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Justin St. Onge
University of Idaho

Karla Eitel
University of Idaho

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Abstract

The aim of this research was to examine the effectiveness of outdoor education on middle school students' energy literacy. An energy literacy curriculum was developed and taught in both outdoor and traditional, indoor classroom settings. Energy literacy constructs of knowledge, attitude, and behavior were evaluated and measured using a survey distributed pre, post, and 1-month after the curriculum was taught. The population (n=130) of this study was 6th grade students attending a five-day residential education program at an outdoor science school. Results showed greater increases in middle school students' energy literacy knowledge, attitude, and behavior when taught in outdoor learning environments. These findings indicate the benefit outdoor and non-traditional learning environments have in improving energy education in order to produce a more energy literate citizenry willing to tackle future energy decisions and challenges.

Key Words: outdoor education, energy literacy, energy attitudes, energy behaviors, environmental perceptions

Justin St. Onge, Graduate Student, University of Idaho; **Karla Eitel,** Associate Professor, Natural Resources and Society, Director of Education, McCall Outdoor Science School, University of Idaho

Address correspondence to Justin St. Onge, jstonge@uidaho.edu, (856) 520-2268

Introduction

Outdoor education is thought to provide an effective setting for youth to connect with nature and to influence their environmental perceptions. Within this context, environmental perceptions are defined as how individuals evaluate and identify with the environment (Bogner, 2002; Ittelson, 1978). Through outdoor education, students can develop a greater appreciation and understanding of the environment that may lead to a greater positive change in attitude regarding conservation and appropriate use of natural resources (Bogner, 1998). These outdoor experiences that positively influence students' environmental perceptions and curiosity in the environment lead to interest in obtaining related knowledge and intention to action (Bögeholz, 2006). Energy has been considered one of the most important issues of the 21st century, yet, prior research has concluded that Americans are generally unable to solve energy related problems and make informed energy decisions (Barrow & Morrisey, 1989; DeWaters & Powers, 2008). This inability to actively solve and express attentiveness towards energy problems is thought to relate to students' lack of energy related knowledge and awareness. As we look for innovative ways of increasing students' energy literacy, outdoor education has the potential to be an important avenue for addressing this issue from a young age.

Energy literacy, as described by the Department of Energy, is the "comprehension and understanding of the nature and role of energy on Earth and in our everyday lives" (Department of Energy, 2014, p. 1). In any learning environment, context is thought to impact learning outcomes (Trigwell & Prosser, 1991). Therefore, setting may also impact energy literacy outcomes. An outdoor education setting expands the learning environment beyond the four walls of the classroom to where students can generate deep emotion and attachment to the natural world (Ramey-Gassert, 1997; Wilhelmsson, Lidestav, & Ottander, 2012). This sentiment and passion towards the natural world is thought to spark interest in obtaining and generating knowledge, fostering greater environmental awareness and motivation to act on beliefs (Bögeholz, 2006). A connection with the natural world has the potential to create a more effective energy education experience for students leading to greater gains in energy literacy.

The objective of this research was to compare changes in energy literacy of middle school students taught in outdoor settings versus those taught in traditional indoor classroom settings. In order to measure change in students energy literacy, an energy literacy assessment was administered immediately before, immediately after and one month after an energy literacy curriculum was taught in both outdoor and indoor classroom settings.

The use of pre and post surveys allowed us to examine in which context students showed greater gains in energy knowledge, attitude, and behavior.

In conducting this research, we hope to fill gaps on the effectiveness of outdoor education for increasing energy literacy. Additionally, we hope to identify further questions to be studied in the energy literacy and outdoor education fields.

Literature Review

Nature experiences and outdoor education classrooms are generally regarded as an effective avenue for enhancing environmental awareness, ecological concern, and promoting a positive change in students' environmental attitudes and actions (Bogner, 1998; Eagles & Demare, 1999). Through outdoor education, students develop environmental appreciation, awareness, and behavior, in addition to fostering a deep connection to the natural world, which influences students' environmental perceptions (Dresner & Gill, 1994; Bogner, 1998). These outdoor education experiences allow students to build positive relationships and understand their connection to the natural world that encourages interest to become more environmentally knowledgeable (Bögeholz, 2006; Farmer, Knapp, & Benton, 2007).

We need a knowledgeable and concerned population in order to tackle our current and future environmental problems. Hungerford and Volk (1990) describe knowledge as being a prerequisite to action. Prior to an individual taking action regarding an environmental problem, such as energy related decisions, that individual must be aware of the presence of the prevailing issue. Once an individual becomes aware and knowledgeable of the issue, they must be willing to take action or change behavior to resolve and improve the problem (Hungerford & Volk, 1990). A deep connection to an area or natural landscape has been shown to enhance care about environmental problems, as well as change one's environmental attitudes and behaviors (Cheng & Monroe, 2012).

Although many researchers would like to think of the knowledge, attitude, behavior conceptual model as simple as knowledge affecting attitudes, and attitudes affecting behavior, we are aware of the complexity found within this model and the contribution of numerous other factors. The intricate relationship found between these three constructs has not lead to agreement between researchers within the outdoor environmental education field and suggests a call for further research (Leeming, Dwyer, Porter, & Cobern, 1993; Martin, 2003). For example, Millar and Tesser (1989) noticed some believe that behaviors are influenced by attitudes and cognitive factors, rather than the linear model of knowledge influencing attitudes and behaviors. Similar to Hungerford and Volk, Marcinowski (2004) suggests that the development and making of an environmental steward relies on an individual's knowledge and capacity to perform environmental actions.

In addition to having the knowledge needed to solve a problem, an individual must have the desire to act on it. As John Burroughs (1919) wrote, "Knowledge without love will not stick. But if love comes first, knowledge is sure to follow." Outdoor education provides an avenue for youth to connect more deeply with the natural world, which might spark motivational attitudes and commitment to the environment. Sobel (1996) builds on Burroughs' idea, suggesting that in fact connection to the natural world is a prerequisite for students to develop concern for environmental issues, and furthermore knowledge about the issue and a desire for action will follow from that connection. These experiences fuel the pursuit of knowledge that leads to shifting attitudes and changes in behavior (Farmer et al., 2007). Outdoor education provides opportunities for students to make emotional connections to the natural world, and cognitive connections between what they are learning and the natural processes occurring in front of their eyes. This process of learning that occurs in an outdoor setting not only helps students learn through first hand experiences in a rich and immersed environment, but knowledge is more easily acquired and held. When the learning process takes place in the indoor classroom, students do not have the ability to use all of there senses to grasp the material and become as excited and interested in the content as one would in an outdoor classroom (Lieberman & Hoody, 1998). These authentic learning experiences inherent in the natural world provide a valuable context for a deeper investigation of ideas and concepts.

Recently there has been a renewed interest and increase in the number of schools and students participating in nature-based programs at outdoor education centers and within their own communities (Bentsen, Schipperijn, & Jensen, 2013; Louv, 2008). This surge in interest is thought to reflect teachers' realization of the positive impacts nature-based programs have on students' attitudes and behavior (Ballantyne & Packer, 2002).

Bogner (1998) evaluated middle school students' environmental attitudes and behaviors after attending both one and five-day outdoor ecology programs located in a national park. Of the 700 students surveyed from both the programs, survey scores showed that both programs increased cognitive understanding; and furthermore, the five-day program prompted a favorable transformation in students' actual and intended behavior and in their pro-conservation attitudes (Bogner, 1998). This study found that the outdoor ecology education program influenced students' environmental concern and provided an effective learning environment leading to a more environmentally literate citizenry who is more willing to take action. Collado, Staats, and Corraliza (2013) found similar results studying children attending summer camps and determined direct nature experiences increased children's emotional attachment towards nature, their ecological beliefs, and inclination towards displaying ecological behavior.

Little research has been conducted on energy education in outdoor education spaces, but numerous energy literacy studies (i.e., home and dorm energy audits, project-based learning, experiential classroom lessons) have shown that observational, field-based immersion experiences can help facilitate the learning process (Caton, Brewer, & Brown, 2000; Brewer, Lee, & Johnson, 2011; van der Horst, Harrison, Staddon, & Wood, 2015). As energy literacy is defined within this research study and academically, becoming an energy literate individual holds more depth than pure knowledge, attitude and behavioral constructs are equally important. Research suggests that meaningful connections with nature are developed when students learn in outdoor settings, which encourage them to become more likely to recycle and conserve water and energy (Ernst, 2005; Kimbell et al., 2009). Outdoor classrooms give students the ability to participate in a comfortable learning environment where they can develop meaningful connections by witnessing nature first hand and observing natural environmental processes (Maynard & Waters, 2007), potentially allowing students to greatly improve not only energy literacy knowledge, but related attitudes and behaviors, as well.

Methods

The aim of this study was to understand the impact an outdoor education learning environment has on middle school students' energy literacy. Energy literacy was measured using the constructs of energy literacy knowledge, attitude, and behavior (DeWaters & Powers, 2008, 2011). These three energy literacy constructs were evaluated and measured in order to address the research question: Do students show a greater increase in energy literacy from learning in an outdoor or indoor setting?

The population of this study was 6th grade students attending a five-day residential education program at the University of Idaho College of Natural Resources McCall Outdoor Science School (MOSS) in McCall, Idaho. The research was conducted under the assumptions of a post-positivist paradigm with a quantitative method of collecting and analyzing data (Creswell, 2014). An energy literacy survey instrument was created using survey items from two other instruments designed to measure students' energy knowledge, attitude, and behavior. The energy knowledge questions were developed by and used for the Northwest Advanced Renewables Alliance Energy Literacy Assessment–Middle School Version (2015). Energy literacy attitude and behavior questions were pulled from the Energy Literacy Survey- Middle School Issue (DeWaters, 2009). The five-page 32-question survey instrument included six attitude questions, six behavior questions, and 20 multiple-choice questions. A Cronbach's alpha value was calculated for each of the energy literacy constructs, with scores of .79 (attitude), .76 (behavior), and .60 (knowledge).

The survey addresses the energy literacy constructs in three sections. Knowledge questions evaluated students' basic energy content understandings. Attitude questions determined students' attitudes about energy production and use. Lastly, the behavior questions determined students' behavior regarding energy consumption. The survey is constructed on a 5-part Likert-type response with one neutral response (1 = Strongly Disagree, 5 = Strongly Agree for attitudes; 1 = Never, 5 = Always for behaviors) to measure attitudes and behaviors, and a 3-option multiple-choice question to measure knowledge of energy concepts.

During the course of the five-day residential program, students were taught four 30-minute energy literacy lessons in either an indoor or outdoor setting. Each student participating in the research study was randomly assigned to a field group. Subsequently, field groups were randomly assigned to either an indoor or outdoor setting for their lessons to control for this external factor. The indoor lessons were taught in a traditional classroom setting with 4–5 students situated at each table. The energy lessons taught in the outdoor setting took place outside the classroom in a nearby forest and on the beach of a lake. Regardless of setting, class sizes consisted of 20–25 students and they were taught the same exact energy lesson. To ensure each field group received the same energy literacy instruction, the same teacher taught every indoor and outdoor energy lesson. This allowed for controlling the energy literacy content knowledge, comfort level, and teaching methods for the instructor of each group. Before students began their energy literacy lessons, students completed a pre-survey to assess initial energy literacy. After participating in four energy literacy lessons in either an indoor or outdoor setting, students completed a post-survey. Students completed a final 1-month delayed post-survey in their school, approximately 30 days after the post-survey was administered. This research used a population sampling strategy by surveying every 6th grade student from one middle school attending MOSS during the study period.

The energy literacy curriculum covered a variety of energy principles and concepts that aligned with the U.S. Department of Energy- Energy Literacy

Energy Literacy Curriculum			
Lesson 1	Lesson 2	Lesson 3	Lesson 4
Students receive an introduction to energy: classifying forms of energy, key terms and laws, states, and systems.	Students identify pros and cons of renewable and non-renewable energy sources and discuss energy technology and practice.	Students learn how energy flows through the Earth system and the environmental impacts of energy production and consumption.	Students examine human energy consumption and conservation while discussing energy policy and decision making. Students understand energy transformation and conversion.

Figure 1 Energy Literacy Framework.

Framework (Figure 1). Lessons included within the energy literacy curriculum provided students with a general introduction to energy (forms, states, systems, laws), energy sources with an emphasis on renewables, environmental impacts due to energy production and consumption, and ways of consuming less energy through conservation techniques.

Data Analysis

Once students had completed the pre, post, and 1-month delayed energy literacy survey, answers were entered into a Microsoft Excel spreadsheet and converted into numerical scores for analysis. Knowledge questions were assigned one point for a correct answer and zero points for an incorrect answer or blank response. The attitude and behavior questions that use a 5-part Likert-type response were entered using the numerical value. Values for each Likert-type question range from one to five, one representing "strongly disagree" to five representing "strongly agree" in the attitude section, and one representing "never" to five representing "always" in the behavior section. Blank responses within the attitude and behavior constructs were omitted from the analysis. Students' responses from each of the three constructs (knowledge, attitude, and behavior) were analyzed separately. Maximum scores on the energy literacy survey are 20 in the knowledge section and 30 in both of the attitude and behavior sections. Additionally, a mean ranging between 1 and 5 was calculated in the attitude and behavior sections.

Statistical analysis was performed with Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 23.0 (IBM Corp., 2015). Using SPSS a Repeated Measures ANOVA test was used to analyze the difference between pre, post, and 1-month delayed knowledge questions. A Wilcoxon Signed-Rank Test was used to analyze attitude and behavior Likert-type questions at each of the three survey periods.

Results

Knowledge Survey Results

A total of 130 6th grade students each completed a pre, post, and 1-month survey (64 taught outside, 66 taught inside). Overall energy literacy knowledge scores were fairly low regardless of students learning environment (pre: 49%, post: 58%, 1-month: 54%). However, students taught in an outdoor setting experienced greater gain in energy knowledge, an increase in survey average of 11.15% between pre and post survey and an increase of 10.55% between pre and 1-month survey. This is compared to an increase in 7.40% between pre and post survey and a small increase of 0.35% from pre to 1-month survey for students taught inside. Students taught in an outdoor setting also showed greater energy knowledge retention rates at the 1-month delayed post survey.

Student performance results are presented in Table 1, showing the comparison between outside and inside learning environments for each survey given during the research study. The knowledge section of the energy literacy survey, included 20 questions each worth 1 point for a maximum score of 20. Pre surveys were given to students at the time of arrival at MOSS, before any energy literacy lessons were taught.

The 64 students assigned to the outdoor learning environment completed the pre survey with a mean score of 9.86. Upon finishing the weeklong energy literacy curriculum and before returning home, the post survey was administered yielding a mean score of 12.09. A pairwise comparison (Table 2) showed a statistically significant difference between outside energy knowledge pre and post survey scores (p = 7.03E-9) and between energy knowledge pre and 1-month survey scores (p = .000002). Even though students experienced a slight decrease and no statistically significant dif-

Table 1 Knowledge Survey Results

	Outside			*Inside*		
	Pre	*Post*	*1-Month*	*Pre*	*Post*	*1-Month*
N	64	64	64	66	66	66
M	9.86	12.09	11.97	9.70	11.18	9.77
SD	3.14	3.07	2.99	2.96	2.98	2.77
Survey Avg. (%)	49.30	60.45	59.85	48.50	55.90	48.85

Table 2 Pairwise Comparisons, Measure: Knowledge Outside

					95% Confidence Interval for Std. Difference[b]	
(I) Time	*(J) Time*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*[b]	*Lower Bound*	*Upper Bound*
1 (pre)	2 (post)	−2.234*	.321	7.03E-9	−3.024	−1.445
	3 (1-month)	−2.109*	.379	.000002	−3.041	−1.178
2 (post)	1 (pre)	2.234*	.321	7.03E-9	1.445	3.024
	3 (1-month)	.125	.397	1.000	−.853	1.103
3 (1-month)	1 (pre)	2.109*	.379	.000002	1.178	3.041
	2 (post)	−.125	.397	1.000	−1.103	.853

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

ference (p = 1.00) in mean score between the post and 1-month survey, a greater overall cognitive improvement was measured over the duration of the research study.

A sample size of 66 students each took the pre, post, and 1-month energy literacy survey before and after being taught inside. Students that were taught their energy literacy curriculum showed slightly less of a knowledge gain when compared to students taught outside. Students assigned to the inside learning environment had a mean score of 9.70 on the pre survey, before any energy lessons were taught. After the weeklong inside energy literacy curriculum, a mean score of 11.18 was measured on the post-survey. However, at the 1-month survey, the mean score was 9.77, a substantial drop in mean score between post and 1-month survey timeframe. A pair-

Table 3 Pairwise Comparison, Measure: Knowledge Inside

(I) Time	*(J) Time*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*[b]	*95% Confidence Interval for Std. Difference*[b] *Lower Bound*	*Upper Bound*
1 (pre)	2 (post)	−1.485*	.382	.001	−2.424	−.546
	3 (1-month)	−.076	.326	1.000	−.878	.726
2 (post)	1 (pre)	1.485*	.382	.001	.546	2.424
	3 (1-month)	1.409*	.334	.0002	.587	2.231
3 (1-month)	1 (pre)	.076	.326	1.000	−.726	.878
	2 (post)	−1.409*	.334	.0002	−2.231	−.587

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

wise comparison (Table 3) showed a statistically significant difference between inside energy knowledge pre and post survey scores (p = .001) and energy knowledge post and 1-month survey scores (p = .0002). There was not a statistically significant difference between energy knowledge pre and 1-month survey scores (p = 1.000).

We were able to determine which knowledge questions were most commonly answered correctly and incorrectly by combining the scores of all students' pre, post, and 1-month surveys taught outside and inside. Each knowledge question was analyzed to determine the fundamental principles and concepts needed in order to answer correctly, based on the Energy Literacy Framework. Results reflect a total of 390 responses for each individual question.

Shown in Figure 2, are the seven Energy Literacy Principles (ELP) students were tested on in the knowledge section. The question that aligns with ELP 4, "Which of the following is able to store energy for the longest period of time?," received the least amount of correct responses on the entire survey, with students' only answering this question correctly 26% of the time (Figure 3). The question that received the second fewest number of correct responses, in which only 33% answered correctly, was somewhat surprising due to the perceived simplicity and the concepts that were taught during the energy lessons. That question, "An average family spends most

Energy Literacy Principles	
1	Energy is a physical quantity that follows precise natural laws.
2	Physical processes on Earth are the result of energy flow through the Earth.
3	Biological processes depend on energy flow through the Earth system.
4	Various sources of energy can be used to power human activities and often this energy must be transferred from source to destination.
5	Energy decisions are influenced by economics, political, envirnomental, and social factors.
6	The amount of energy used by human society depends on many factors.
7	The quality of life of individuals and societies is affected by energy choices.

Figure 2 U.S. Department of Energy–Energy Literacy Principles

Department of Energy [DOE}, 2014, p. 5

of their electrical bill on?" is covered in ELP 6. Lastly, the question that falls under ELP 3, "How does removing trees from the forest impact energy flow through the forest ecosystem?" which has three logical choices for a 6th grade level was only answered correctly 36% of the time.

Shown below in Figure 4, are the three most common correctly answered questions on the knowledge section of the survey. One of the objectives of the energy lessons taught during the weeklong curriculum focused on improving students understanding of renewable and nonrenewable resources so they can make better-informed decisions regarding energy. The high percentage of correct answers for the question covered in ELP 4, "Which list of energy sources includes only NON-renewable sources?" is exciting, with 78% of students choosing the correct answer. 72% of students' correctly answered the question, "Plants use energy from _____to make sugars." which demonstrates their comprehension of biological processes and how energy flows through an ecosystem, covered in ELP 3. Closely tied to the question regarding nonrenewable resources, the question, "Which energy

Knowledge Questions Most Commonly Answered Incorrectly	% Respondents Answering Correctly
Which of the following is able to store energy for the longest period of time? a. solar panels b. hydropower dams c. coal	26
An average family spends most of their electrical bill on __________. a. heating and cooling b. powering appliances, like TVs c. lighting	33
How does removing trees from the forest impact energy flow through the forest ecosystem? a. It changes the food chain in the forest b. It changes animal habitat c. It changes the soil make-up	36
*Statistics based on 390 responses during pre, post, and 1-month surveys.	

Figure 3 Knowledge survey questions which students answered most incorrectly

source is LEAST likely to have a negative impact on air quality?" which received the third highest percentage of correct answers at 69%, fits into ELP 7.

Attitude Survey Results

An important aspect of energy literacy is an individual's attitude toward energy production and use. Students' attitude towards energy were measured in the energy survey and analyzed to examine the influence learning environments and greater energy knowledge had on students' views. The results representing students' energy attitudes throughout the study were very encouraging.

All students attending the weeklong residential education program and

Knowledge Questions Most Commonly Answered Correctly	% Respondents Answering Correctly
Which list of energy sources includes only NONrenewable sources? a. coal, oil, wind b. coal, oil, nuclear c. coal, oil, water	78
Plants use energy from ______________ to make sugars. a. carbon dioxide b. the sun c. water	72
Which energy source is LEAST likely to have a negative impact on air quality? a. coal b. hydropower c. natural gas	69

Figure 4 Knowledge survey questions which students answered most correctly

participating in the energy literacy curriculum came to MOSS with a similar base energy attitude level. However, apparent in the results (Table 4), the setting in which the students were taught and learned about energy seemed to have an influence in their future energy attitudes. The attitude section of the survey consisted of six 5-part Likert-type questions with a maximum mean score of 30 for the entire section.

Students who learned outside in a natural setting experienced slightly greater increases in energy related attitudes compared with those who learned inside. An increase in mean score of 24.92 on the pre survey and mean score of 26.83 on the post survey, leading to a statistically significant difference (p = 8.58 E-7), was measured within the duration of the residential education week. Interestingly, after leaving MOSS and returning home, students taught outside continued to increase their energy attitudes. An increase was measured between the post survey with a mean score of 26.83

Table 4 Attitude Survey Results

	Outside			*Inside*		
	Pre	*Post*	*1-Month*	*Pre*	*Post*	*1-Month*
N	64	64	64	66	66	66
M	24.92	26.83	26.97	25.02	26.35	25.12
SD	3.84	3.84	3.47	3.55	2.83	4.14
Mean Score/ Q	4.15	4.47	4.50	4.17	4.39	4.19

Notes: *Mean Score/ Q: values based off of Likert-type question ranging from one to five, one representing "strongly disagree" to five representing "strongly agree" in the attitude section.

and a 1-month mean score of 26.97 (p = .814). The development of students' energy attitudes measured between pre and 1-month surveys (p = .00005) highlight the positive transformation of students' views and thoughts on energy production and use when learning in an outdoor classroom.

For students taught inside there was a substantial increase in students' energy attitudes between pre and post surveys (p = .001), measured with a mean score of 25.02 on the pre survey and a mean score of 26.35 on the post survey. Students experienced a decrease in their energy attitudes between the post and 1-month survey (p =.008). After returning home and taking the 1-month survey a mean score of 25.12 was calculated. No statistical significant difference was measured between the pre and 1-month survey (p = .874) timeframe and a small overall change in students' energy views and thoughts were measured for students learning inside. These results echo what was seen in the knowledge scores where both groups showed increases over the course of their short residential experience but those who learned outside retained or increased those gains at the 1-month delayed measurement while students who learned inside did not show a difference between pre-instruction scores and the 1-month delayed measurement.

Behavior Survey Results

Student responses to behavior questions were analyzed to measure behavior regarding energy consumption. Students taught in both inside and outside settings experienced an increase in positive energy behavior throughout the research study.

When comparing behavior question results, in Table 5, there is a visible difference in mean scores between students' attitude (Table 4) and behavior levels. Energy behavior mean score levels of students were lower than compared to attitude levels measured at each stage in the research timeframe.

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Table 5 Behavior Survey Results

	Outside			*Inside*		
	Pre	*Post*	*1-Month*	*Pre*	*Post*	*1-Month*
N	64	64	64	66	66	66
M	19.98	22.84	23.27	21.06	21.89	22.06
SD	4.83	4.39	5.07	3.72	3.96	3.14
Mean Score/ Q	3.33	3.81	3.88	3.51	3.65	3.68

Notes: *Mean Score/ Q: values based off of Likert-type question ranging from one to five, one representing "never" to five representing "always" in the behavior section.

Furthermore, students' maximum mean behavior scores are well below students' minimum mean attitude scores. These results highlight a noteworthy aspect of the data in regards to students' thoughts and actions. Maximum mean score in behavior section was 30, based on six 5-part Likert-type questions.

Even though students taught outside started with a lower baseline behavior level, measured by a mean score of 19.98, the increase experienced between pre and post surveys (p = 7.89 E-7) were greater than students taught inside. Students taught in the outside setting continued to increase their energy behavior once leaving MOSS and returning home. A mean score of 22.84 was measured for the post survey and a mean score of 23.27 was measured for the 1-month survey, showing a small but positive change between these two time periods (p = .702). For these students immersed in the outdoor learning environment, a substantial increase in mean score was observed between pre and 1-month surveys, in addition to a measured statistically significant difference (p = .00009), showing the positive change in students actions and behaviors towards energy over the course of the research study.

Students taught inside experienced a small but positive increase in energy behavior throughout the study timeframe and at each of the three survey periods. The students' energy behavior baseline mean score level was measured at 21.06 during the pre survey. A small but positive increase was measured between pre and post energy behavior survey questions (p = .023). Mean scores for students post surveys were 21.89, which continued to increase slightly to a 1-month mean score of 22.06 (p = .773). There was no statistically significant difference measured between pre and 1-month surveys (p = .108) for students learning inside as a result of a small improvement in energy behaviors over the research timeframe.

Discussion

This study provides evidence that an outdoor learning environment may facilitate greater gains in energy literacy compared to teaching energy literacy in a traditional indoor classroom setting, particularly in terms of gains that persist over time. This outcome has significance in the consideration of the benefits of outdoor learning environments for the development of energy literate students and our next generation of environmental stewards.

Though the study was not designed to understand why we might see differences in learning outcomes between indoor and outdoor settings, one possible explanation for this difference is students who were taught in the outdoor environment had a greater connection to the material. The energy literacy lessons taught outdoors provided students greater opportunity to develop a connection to the natural environment. Furthermore, the outdoor classroom potentially fostered greater use of imagination and creativity as students witnessed environmental systems and processes occurring right from their seat on the ground. Learning in this setting helps students become aware of the interdisciplinary connections through observation and critical-thinking, where students can draw on past knowledge and current lesson material to fully understand the environment around them without artificial boundaries (Lieberman & Hoody, 1998).

The outdoor setting promotes greater inquiry of natural and human communities, cultivating a strong sense of place in nature and a desire to acquire knowledge to act environmentally ethical (Woodhouse & Knapp, 2000). In the context of energy education, a discipline that draws on environmental elements, students learning outside the classroom could experience lesson content directly within the natural surroundings. For example, observing radiant energy emitted by the sun as they warm-up on the banks of the lake while the teacher talks about forms of energy; and watch deer and rabbits run around in the distance while the teacher covers trophic cascades and how energy flows through an ecosystem. The natural world in which students are immersed in during outdoor classrooms provide a rich setting for class material to be observed and easily conceived, right behind the teachers back.

Energy education, which relies strongly on using the environment and natural world as a learning platform, is well suited and potentially best taught within the residential outdoor environmental education (ROEE) setting where students are immersed in a living and learning community amongst nature for an extended period of time. We are aware that conducting this research study in a traditional school setting, utilizing indoor classrooms and outdoor spaces adjacent to school, could have yielded different results and outcomes. Even though within a traditional school setting the opportunity for curriculum duration are greater, longer energy lessons and additional weeks, the context and setting in which this energy curriculum is taught may not provide the same rich environment for students to be fully immersed in their learning.

One of the most effective ways of expressing to students the importance of an environmental message is through direct engagement and experience, especially an experience that allows the student to observe the direct impact that environmental problems have on natural environments (Ballantyne & Packer, 2002). Throughout the energy literacy lessons, students learned about the environmental and social impacts of energy usage. Outdoor educational experiences have been shown to provide an avenue for students to connect and interact with the natural environment, which can promote the development of environmental attitudes, environmental sensitivity, and an individual's concern for the natural world (Emmons, 1997; Iozzi, 1989). While the lessons taught in both the outside and inside classroom were facilitated and critically evaluated so that the delivery would be the same for the energy lessons, students who learned inside the classroom were removed from the visuals of the natural landscape. Students learning in an outside setting could more easily see the relationships presented in the lessons, such as between the lake water and a renewable energy source. Students learning outside could have had an easier time envisioning how the trees that they lay under or the water they hear splashing by the dock could be used for energy, and in the contrary how these beautiful and majestic places could be harmed without the proper energy decisions and actions.

One particularly interesting aspect of the energy literacy results relate to students attitudes towards energy issues. Students that were taught inside increased their energy attitudes during the time they completed the pre and post survey. However, they experienced a decrease in their energy attitudes between post and 1-month surveys, to a level just slightly above pre survey scores. For students completing the outside energy literacy lessons, their scores increased at each survey taken during the study timeframe. Interestingly when these students left MOSS and returned home, they continued to increase their energy attitudes even after being settled back at home for over a month. One possibility that could explain this development of positive attitudes over time is their association of energy literacy lessons with attachment to the natural world cultivated during their time at MOSS. While all students at MOSS have the chance to develop a connection to the natural world, students participating in the outside energy lessons may have developed a great connection between energy concepts and their appreciation and attachment to the natural environment that continued when they returned home. The students that have established a deep interest in energy related issues through energy cognition and nature connection may be more likely to discuss these topics at home with their families and friends, further increasing their attitudes. Connecting energy learning to these nature-based experiences can promote positive attitudes about the environment and energy, enhancing students' appreciation for nature and a greater desire to safeguard these resources for future generations (Neal & Palmer, 2003).

As shown in Table 5 (Behavior Survey Results), the energy literacy curriculum taught to students was successful in increasing students' energy behaviors. Students taught in both outside and inside settings increased their energy behaviors during each of the three survey phases. Students that were taught outside did experience a greater increase in energy behavior over time. These research results support the belief that values and thoughts are correlated to energy related behaviors and individuals attentiveness towards protecting the environment (Karp, 1996). The natural setting where outside energy literacy lessons took place may have had an influence on students' values and connection to the material, which in turn could have fostered greater behavior in regards to protecting the environment through correct energy actions. Additionally, once students left MOSS and returned home they continued to increase their energy related behaviors.

Energy behavior mean scores were lower than compared to students' energy attitude mean scores. This specific data trend is both interesting and concerning. Regardless of setting, students' mean attitude scores per question ranged from 4.15–4.50, falling into the category as "agree moderately." However, in measuring the same students energy behavior mean scores per question their answers ranged from 3.33–3.88, representing "sometimes." This may point to differences between these 6th grade students' intentions, thoughts, and beliefs in comparison to their actions. For example, many students thought strongly about the importance of saving energy and that they could contribute to solving energy problems by making appropriate energy related choices and actions. However, when it came to putting these attitudes and thoughts into action by saving water, turning lights off when leaving a room, or walking/biking rather than using a car, they were less likely to behave in this manner. Exploring this relationship was an intention of the current study; future studies may explore this question through the lens of the Theory of Planned Behavior (Ajzen, 1991) which includes the variable of "perceived behavioral control" to explain how even though a positive attitude exists towards a behavior, lack of perceived personal control over actions (as may very likely be the case for 6th graders) could lead to lower rates of actual performance of behaviors.

One suggestion for further research points to a longer longitudinal study focusing on students' energy attitudes and behavior. With our research study timeframe extending only one-month beyond the residential education program and energy lessons, the authors recognize the benefits and desire to track students' energy attitudes and behavior change over additional time. We can expect knowledge, especially in the absence of continued learning immersion in the specific discipline, to decay overtime. However, an extended examination of energy attitudes and behavior would be of interest in determining future energy conservation thoughts and actions. The addition of perceived behavioral control may also provide insight.

Within the context of our study, students were given an in-depth energy education experience during the weeklong program. They learned about energy sources and systems, energy conservation decisions and choices, how energy flows in physical and biological processes, and other content found within the 7 Energy Literacy Principles. This knowledge allowed students to become more aware of the overall social and environmental impacts that can occur with improper energy consumption and usage and how they can make more informed energy decisions. Additionally, within this education experience students increased their energy knowledge and attitudes, and particularly for students learning outside, they witnessed a greater desire to put their values and attitudes into action fostering an environmentally responsible citizen.

Conclusion

Several aspects of the research results reveal important information regarding energy literacy education and the means of producing an energy literate citizenry. As Nobel Prize–winning scientist Richard Smalley (2003) concluded, the most important issue and greatest challenge facing humanity is energy. As we transition into a future where correct energy decisions will determine the fate of our existence, it is apparent energy education should be held at the forefront in producing correct energy behavior and action. Improving individuals' energy knowledge and understanding of behavior regarding energy consumption and attitudes about energy production and use is a difficult task, but as demonstrated in this research, properly using outdoor education learning settings is an effective avenue.

As daunting as teaching in outdoor learning spaces might appear, the research conducted within this study and many others suggests that the advantages may be worth the effort. By using outdoor spaces as a complement to the traditional classroom, teachers can inspire interest before the lesson even starts and provide first hand experiences that draw students closer to the class content (Slingsby, 2006). With energy literacy relying on comprehending environmental processes and ecological components the outdoors is a rich and stimulating learning environment. Outdoor spaces encourage students to uses their senses and inquiry skills to understand and seek more knowledge concerning class content, in addition to experiencing processes and class material enfold in front of their eyes (Olsson, 2013). By effectively using outdoor classrooms for the teaching of energy literacy we can help facilitate the learning process and improve individuals energy attitudes and actions.

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