seems more hands-on because I feel I am able to be where what I am learning happens”*	20.32%
2) Interact with / experience nature in the outdoors		*“You learn stuff through experience, not a textbook”*	17.78%
3) Outdoor learning involves more “exploration”		*“When you are outdoors you get to explore outside. When inside a classroom you don’t get to do a lot of exploring”*	3.17%
4) Outdoor learning is more active/kinesthetic (learn by actively “doing” science)		*“Learning science in the outdoors is different than indoors because outdoors you actually get to do it, but indoors you just hear it”*	20.63%
5) Outdoor learning is more sensory		*“Learning science in the outdoors gives the student a first-hand sense of the subject, and it allows the student to experience the subject using all of the senses”*	23.49%
	6) Touch/Feel	*“In the outdoors you can see, smell, and touch. It’s like textbooks coming to life!”*	4.13%
	7) Visual		20.32%
	8) Smell		1.59%
	9) Auditory		0.63%
10) Outdoor learning is more “fun”/”exciting”/”adventurous”		*“It [outdoor learning] is more fun and exciting””*	13.02%
11) Outdoor learning is more interesting (less boring)		*“Learning outside keeps me more interested and inside its boring”*	5.08%
12) There are more learning opportunities in the outdoors		*“You get to do more things that you can not do in a classroom”*	7.62%
13) There is more time to learn in the outdoors		*“Learning outdoors puts you hands-on the topic that you are learning. You can still learn hands-on in a classroom through labs, but it is nothing like learning about stuff all day every day outside for 8 hours. I really enjoy hands-on type of topics that get me messy and laughing”*	0.95%
14) Outdoor learning has more open air / “free-space”		*“It [outdoors] was calmer and more wide open. We were not all crunched together”*	8.89%
15) It is more peaceful in the outdoors		*“A lot more peaceful, and its much more interesting”*	1.27%
16) Weather / environmental conditions (positive/neutral)		*“Outside: fresh air, sun, light breeze, fresh pine. School: hot, stuffy, boring”*	4.44%
17) Weather / environmental conditions (negative)		*“Its cold and miserable without extra stuff”*	3.17%
18) Learning outdoors is more tiring		*“Learning science in the outdoors is different from learning in a classroom because its fun to be outdoors, but it’s tiring.”*	0.63%
19) Harder to focus / more distractions outdoors		*“It is more exciting to learn outdoors, but harder to focus”*	4.76%
20) Other		*“The difference is you’re outside”*	2.86%
21) *No response*			2.22%

The vast majority of responses centered around the *active* nature of outdoor learning experiences, most specifically in Categories 1 (20.32%), 2 (17.78%), 4 (20.63%), and 5 (23.49%). Students reported feeling much more involved and connected to the topics through genuine and direct experiences with the topics they were studying. Examples of student responses include: “You learn from experience, not a textbook;” “It is more hands-on outdoors because you went to the place, performed the experiment, and went back. You also had to be more focused;” “Classroom learning is paper in front of you, and outdoor learning you have the whole woods to explore;” “Learning outdoors puts you hands-on the topic that you are learning. You can still learn hands-on in a classroom through labs, but it is nothing like learning about stuff all day every day outside for 8 hours. I really enjoy hands-on-type of topics that get me messy and laughing.”

When comparing responses from groups of students to the overall averages for given categories, age was the only factor showing significant differences in several categories (the three students not reporting ages within 9-11 or 12-14 were omitted due to small *n*-values) (Figure 2).

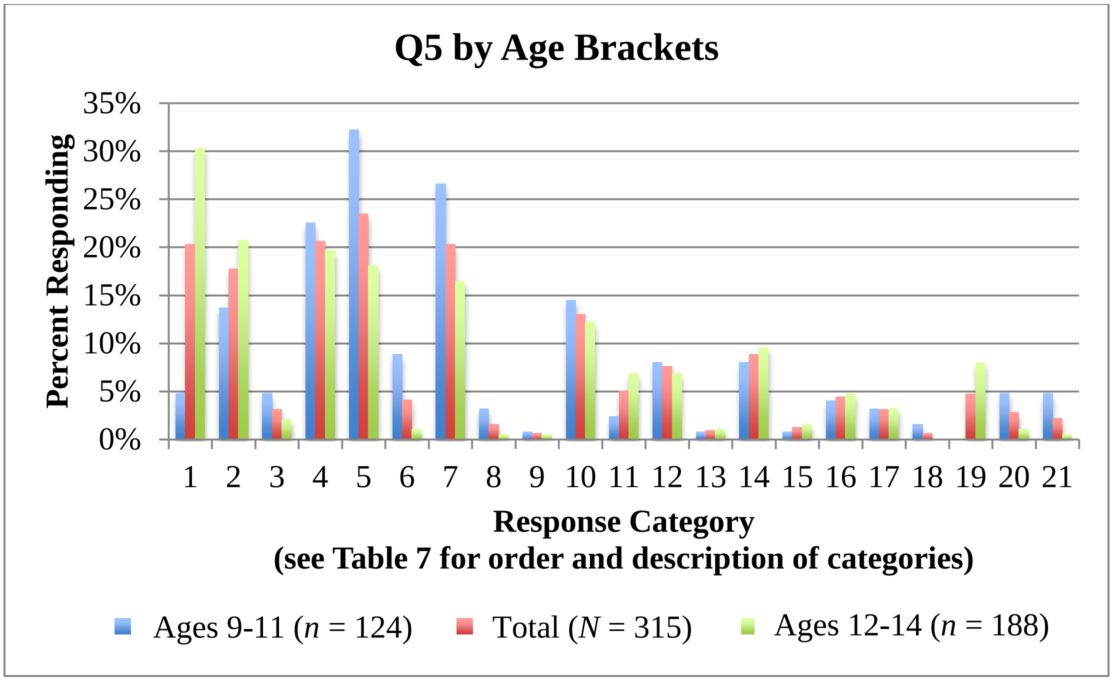

Figure 2. Summary of responses to Q5 by age, (N = 315).

Older students tended to respond with a significantly higher frequency in Category 1 (Outdoor learning is more “hands-on”), while younger students were much more in tune with the sensory aspect of outdoor learning. Specifically, younger students cited touch/feel and visual senses much more frequently. In regards to the more negative responses to Q5 (Categories 17, 18, and 19), older students also accounted for the majority of responses. Eight percent of 12-14-year-olds responses (n=15) were counted in Category 19 (Harder to focus / more distractions outdoors), while nearly 0% (n=1) of students age 9-11 responded similarly. It is difficult to explain why age would be such a determining factor in these categories, while other factors have a much lower correlation to responses. When students transition from elementary experiences to middle school classroom environments, perhaps they grow accustomed to a different teaching style and classroom structure. Further investigation and observations into this matter would be necessary to make such a conjecture.

Another method of gauging student attitudes and the effectiveness of outdoor education methods and strategies is to look at what students had to say about their instructors. Question 7 (Q7) was a three-part item. Using a 10-point interval scale, the first part of Q7 asked students: "How would you rank the ability of your KSS instructor as a teacher." The second part asked students to remark on things instructors did well, while the third part asked what their instructors could do better. On average instructors received an average score of 8.89 (*sd*=1.67), indicating the majority of students felt strongly that their instructors were highly effective as teachers. There was a statistically significant effect between for instructor gender, $t(204) = 5.09$, $p < .001$ with male instructors receiving higher scores, as well as for student age, $t(301) = 4.52$, $p < .001$. A further analysis using a series of independent two-tailed t-tests was performed to determine if a connection between instructor genders, age, and particular groups of students existed (Table 8 and Table 9).

Table 8

Student Survey Question Seven (Q7) Analysis by Student and Instructor Genders (N=305)

Variable: Instructor Gender		**T-Test Result**
Boys w/ Male instructor *average response: 9.57* *n=35*	Boys w/ Female instructor *average response: 8.57* *n=114*	$t(127) = 4.59$ $p < .001$
Girls w/ Male instructor *average response: 9.41* *n=50*	Girls w/ Female instructor *average response: 8.76* *n=105*	$t(152) = 2.79$ $p = 0.006$

Variable: Student Gender		**T-Test Result**
Boys w/ Male instructor *average response: 9.57* *n=35*	Girls w/ Male instructor *average response: 9.41* *n=50*	$t(80) = 0.83$ $p = 0.408$
Boys w/ Female instructor *average response: 8.57* *n=115*	Girls w/ Female instructor *average response: 8.76* *n=105*	$t(213) = 0.76$ $p = 0.449$

Overall Gender Comparison		**T-Test Result**
Same gender *average response: 8.96* *n=140*	Opposite gender *average response: 8.83* *n=164*	$t(288) = 0.71$ $p = 0.481$

Table 9

Student Survey Question Seven (Q7) Analysis by Student Age and Instructor Genders (N=305)

Variable: Student Age		**T-Test Result**
Boys, ages 9-11 *average response: 9.30* *n=66*	Boys, ages 12-14 *average response: 8.42* *n=84*	$t(139) = 3.44$ $p < .001$
Girls, ages 9-11 *average response: 9.43* *n=58*	Girls, ages 12-14 *average response: 8.75* *n=101*	$t(155) = 2.97$ $p = 0.003$

Variable: Student Gender		**T-Test Result**
Boys, ages 9-11 *average response: 9.30* *n=66*	Girls, ages 9-11 *average response: 9.43* *n=58*	$t(122) = 0.71$ $p = 0.481$
Boys, ages 12-14 *average response: 8.44* *n=84*	Girls, ages 12-14 *average response: 8.75* *n=101*	$t(177) = 1.14$ $p = 0.254$

As evident in the results of these analyses, the gender of the student was not nearly as significant as the gender of the instructor or age in determining responses to the first part of Q7. Students of both genders tended to score male instructors higher than their female counterparts. Younger students tended to score their instructors higher than did older students. Similar analyses were performed with tMax, yielding no significant correlation between environmental conditions (i.e. temperature) with students' rating and teaching abilities of their instructors. This tells me that students either simply did not take environmental conditions into effect when rating their instructors abilities, or the instructors themselves were successful in preparing students for dealing with environmental conditions while in the field. This is important in understanding the importance both mental and physical preparation have on the attitudes of students toward their learning experience.

In summary, many items on the student survey served to gain a deeper understanding of student attitudes toward learning science in the outdoors. Three factors emerged frequently as important in determining comfort levels, engagement, and effectiveness of outdoor education methods and strategies: student age, student gender, and instructor gender.

Teacher Questionnaire Results

Of the nine participating school groups, five teachers provided feedback for this study via the Teacher Questionnaire (Appendix F). One school participated three different times with different students, but the same lead teacher (who provided feedback once). Eleven items of the questionnaire provided mainly qualitative results, and were very helpful in providing a backdrop for students' outdoor learning experiences at

Keystone Science School from the teachers' perspectives. This anecdotal evidence was especially useful to determine why teachers find KSS programs valuable, and to gain a sense of what difficulties teachers face in setting up programs with KSS.

According to responses to the second question, "How many years/sessions have you attended Keystone Science School as a teacher?" all teachers had previous experiences with students at KSS (responses: 2, 3+, 8, 14, 17). By choosing to return to KSS with new students each year, teachers demonstrate that they find KSS programs extremely valuable. Item 3 on the questionnaire asks teachers directly "What are reasons you chose to have students participate in the program at Keystone Science School?" (Table 10).

Table 10
Teacher Questionnaire Item Three Response Summary (N=5)

Teacher	Item Three Response: *What are reasons you chose to have students participate in the program at Keystone Science School?*
A	"The winter program is extremely educational for our students"
B	"Variety of curriculum; Cost"
C	"Strong science and outdoor ed. Experience; strong environmental focus; we are an Expeditionary Learning school"
D	"It is a great way for our kids & teachers to get out of the classroom and see each other in a different venue. We love this place for making our kids grow up a little. Not easy in Feb."
E	"We consider it the "capstone" experience for our graduating eighth-graders"

Several teachers cite academic reasons, while others speak to the personal and interpersonal growth they observe students experience through overcoming challenges. In general, these responses speak to the academic benefits of direct and genuine experience with the outdoors as described in the literature review for this study. It is important to recognize that teachers consider the overall experience at KSS, including personal and interpersonal growth, as essential to the learning process and engagement of students in academic content. Teachers also recognized the opportunities for quality community and team-building while at Keystone Science School. As John Dewey (1938) points out, quality experiential-learning experiences should be shared by all members of the group, equally including teachers. In support of this idea, Item 9 of the questionnaire seeks to further address how teachers perceive differences between outdoor education experiences and typical classroom experiences (Table 11).

Table 11
Teacher Questionnaire Item Nine Response Summary (N=5)

Teacher	Question Nine Response: *Based on your experience and observations, what are differences between science lessons taught in an outdoor setting and those typically taught in a classroom setting? What are advantages/disadvantages of each?*
A	"The connection between academic content and field experience is invaluable. The values of an outdoor-oriented lifestyle is something I enjoy sharing with students"
B	"Inquiry-based is always a great way to teach"
C	"Can be more engaging taught outdoors - more experiential"
D	"Gives kids who are less academic a chance to shine"
E	"My kinesthetic learners are always more focused. I find that the pacing (classroom, hands-on, outside) of different activities [at KSS] increases their retention. Honestly, no disadvantages!"

Teachers participating in this study recognize and value the experiential and inquiry-based lessons. This supports both the idea that these experiences are important in engaging students in science, as well as that these types of experiences are much more significantly related to learning in an outdoor setting. Another indicator of the value teachers place in experiences at KSS is the final item of the questionnaire, Question 11: "Would you come back to Keystone Science School? Why or why not?" to which all five participating teachers responded "yes."

Feedback from teachers about challenges they face in organizing trips to KSS is important to understanding about value of programs and outdoor experiences. It is important to recognize how challenges may prevent or limit opportunities for students to gain these valuable learning experiences. It is also important for the administrative team and instructional staff at KSS to be aware and empathetic to problems and issues teachers face so programs can be managed and operated efficiently and effectively. Item 4 of the questionnaire directly asked teachers about challenges they have experienced in setting up the KSS trip for their students. Issues brought up by teacher participants include cost for families and the ability to find assisting scholarships, fundraising, finding chaperones, and acquiring transportation to and from KSS. These responses indicate difficulties involved with participation are not as much programmatic or content-based, but logistic in nature, primarily involving financial feasibility of participation. While teachers agree the cost to participate in KSS programs is fair, situations exist for individual families that can make covering this cost a difficult endeavor. Fundraising and scholarship is a helpful solution to this, but is not always available. Finding adult chaperones is also an aspect of participation that can also be a challenge. With other school responsibilities, finding assisting teachers for a school group can be difficult, and parents often are unable to take several days away from employment for the experience.

In summary, the teacher questionnaire provided a great deal of qualitative information about programs at Keystone Science School, and the value of outdoor education experiences. Teachers in this study found the academic, personal, and social growth opportunities valuable to their students. Challenges hinge around funding for these opportunities, and I suspect (through my own previous experience as well) that this may be a factor for some schools choosing to participate in KSS programs in the first place. Clearly, participating teacher find the academic benefits to students are worth the time and energy necessary to address challenges to provide learning opportunities at KSS.

Instructor Observation Results

When students participate in typical programs at Keystone Science School, several different techniques and strategies are used, and are predominantly dependent on styles and preferences of individual field instructors. The purpose for field observations was to look for patterns or similarities of methods used by instructors, and observe impact on student engagement. Structures of overall schedules were highly dependent on curriculum, specific group learning goals, teachers' requests for particular sections of the field journal to be completed, location of the field lessons (i.e. trail choice), environmental conditions, etc. Instructors at Keystone Science School typically use some combination of indoor learning (pre-briefing, data analyses, reflections, etc.) and outdoor learning. Throughout these lessons, academic themes are reinforced through team-building and development of physical skills as well, such as cross-country skiing and snowshoeing.

Instructor Observation Form

Throughout the period of data collection, I was able to accompany field groups on three different occasions. Because of the variation of schedules for field groups of each school group, I chose to observe and document only pre-scheduled experiences away from campus to get a picture of a true "outdoor lesson" (Table 12). Time spent by participants engaged in different types of activities was recorded on an instructor observation form (Appendix G). Time periods specifically designated for lunch and breaks (i.e. "stoppage-time") were intentionally omitted from time-percent calculations, but were nonetheless extremely valuable to my overall observations and interpretations of student engagement, as recorded in my personal field observation journal. The observations did not take into account any time spent before the field lesson activities (pre-briefing, discussions to access prior knowledge, etc.) or after the field lesson (reflections, written reports, etc.) that may have occurred. I included time spent doing "physical activity" during the lesson, as spontaneous naturalizing frequently occurred throughout the field lesson. I found that despite not being a formal aspect of the lesson, these periods of unplanned learning was extremely valuable to student engagement. I observed and recorded official time spent "naturalizing" as whole group discussions, small group discussions, or teacher presentation as appropriate.

Table 12
Instructor Observation Summary

Category	Activity	Percentage of Time / Activity: Observation 1: 2/9/12	Observation 2: 2/21/12	Observation 3: 3/13/12	Average
	Age:	12-13	10-11	9-12	-
	Student Genders:	4m, 4f	9m, 3f	3m, 6f	-
	Instructor Gender:	m	f	f	-
Listened to Presentation:	by teacher	10%	9%	7%	8.67%
	by student	6%	4%	4%	4.67%
	by guest speaker	0%	0%	0%	0%
	TOTAL:	**16%**	**13%**	**11%**	**13.33%**
Engaged in discussion seminar:	whole group	25%	25%	29%	26.33%
	small groups / pairs	8%	10%	13%	10.33%
	TOTAL:	**33%**	**35%**	**42%**	**36.67%**
Engaged in problem-solving:	manipulatives	4%	4%	0%	2.67%
	learning game	0%	6%	2%	2.67%
	followed instructions	12%	8%	10%	10%
	design investigation	6%	6%	4%	5.33%
	record data	6%	2%	4%	4%
	patterns/trends	2%	2%	2%	2%
	evaluate claims	0%	0%	0%	0%
	justif / proof	2%	2%	0%	1.33%
	TOTAL:	**32%**	**30%**	**22%**	**28%**
Engaged in reading / reflection / written communication:	read science	0%	0%	0%	0%
	text Q & A	0%	0%	0%	0%
	reading reflection	0%	0%	0%	0%
	written report	0%	0%	0%	0%
	write plan/procedure	4%	2%	2%	2.67%
	write reflection	0%	4%	2%	2%
	TOTAL:	**4%**	**6%**	**4%**	**4.67%**
Used tech/AV:	**TOTAL:**	**0%**	**0%**	**0%**	**0%**
Other:	arts/crafts	0%	0%	0%	0%
	story (listen)	0%	3%	0%	1%
	write poem/story	4%	0%	0%	1.33%
	other: (draw)	0%	0%	4%	1.33%
	TOTAL:	**4%**	**3%**	**4%**	**3.67%**
Physical (hiking, skiing, etc.)	**TOTAL:**	**11%**	**13%**	**17%**	**13.67%**

While many would rightfully argue that various basic skills such as reading and writing are extremely important to the academic growth of a student (which I would not disagree with), it is nonetheless important to recognize time spent on other skills during outdoor field experiences. It is my assertion that *types* of activities are at least as responsible (or more) for student engagement in science as the content being addressed. Notably, the percentage of time spent problem solving (average 28%) and time spent engaged in discussion (average 36.67%), both of which emphasize social and communication skills, as well as the time spent doing physical activities (average 13.67%). Based on the feedback included in the student surveys and teacher questionnaire instruments, the general outcomes support the notion that time spent studying in the outdoors using specific outdoor education methods and strategies (as indicated in Table 12) has a greater impact on student engagement. While no direct comparative classroom observation data was collected in this study, further investigation could indicate more specific strategies and methods typically used in classrooms. Based on the results of Q3, Q4, and Q5 of the student survey, there are definite perceived differences between the methods and strategies used in these settings, and both students and teachers indicate a more positive effect of these methods and strategies on student attitudes and engagement in the outdoor setting.

Observation Notes

While performing observations in the field, I also recorded thoughts and summaries in my personal journal to describe the nature of the educational experience for students. This was primarily regarding methods and strategies I observed field instructors using that stood out as very “outdoor”-specific, and how these seemed to affect student engagement. Some portions of journal entries relevant to this study discuss benefits of the social aspect of outdoor education experiences at Keystone Science School to the academic engagement by students:

> - *During the designated lunch break, several students began an impromptu snowball fight. [The instructor] jumped in and paused the battle right away, but did not tell students they couldn't have a snowball fight. Instead, [the instructor] very briefly had students discuss dangers associated with the snowball fight and with a positive attitude came up with ground rules (boundaries, legal hits, etc.) to ensure safety. Eventually the entire group, instructor and chaperone included, were participating, laughing and having a blast. They even came up with more rules to make it more challenging for some (a welcome challenge). This was an important time for the group in terms of group dynamics, establishing the adults as equal participants. This set up the rest of the day as a "group" learning experience, not just for students. Because there was organization involved, students responded much better than expected when it was time to settle down and get back to academics (2/9/12).*

The above observation summarizes how this instructor (as is common at KSS) used formal collaborative learning techniques, and allowed for the unstructured play to help establish and maintain positive group dynamics. This was immediately apparent to me as a major way that outdoor lesson strategies differ greatly from how typical classroom settings are set up. As described in the literature review, these experiences can be a powerful method in establishing positive and effective learning environments.

- I think it is important to recognize the flow of the day during the outdoor lesson. The social time in-between structured activities seem just as important as the planned activities. It allows the students to really "share" the experience. So much about the classroom seems focused on individual performance, where-as in the field, students were working together socially and help each other learn. If led and well-managed, students motivate each other to participate and engage in the experience. In the outdoors, students are continuously participating in the experience, even if they aren't directly engaged in a structured activity. The main idea is that students refer back to the over-all experience and their emotional attachment when they access their memory. If the learning isn't taken out of context from the experience, they become one-in-the-same (3/13/12).

The above observation is important in recognizing that, despite many students feeling free and open in their learning (as reported in Q5 of the student survey), there is definite organization and intentional group management that occurs in the outdoor setting. This allows the outdoor education methods and strategies to be effective in student engagement as well as meeting the academic goals and objectives. By maintaining the organizational structure of the activities, instructors seem to spend less time concerned with managing the group and are more able to address individual or small group questions. Students learn quickly they are able to work well without the direct supervision often prevalent in typical school and classroom settings, reinforcing their problem-solving abilities along with their interpersonal communication skills.

INTERPRETATION AND CONCLUSION

The purpose of this action research was to investigate how outdoor education experiences are effective at engaging students in science. As a teacher who once observed classroom students transform their attitudes towards learning science while at the Keystone Science School, and as a KSS administrator who continually received testament and praise to the quality of programming from parents and teachers, I wanted to describe what has been going on at KSS that increased engagement in science. Several measurable sub-questions helped guide my discovery throughout this descriptive research. Through data collected from student surveys, teacher questionnaires and outdoor lesson observations, I focused on how lessons at KSS were effective at engaging students in science, what specific methods and strategies were employed that allowed for student engagement to occur, what value teachers see in KSS programs, and what challenges might exist in getting students to participate in KSS programs.

Effectively Engaging Students Through Outdoor Education Methods

The first sub-question: "How are lessons taught at Keystone Science School effective at engaging students in science?" directly addresses the importance of engagement in material through effective use of outdoor education methods and strategies. It became clear through this study that students by-and-large were extremely engaged in learning science while at Keystone Science School. Students' perceptions of how much they learned while at Keystone Science School increased (80% of students surveyed indicated some increase in understanding of their topic on the student survey), observed across all groups of students analyzed (age, gender, etc). Based on the wide range of students who participated in KSS programs during the scope of this study, and the wide range of conditions that existed, these results indicated that lessons were taught in ways that addressed multiple types of students in varying conditions. Students and teachers recognized that when learning outdoors, concepts and content become more accessible to a wide range of students.

The instructor observations performed during the course of this study supported the idea of increased student engagement, as I observed students demonstrating extremely positive attitudes toward their experience, and obvious interest in topics covered. Outdoors, students reported to feel fully immersed in the learning environment, and enjoyed guiding their own discovery through hands-on activities, exploration, and sensory engagement (as indicated by responses to Q5 of student survey).

Effectively engaging students is closely related to ensuring students have positive attitudes toward learning science. The basis for this study was to analyze how students perceive that outdoor experiences differ from typical classroom experiences. The second AR sub-question: seeks to address how students in the study perceived differences in outdoor learning experiences at KSS versus classroom learning experiences. At Keystone Science School, outdoor education is extremely focused on providing experiential learning opportunities, and ensures that all lessons are designed with this in mind. Gilbertson et al. (2006) describes experiential learning as a method (or philosophy) of education that occurs through authentic experience, but is more than just having an experience outdoors; it must involve overcoming challenges and following rigorous scientific principles (2006).

It became clear throughout the study that comfort levels of students have a dramatic impact on student attitudes, especially considering the challenges that participants face. Student and adult participants spent several hours outside in the uncontrollable, and occasionally harsh, natural elements. Many participants were learning an outdoor activity like snowshoeing or cross-country skiing alongside the academic content. Several students reported on the student survey that they felt nervous or anxious prior to their experience because they weren't sure how they would handle the challenges associated with learning outdoors. Based on these comments (specifically to Q7, Q10, and Q11 on the student survey), it was evident that through positive attitudes of instructors, adequate preparation, and approach to content delivery, students became more comfortable learning in the outdoors. This is supported by results of Q3 of the student survey, in which 66% of students reported a higher comfort level learning in the outdoors compared to 10% of students who reported to be more comfortable learning in a classroom. It was obvious during my observations that comfort level was intentionally distinguished from "making things easier" by KSS instructors, so that students experienced appropriate growth and development not only academically, but socially and emotionally.

In answering the third sub-question regarding why teachers choose to have their students participate in KSS programs, it became clear that teachers value the effectiveness of the outdoor education methods and strategies used by KSS as opposed to their typical classroom experiences. What I observed in this study highlighted how aspects of outdoor lessons differ from typical classroom lessons. The amount of time spent on "active" learning, as recorded in field observations stands out as indicative of outdoor learning experiences, following inquiry-based scientific method processes and the freedom of exploration. Many students reflect this through their responses to Q5 of the student survey. Their perception of getting the chance to “do” science directly in nature allows students to feel a sense of empowerment and involvement in nature, a “connectedness” that many feel is lacking in the typical classroom setting.

Teachers tend to agree (on items three and nine of the teacher questionnaire) that the connection between academics and experience is what makes experiential learning meaningful and valuable to students. The time I observed students performing problem-solving activities (28% on average), and discussing their topics (37% on average), were predominately in community settings. By learning socially, students were able to share and discuss what they observe, learning more from each other than directly from the instructor. While at KSS, instructors take the lead academically and give accompanying teachers and chaperones the opportunity to allow students to see them in a different light (and vice-versa) while at Keystone Science School. Teachers appreciate the opportunity to come to KSS because of this bond and connection that can be established (item 3 and item 9 of the teacher questionnaire). As described in the literature review for this study, developing genuine relationships between students and teachers creates a dynamic of mutual respect, trust, empathy, and understanding. This can have a dramatic effect on student attitudes toward learning and open-mindedness that can last long after the KSS experience. Despite having a very short time to develop these meaningful bonds with students, I observed that KSS instructors were extremely successful in doing so through their own attitudes, and effective use of outdoor education methods, and strategies.

These factors together contributed to students having positive experiences, and general positive attitudes toward learning science.

Challenges with KSS Experiences

Despite receiving overwhelming amount of rave reviews from teachers and students about their experiences at Keystone Science School, there are inherent challenges that exist. In response to my AR sub-question regarding challenges that teachers face in organizing trips to KSS, one of the biggest challenges is in getting participants to KSS in the first place. Regardless of its status as a non-profit organization, Keystone Science School has implicit operating costs, therefore it is necessary to pass on some amount of cost to participants. Keystone Science School is committed to addressing these issues, keeping programs as accessible as possible to ensure students are provided with the greatest learning opportunities.

From students' perspectives, challenges are quite different. Anxieties that students face regarding the unexpected is of significant concern to them. Students may not have had extensive experiences away from their families and pets for several days at a time or had other events or activities they were missing because of the KSS experience. Sleeping away from home or in a bed they weren't comfortable in, inexperience with activities in the outdoors, weather or conditions, and general anxieties about being in a strange and unfamiliar setting can all be factors that may contribute to students not choosing to participate in programs at KSS. This amplifies the need for intentional and adequate social, emotional, and physical preparation prior to students' outdoor learning experiences.

VALUE

The job description I use for a science educator is one who inspires curiosity of the natural world. To form a sense of wonder about how the world works, there must be some experience with the world, and to me that means getting out of the classroom and into the world. Outdoor education provides an opportunity for students to be very intentional about how they study aspects of the natural environment, and the chance to learn by sharing with those learning around them. For students around the middle-school age, this is an extremely important time in their development, as attitudes and opinions begin to solidify and take hold within their world perspective through their experiences. In reflecting upon this study, I am able to translate my findings about students' attitudes toward learning science because of their outdoor learning experiences at Keystone Science School to other areas of science education and experience.

Feedback for Keystone Science School

The research in this study has relevance and application in different arenas. First, I am able to provide the administrative and instructional staff with ideas on how to approach improvement of programs that are offered.

My first recommendation is for KSS to provide participating classroom teachers with certain resources. It was evident that many students came to Keystone Science School with anxieties because they aren't sure what to expect (Table 5). While I certainly find a great deal of value in allowing students the opportunities to overcome challenges such as homesickness and certain social interactions, some anxieties and issues could be avoided with intentional preparation. KSS provides an extensive packing list and a generalized schedule to teachers prior to a group's arrival. I recommend that additional materials or resources such as a series of in-class lesson plans focused on preparing students for packing and possible extreme environmental conditions (without *scaring* students) be made available to be included in the pre-trip packet of materials. Supportive evidence through future studies similar to this could be made available to these teachers to help them see the value in this type of preparation. This would help establish realistic and positive expectations from students about the upcoming KSS experience, and minimize some anxiety.

Either before or immediately upon arrival (perhaps during chaperone orientation), I also suggest preparing teachers more in-depth about the overnight dorm experience by providing ideas of effective management techniques. The social aspect of outdoor learning is paired so tightly to the overnight experience as a crucial part of the overall program objectives, and it is important to keep this part of the experience positive. One anxiety/difficulty students somewhat frequently cited (10% overall) involved the sleeping arrangement, counted as a separate category from "homesickness". Maintaining the structure necessary to ensure proper sleep and provide appropriate, healthy social development opportunities can make for a truly memorable experience for participants, and teachers need to be properly prepared to manage this.

A third recommendation to the Keystone Science School staff based on my findings is in regards to assisting school groups with funding. This is perhaps the most difficult issue, as schools are coming from different communities, regions across the state (and sometimes the country), have their own financial needs, and varying access to funding sources. I would encourage any administrative staff at KSS responsible for researching grant and scholarship programs compile and update a supplemental regional list of financial assistance opportunities that can be disseminated to interested teachers so they have a way to find applicable programs that may exist to assist them in providing opportunities for students to attend.

Finally, this study provides a basis for development of a sustainable method for obtaining meaningful feedback from students about KSS programs. Data collection techniques used in the student survey can prove as a model for assessing instructor performance, or provide an instructor with direct feedback for their personal and professional development. This could increase awareness or sensitivity to particular issues involving effectiveness to groups of students (gender, age, ethnic, etc.). While developing, implementing, and reviewing my own methods for obtaining useful information, I recognized several things I would change. First, I realized that there is definite bias in assigning categories to analyze qualitative data. As the only person entering data in this study, my own interpretations remained consistent. These categorical assignments become very subjective if entered by different people, however. I would recommend devising a method of data collection that allows for more objective interpretation of responses to see trends emerging over a longer period of time while still allowing students the freedom of expression (which is extremely useful).

Another issue regarding bias with this study is the limited number of groups I was able to use in my interpretations. According to the demographics recorded by KSS during the time of this study, 89% of students were of Caucasian descent. Knowing this likely does not representative of the overall student demographics over the course of an academic year, I would suggest further interpretation of data over a longer period of time to include a wider range of students (and a wider range of topics studied) to investigate if further trends emerge.

It is difficult to offer any specific instructional advice to Keystone Science School staff, as the findings suggest a great deal of success at effectively engaging students in science. Only one item on the student survey directly asks students about instructor performance, but KSS administrative staff could develop a useful tool to add/amend the survey to include more detailed information or quantitative assessment of instructor effectiveness. It is possible the student survey be used as a tool to provide useful feedback for individual instructors and act as a basis for personal and professional development.

Personal Approach to Education

The findings of this study are useful to improving my own approach and preparation of classroom environment and inclusion of outdoor learning opportunities and hopefully the approach of similar teachers. Even in a more formal school setting, it is realistic to be able to use the methods and strategies used by outdoor educators. I realize it is not realistic, or even productive in my view, that *all* learning take place outdoors. The opportunity for genuine experience, however, can and should be provided in any setting. The findings of this study suggest there is a deliberate approach to methodology and strategic planning that outdoor educators use that can be translated into a more typical classroom setting.

First, I look at the classroom as an environment, and would like to set up that environment with the positive aspects observed in the outdoors. With creativity, it could be possible to set up an environment with “free” space, open/clean air, opportunities for unstructured exploration, and full immersion in experience. This type of classroom environment should be paired with as many legitimate outdoor opportunities as possible to obtain unexpected and unguided learning opportunities and experiences.

This study reinforces the critical importance of collaborative learning and positive relationship-building in education for me. Academic development involves personal and social growth through direct experience as much as anything else. I have observed that allowing for collaborative learning is not only powerful, but perhaps necessary in true quality learning and growth. I can accomplish this by intentionally establishing a classroom culture with a sense of community based on respect, understanding and trust. These relationships are between students and teachers, as I think it is just as important for teachers to be learners in the classroom environment. This type of social learning allows for students to challenge themselves and those around them, creating an environment not of competition, but of belonging.

A large part of establishing such a community is associated with a positive sense of learning. Celebration of students' individual personalities begins with being supportive and positive, and allows for students to be confident and comfortable navigating the extensive challenges that come with being middle school science students. Allowing students to have "letting-it-sink-in-time" by audibly embracing constructive "side-talk" can go a long way towards facilitating social learning, as well as in the establishment of trust and accountability within the community. Collaborative learning researchers Johnson and Johnson offer an outline (Appendix I) suggesting how educators might effectively implement such techniques in their teaching situations.

It is also powerful to see the impact of providing opportunities to learn science in-depth on students' attitudes. The focus of learning in-depth is less about pace of learning (which seems to put many students at an immediate disadvantage), but on the capacity to think about and understand a topic. Thinking about a topic more in-depth involves creating more questions than answers, and encourages a sense of exploration, investigation, and even adventure. This study has reinforced for me that an approach such as this is critical to inspire an unyielding curiosity for science within students. From a teacher's perspective, this can be done by allowing for longer-term, more in-depth studies of broader topics that students can see relevance and importance in.

Lastly, this study has helped me to see that a way for teachers to be the most effective is to sometimes *not* be the teacher. Seeking and embracing opportunities for other people, be it other teachers, instructors, community experts, other students, etc., learning from a variety of people can reinforce the learning process for students, and make them excited to learn. Also allowing for unstructured exploration, play, and reflection all allow students to build their own sense of wonderment. It is important for students to look at the world from various perspectives, think deeply and reflect about those perspectives, and be inspired to form their own views and ideas. That is the power of education.

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APPENDICES

APPENDIX A

KEYSTONE SCIENCE SCHOOL SNOW SCIENCE CURRICULUM (2012)

Keystone Science School
Snow Science Curriculum Map

Essential Understandings

Snow is not uniform; differences in temperature and pressure cause the physical change of snow grains over time	Snow plays an important role in ecosystems and watersheds	Snow is important to humans because it can create avalanche danger and it is an important water source

Essential Questions

What causes snow to change?	How does snow affect a watershed?	How does snow affect an ecosystem?	How does snow affect humans?

Knowledge

The temperature gradient causes snow grains to metamorphose due to the movement of water vapor within the snowpack Snow changes from airborne snow flakes to partially settled flakes and grains on snowpack surface to snow grains within the snowpack The snowpack is a combination of layers of many different types of snow grains Each snow grain type has unique physical properties that affect the overall stability of the snowpack Different types of snow grains hold different amounts of water	Water occurs naturally in 3 physical states (solid, liquid, gas) and changes between each state A limited amount of water is recycled through the water cycle Snowmelt provides an important source of water within a watershed	Organisms have developed physical and behavioral adaptations for winter survival Snow is a good insulator and allows organisms to survive the cold winter temperatures	Avalanche danger in a particular area is determined by the weather, terrain, and snowpack conditions Water is needed for human survival and less than 1% of Earth's water is available for human use Major human uses of water include: agriculture, industry, personal, and recreation Water rights in Colorado are governed by the state judicial system

Activities

Snow Science Vocabulary Journal Page Snow Metamorphosis Indoor Lesson Snow Pits and Snow Profile Journal Page Snow Scavenger Hunt Snow Met Prof Hike Icety-Ice-Ice Freezemeister is Coming Snow Journey EP Avy Search and Rescue Snow Science Research Project	Water Cycle Journal Page States of Water Journal Page Water Cycle Journey Activity States of Water Activity Cards Snow-Water Equivalency Watershed in your Hand Downriver Icety-Ice-Ice Avy Search and Rescue	Winter Adaptations Game Winter Adaptations Fact Sheets Forest Ecology Prof Hikes Wildlife Labs EP	Snow Pits and Snow Profile Journal Page Avalanche Prof Hike Avalanche EP Avy Search and Rescue Water Management Prof Hike Water Planet Demo Snow-Water Equivalency Snow Science Research Project Water Management EI

Skills

Describe snow metamorphosis Identify types of snow grains	Diagram the water cycle and a watershed Identify winter adaptations and organisms	Dig a snow pit and use tools Apply and use scientific process	Evaluate snowpack for avalanche danger and water content Describe personal and human uses of water

APPENDIX B

KEYSTONE SCIENCE SCHOOL FOREST ECOLOGY CURRICULUM (2012)

Keystone Science School
Forest Ecology Curriculum Map

Essential Understandings

All populations living together and the physical factors with which they interact compose an ecosystem	Biodiversity is the variation of organisms in an ecosystem and is a measure of ecosystem health	Natural and human-related disturbances can both positively and negatively affect a forest ecosystem

Essential Questions

What are the components of an ecosystem?	How do organisms interact within an ecosystem?	What type of land ecosystems are found in Colorado?	What types of organisms are found in Colorado forests?	How do organisms survive in a particular ecosystem?	How do natural disturbances affect forest ecosystems?	How do humans affect forest ecosystems?

Knowledge

The major source of energy in an ecosystem is sunlight An ecosystem is comprised of biotic and abiotic factors A population consists of all individuals of a species that occur together at a given place and time The number of organisms an ecosystem can support depends on the available resources and abiotic factors	Populations of organisms can be categorized by the function they serve in an ecosystem All organisms are interconnected by their need for food Food webs identify the relationships among producers primary consumers, secondary consumers, and decomposers in an ecosystem Organisms with similar needs compete for limited resources	Colorado has five major life zones and the boundaries of each life zone are determined by elevation The abiotic factors present at different elevations, such as precipitation, length of growing season, temperature determine the biotic factors of the life zone Organisms have developed specific physical and behavioral adaptations for survival in a particular life zone	The health of a forest ecosystem depends on the amount of biodiversity of the system Classification systems of organisms are based on the different structures of organisms Plants use sunlight to make their own food, and animals consume energy-rich foods Each Colorado life zone has specific plant and animal species	All organisms must be able to obtain and use resources to grow and reproduce Species acquire characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations Adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a given environment	Natural stressors on wildlife can include available habitat & climate Forest fire destroys old stands of trees and allows for new plant species to grow When natural population controls fail to limit an organisms 'population, the health of the ecosystem is affected Non-native species can often outcompete native species for resources in an ecosystem	Human development of land can decrease wildlife habitats and reduce the quality of available food, water, and shelter Humans can help control the populations of organisms as well as other natural disturbances Humans can determine the health of a forest ecosystem and interfere on the behalf of a species

Activities

Forest Ecology Vocab Journal Page Forest Ecology Prof Hikes Forest Eco Scavenger Hunts Eagle Talons Web of Life / Who am I? Oh Deer! How many bears in the forest?	Forest Ecology Prof Hikes Web of Life / Who am I? Wolf - Elk - Aspen Predator – Prey Bear – Trout – Fly Tag Game Forest Occupation Cards Hawk Eyes Camouflage Web of Life EP Forest Ecology Research Wolf Management EI Mountain Pine Beetle EI	Forest Survey Journal Page Younger Forest Eco Prof Hike Montane / Subalpine Prof Hike Alpine Prof Hike Forest Eco Scavenger Hunts Mountain Life Zones EP Comparative Ecology Research	Forest Survey Journal Page Forest Ecology Prof Hikes Forest Eco Scavenger Hunts Web of Life / Who am I? Tracks and Signs Keys Tracks Relay Race Colorado Tree and Shrub Keys Meet a Tree Build a Tree Parts of a tree Trunk Cards Create a Key Mountain Life Zones EP Wildlife Labs EP Tracks and Signs EP Forest Ecology Research	Forest Ecology Prof Hikes General Adaptations Game Winter Adaptations Game Bird Adaptations Game Create a Critter Adaptations Auction Scent Tracking Hawk Eyes Camouflage Beaver Dress-up EP Wildlife Labs EP Night Hike	Forest Eco Scavenger Hunts Forest Succession Game Forest Ecology Research Fire Ecology EI Wolf Management EI Mountain Pine Beetle EI	Forest Eco Scavenger Hunts Forest Ecology Research Fire Ecology EI Wolf Management EI Mountain Pine Beetle EI Mining and Water Quality EI

Skills

Determine biotic and abiotic factors of an ecosystem
Determine biodiversity of an area
Describe food webs Identify local species using dichotomous key
Describe how adaptations help organisms survive
Describe natural and human-related disturbances
Apply and use Scientific Process
Correctly use forest tools

APPENDIX C

KEYSTONE SCIENCE SCHOOL DATA COLLECTION APPROVAL

School Administrator Approval

I, David Miller, as Director of School Programs at Keystone Science School, grant approval for Daniel Rudolf to obtain educational research data through participating school group programs at KSS.

Signed:______________________________________ Date: 12/13/2011

APPENDIX D

IRB RESEARCH APPROVAL

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Daniel Rudolf

FROM: Mark Quinn, Chair *Mark Quinn CJ*

DATE: December 15, 2011

RE: Effect of Outdoor Education Methods and Strategies on Student Engagement: a Descriptive Study *[DR121511-EX]*

The above research, described in your submission of December 7, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX E

STUDENT SURVEY

Keystone Science School

Student Survey

Participation in this survey is completely voluntary and anonymous, and will not affect a student's grade or class standing.

School:____ Today's Date:_______________

Grade in School (*circle one*): **2 3 4 5 6 7 8 9 10 11**

How old are you? _____________

Gender: ◯ **Boy** ◯ **Girl**

What is the name of your KSS Instructor this week? _______________________________

How much do you think you knew about this week's topic **before** you came to KSS? (*circle a number*)

0 1 2 3 4 5 6 7 8 9 10

How much do you think you know about this week's topic **after** coming to KSS? (*circle a number*)

0 1 2 3 4 5 6 7 8 9 10

Are you more **comfortable** learning in a classroom or in the outdoors? (*circle a number*)

0 1 2 3 4 5 6 7 8 9 10

Do you think you **learn more science** by studying in a classroom or in the outdoors? (*circle a number*)

0 1 2 3 4 5 6 7 8 9 10

How is learning science in the outdoors *different* from learning in a classroom? (be as specific as possible)

Have you ever attended an outdoor school before? (If yes, how does your experience at KSS compare to that?)

◯**Yes** ◯**No**

How would you rank the ability of your KSS instructor as a teacher? (circle a number)

0 1 2 3 4 5 6 7 8 9 10

What did he/she do well?:

What could he/she do better?:

How much did you like staying overnight at KSS?

0 1 2 3 4 5 6 7 8 9 10

How did staying overnight add to your total KSS experience?:

How would you rank the meals at KSS?

0 1 2 3 4 5 6 7 8 9 10

Comments:

What was the hardest thing about coming to KSS?

What was the best thing about coming to KSS?

What are things you would change about KSS?

Have you ever attended a different KSS program (summer camp, harvest camp, girls-only camp, boys-only camp, etc.)? ◯**Yes** ◯**No**

Would you be interested in coming back to KSS for a different program (summer camp, harvest camp, girl's-only camp, boys-only camp, etc.)? ◯**Yes** ◯**No**

APPENDIX F

TEACHER QUESTIONNAIRE

Teacher Questionnaire

Teacher: ____ School/Group: ____________________________________

Grade level of students: _____________________ Dates of visit: ____________________________

When complete, please return to any KSS staff member. Feel free to use the back of this page to expand on any item or to add additional comments. Participation in this questionnaire is completely voluntary.

1. How did you hear about the program offered at Keystone Science School?

2. How many years/sessions have you attended Keystone Science School as a teacher?

3. What are reasons you chose to have students participate in the program at Keystone Science School?

4. What are some challenges you faced in organizing a program at KSS?

5. Was student participation mandatory for this program? ◯ Yes ◯ No
If not, are students not attending still responsible for learning the same material? What methods/strategies are you using to do this?

6. Does your school or other programs subsidize the cost for students to attend? ◯ Yes ◯ No
7. Do you feel the pricing for KSS programs is: ◯ Underpriced ◯ Fair ◯ Overpriced
8. Do students from your school participate in other residential programs throughout their student career? ◯ Yes ◯ No
   If yes, what other programs do students participate in?

9. Based on your experience and observations, what are differences between science lessons taught in an outdoor setting and those typically taught in a classroom setting? What are advantages/disadvantages of each?

10. Are there other programs that would benefit your teaching situation that KSS currently doesn't offer?

11. Would you come back to Keystone Science School? ◯ Yes ◯ No
    Why or Why not?

APPENDIX G

INSTRUCTOR OBSERVATION FORM

Instructor Observation

◯ **Classroom** ◯ **Outdoor**

Instruction Methods: Instructor observed:____

Indicate the *major*[1] *way(s)* in which student activities were structured.

◯ As a whole group ◯ As small groups ◯ As pairs ◯ As individuals

Indicate the *major*[1] *way(s)* in which students engaged in activities.

◯ Entire class was engaged in the same activities at the same time
◯ Groups of students were engaged in different activities at the same time (e.g., centers).

Indicate the activities of students in the lesson and approximate overall percentage of time spent.

◯ **Listened to a presentation:**
- ◯ By teacher _______
- ◯ By student _______
- ◯ By guest speaker _______

◯ **Engaged in discussion seminar:**
- ◯ Whole group _______
- ◯ Small groups/pairs _______

◯ **Engaged in problem-solving/investigation:**
- ◯ Worked with manipulatives _______
- ◯ Played a game to build or review knowledge/skills _______
- ◯ Followed specific instructions in an investigation _______
- ◯ Had some latitude in designing an investigation _______
- ◯ Recorded, represented and/or analyzed data _______
- ◯ Recognized patterns, cycles, or trends _______
- ◯ Evaluated the validity of arguments or claims _______
- ◯ Provided an informal justification or formal proof _______

◯ **Engaged in reading/reflection/written communication about science topic:**
- ◯ Read about science _______
- ◯ Answered textbook/worksheet questions _______
- ◯ Reflected on readings, activities, or problems individually or in groups _______
- ◯ Prepared a written report _______
- ◯ Wrote a description of a plan, procedure, or problem-solving process _______
- ◯ Wrote reflections in a notebook or journal _______

◯ **Used technology/audio-visual resource:**
- ◯ To develop conceptual understanding _______
- ◯ To learn or practice a skill _______
- ◯ To collect data _______
- ◯ As an analytic tool _______
- ◯ As a presentation tool _______
- ◯ For word processing as a communications tool _______

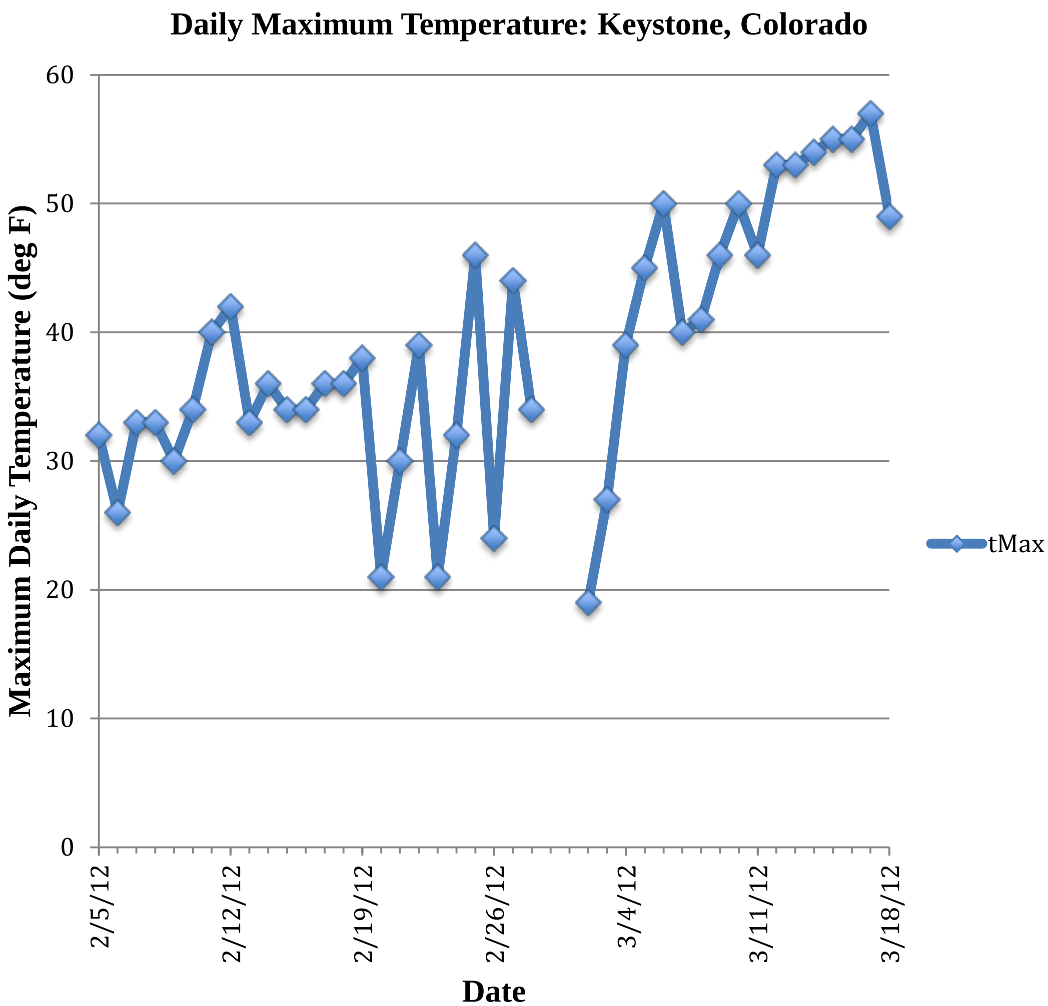
◯ **Other activities:**
- ◯ Arts and crafts activity _______
- ◯ Listened to a story _______
- ◯ Wrote a poem or story _______
- ◯ Other (please specify): _____________________________________ _______

---

[1] "Major" means was used or addressed for a substantial portion of the lesson. If you were describing the lesson to someone, this feature would help characterize it.

APPENDIX H

WEATHER DATA FOR KEYSTONE, CO: 2/5/12 – 3/18/12



Source: http://www.weathersource.com

APPENDIX I

FORMAL COLLABORATIVE LEARNING

Formal cooperative learning consists of students working together, for one class period to several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments (Johnson, Johnson, & Holubec, 2008). In formal cooperative learning groups the teachers' role includes:

1. Making preinstructional decisions. Teachers (a) formulate both academic and social skills objectives, (b) decide on the size of groups, (c) choose a method for assigning students to groups, (d) decide which roles to assign group members, (e) arrange the room, and (f) arrange the materials students need to complete the assignment. In these preinstructional decisions, the social skills objectives specify the interpersonal and small group skills students are to learn. By assigning students roles, role interdependence is established. The way in which materials are distributed can create resource interdependence. The arrangement of the room can create environmental interdependence and provide the teacher with easy access to observe each group, which increases individual accountability and provides data for group processing.

2. Explaining the instructional task and cooperative structure.Teachers (a) explain the academic assignment to students, (b) explain the criteria for success, (c) structure positive interdependence, (d) structure individual accountability, (e) explain the behaviors (i.e., social skills) students are expected to use, and (f) emphasize intergroup cooperation (this eliminates the possibility of competition among students and extends positive goal interdependence to the class as a whole). Teachers may also teach the concepts and strategies required to complete the assignment. By explaining the social skills emphasized in the lesson, teachers operationalize (a) the social skill objectives of the lesson and (b) the interaction patterns (such as oral rehearsal and jointly building conceptual frameworks) teachers wish to create.

3. Monitoring students' learning and intervening to provide assistance in (a) completing the task successfully or (b) using the targeted interpersonal and group skills effectively. While conducting the lesson, teachers monitor each learning group and intervene when needed to improve taskwork and teamwork. Monitoring the learning groups creates individual accountability; whenever a teacher observes a group, members tend to feel accountable to be constructive members. In addition, teachers collect specific data on promotive interaction, the use of targeted social skills, and the engagement in the desired interaction patterns. This data is used to intervene in groups and to guide group processing.

4. Assessing students' learning and helping students process how well their groups functioned. Teachers (a) bring closure to the lesson, (b) assess and evaluate the quality and quantity of student achievement, (c) ensure students carefully discuss how effectively they worked together (i.e., process the effectiveness of their learning groups), (d) have students make a plan for improvement, and (e) have students celebrate the hard work of group members. The assessment of student achievement highlights individual and group accountability (i.e., how well each student performed) and indicates whether the group achieved its goals (i.e., focusing on positive goal interdependence). The group celebration is a form of reward interdependence. The feedback received during group processing is aimed at improving the use of social skills and is a form of individual accountability. Discussing the processes the group used to function, furthermore, emphasizes the continuous improvement of promotive interaction and the patterns of interaction need to maximize student learning and retention.

Adapted from Johnson D. & Johnson R. (n.d.)