ASSESSING THE EFFECTIVENESS OF AN ELECTRONIC ENVIRONMENTAL EDUCATION CURRICULUM WITH APPLIED USE OF TRAIL CAMERA PHOTOGRAPHS

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ASSESSING THE EFFECTIVENESS OF AN ELECTRONIC ENVIRONMENTAL EDUCATION CURRICULUM WITH APPLIED USE OF TRAIL CAMERA PHOTOGRAPHS

By

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Thesis

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Abstract

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Assessing the effectiveness of an electronic environmental education curriculum with applied use of trail camera photographs.

Chairperson: Dr. Fletcher Brown

Place-based conservation education programs are continuously adapting to ever evolving technological advancements to remain effective and connected to K-12 schools and students. One response to this challenge was an inquiry based, learner centered pedagogy which teaches science-based concepts via real life images captured on trail cameras.

This paper will describe the benefits of a distance learning program which teaches students about wildlife science using trail camera photos and associated lessons. In a time when students are more disconnected from the outdoors than ever. The use of trail cameras, based on these experiences, has the potential to reconnect students to the great outdoors. Now is the time to get kids into the outdoors using technology.
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Background

Since 2008, Richard Louv’s idea of “nature deficit disorder” has been cited and referred to thousands of times over by parents, educators, federal agency personnel and lawmakers. According to Louv himself, “Nature-deficit disorder is not an official diagnosis but a way of looking at the problem, and describes the human costs of alienation from nature, among them: diminished use of the senses, attention difficulties, and higher rates of physical and emotional illnesses. The disorder can be detected in individuals, families and communities” (Louv, 2005). The most important population facing this epidemic however may be children.

As if the health and happiness of our children is not enough, the health and well-being of our entire planet is at risk if this disorder cannot be cured or at least treated. Nature, the outdoors, wildlife and wild places all lose if conservation ideas and practices are not successfully taught to today’s youth. Jacobson, McDuff and Monroe put the importance of Conservation Education into perspective in their book Conservation Education and Research Techniques (2006) by explaining,

“Think of a challenging conservation problem you have encountered – protecting a rare species, winning support for legislation, cleaning up a river, or sustainably managing a forest. Inevitably, people are part of the problem and public education and outreach will be part of the solution. Effective education and outreach are essential for promoting conservation policy, creating knowledgeable citizens, changing people’s behaviors, garnering funds and recruiting volunteers. The fate of our ecosystems and the plants, animals and people that depend on them lies with our ability to educate children and adults, in settings as diverse as schools, communities, farms and forests.”

Unfortunately, however the task at hand will not be as easy as some may believe.

According to a 6-year University of Maryland study, the proportion of children ages 9-12 who spent time participating in outdoor activities such as hiking, fishing and even walking declined by 50% between 1997 and 2003. (Hofferth and Curtin, 2006) Even more troubling than the decrease in outdoor physical activities youth today experience is their knowledge of the wildlife and wild things that surround them, or lack thereof. For instance, in a 2002 study, Balmford, Clegg, Coulson and Taylor concluded that by age 8 British children were able to successfully identify 25% more Pokemon characters, by their names such as “Pikachu” or “Jigglypuff”, than they were native plant and animal species such as “oak tree”, “beetle” or “deer”.

Many variables can be linked to the cause of nature deficit disorder within children including, how safe parents feel when letting their kids freely play outdoors (Bagley, Ball and Salmon, 2006), children having fewer and less diversity among their friends and playmates (Karsten, 2005), local crime rates and inadequate time parents have to spend outdoors with their children (Clements 2004) as well as a child’s limited amounts of freedom and mobility to choose and actually get to an area out of doors (Tandy 1999).
One trend that also frequently appears to make headlines in regard to limiting the amount of time today’s youth spend outdoors and thus inhibits their connectedness to nature is technology. Playing computer games and time spent watching television was reported by 85% of mothers to be the number one factor limiting outdoor play (Clements 2004). Other technologies such as smartphones in the hands of youth can also have negative impacts on their ability to enjoy the outdoors. For example, in October of 2019, nowthisnews.com reported that in South Korea the “Ministry of Gender Equality and Family hosted 400 middle school and high school students in 16 detox camps across the country” (NowThis, 2019). These camps lasted up to 12 days and included outdoor sports activities, scavenger hunts and time for quiet, tech-free meditation for South Korean teens who were overdependent or literally addicted to their smartphones.

In a time of such technological addiction and environmental absenteeism type of epidemics, today’s youth, specifically young teens, are falling away from forming a connection with nature and finding themselves more and more dependent upon technology. This crisis has literally led them into lethal danger when trying to spot their next “PokemonGo” critter in a busy urban sprawl. Glued to their cell phone and absent of the real world that surrounds them such augmented reality apps as this have cost the lives of at least 250 individuals and millions, if not billions, of dollars nationwide (Faccio and McConnell, 2018).

But what if technology could be used to do the opposite? Save lives, connect humans back to nature and promote conservation education while doing so. Used in moderation, teaching science-based concepts, using real world content, and a moderate amount of technology, electronic environmental education can and has been doing just that!

Environmental Education (EE) through electronic based platforms has been proven to be more cost effective and can reach a larger geographical audience than those that may otherwise never have the opportunity to experience such lessons (Whitehorse, 2008). In regard to teaching across time zones and adhering to financial restrictions that many institutions may face, information and computer technologies (ICT) can facilitate information gathering and dissemination far more efficiently than some traditional methods (Aivazidis, 2006).

Using platforms that students are already familiar with as well as offering new opportunities to learn while using technology can make students more excited to become professionals in their field of interest. Higher levels of student engagement and motivation have also been reported from experiences using technology in a practical, outdoor based manner (Kamrainen et, al. 2013).

Many teachers agree that supplementing standard textbook instruction with technology-based, research or inquiry-oriented learning materials should be designed for today’s schools and especially within science classrooms (McLaughlin, J. & Arbeider, D. 2008). In a time when STEM based pedagogy carries so much momentum it would seem...
to be most appropriate to open the doors to technology in order to get more youth interested in the out of doors.

This is where trail cameras, also known as game cameras, come into the picture. Using motion sensor technology, these durable, battery powered, and weather resistant devices can be used to capture photographs day or night, in some of the harshest conditions, literally anywhere in the world. Likewise, downloading the photos off an onboard Secure Digital (SD) card and uploading them onto a computer can create opportunities to share information across all corners of the globe within minutes.

Observing nature that would otherwise be inaccessible by the use of “camera traps” data is just one-way trail cameras can help increase awareness and inspire individuals to engage in the outdoors and thus feel more connected to nature (Schuttler et al. 2018). Giving youth citizen scientists the opportunity to experience nature using a medium that they are familiar with presents an option that deserves a swipe right.

There is a lot to be gained by providing students with a true learning experience rather than just educational content. Experiential learning can increase problem solving and critical thinking skills as well as knowledge retention, especially within wildlife and natural resource related fields (Millenbah & Millspaugh, 2003). An experiential learning opportunity such as deploying a camera trap, may not only be a highly favorable experience to a middle schoolers scholastic workload but can also lead to increased motivation in becoming independent thinkers (Davis, 1993) as well as offers ample time for reflection, generalization and further experimentation, especially after viewing the cameras weeks’ worth of stored images.

Critical thinking, problem solving, and place-based learning can all be byproducts of a successfully implemented inquiry-based pedagogy. Involving students in such an extensive investigation as translating trail camera data, “encourages students to maintain ownership of the process and products of their scientific investigation and facilitates development of core scientific skills such as formulating questions, collaborating with others and communicating their information” (Edelman and Edelman, 2017). Many of these instructional outcomes are key skills reflected in today’s public schools’ systems federally or state mandated instructional standards.

Camera traps have been used for many years now to gather information on native, exotic, secretive and threatened species as well as to illustrate concepts such as species diversity, richness and evenness (Karlin and De La Paz, 2015). My personal experiences using trail cameras to connect youth with not only the outdoors but also to the technology that allows us to monitor species that may otherwise go unnoticed has proven to me that there is great excitement and enthusiasm when kids see wildlife in their native habitat, whether in the field or on a screen.

Whereas many outdoor educators meet resistance when trying to disconnect their students from technology in order to instill within them a deep appreciation and understanding of the natural world around them Bryan (2011) suggests that outdoor
educators must use technology to their advantage to deliver educational content in a less than traditional, web-space rather than place-based, type of platform. In an age of STEM based curriculum, camera traps could not represent a better opportunity for bringing the outdoors into the classroom in an effective and efficient, not to mention highly engaging, fashion. Instead of outdoor summer camps banning the possession of electronic devices like smartphones, what if educators could use these devices as learning tools?

In 2009, a new all-time high of children’s “media time” was recorded at more than seven hours per day according to Kaiser Foundation research (Rideout et al. 2009). Media time and more so, “screen time”, includes watching TV, playing video games, being on a computer or consumed by internet or mobile phone apps. These thing are not all bad however. Results from the same Kaiser Family Foundation study show that, “another trend, the growth of technology-based outdoor leisure activities that incorporate electronic media has already become important in the lives of children. This electronic influence – indoors and outdoors – is likely to increase in the years ahead, and park and recreation professionals could respond to this trend by developing innovative ways to link outdoor time and electronic media consumption.”

Remote cameras themselves have the ability to do just that. We can now create environmentally based, educational content from anywhere in the world and distribute it within any schoolyard or classroom thousands of miles away. In this projects case, to bring the Theodore Roosevelt Memorial Ranch and all of its Rocky Mountain ecosystem inhabitants into the lives of classroom teachers and students, pre-selected slides which will focus on a variety of large and small game mammal species as well as birds, bats and even plant life will be shared electronically.

**Purpose**

The purpose of this action-based project was to create and assess a middle school curriculum, which adhered to current Next Generation Science Standards (NGSS) and used trail camera photo sequences, short answer questionnaires, teacher keys, lesson extensions and background information to teach practical, real-life biological principles with no travel or field trip related expenses required.

One of the primary goals of the curriculum was to increase in awareness and understanding of the integration between wildlife conservation, private land and livestock management. Other learning outcomes of this specific project included:

1) Species Identification of MT Wildlife
2) Trail Camera Uses and Operation
3) Using observation, inquiry and reasoning techniques to support a claim

This technologically based pedagogy embedded in the curriculum hoped to offer a real-world perspective that fostered shared use of natural resources and promoted stewardship of the land to build common ground for sustaining healthy ecosystems and has the potential to not only increase student’s science knowledge but also create more environmentally responsible behavior within students’ daily lives. The research focus of
this study was to evaluate whether or not the students who completed this curriculum would gain a greater knowledge base of and appreciation for their innate sense of nature no matter what part of the world that they find themselves in.

The research questions for this project were:

1) Can viewing trail camera images indoors actually increase the amount of time students spend outdoors?
2) Will learning about wildlife and science-based concepts using this methodology (tech) increase student’s appreciation and values of wildlife conservation?
3) Are students more likely to identify wildlife species correctly after participating in this project?
4) Does completion of this curriculum increase favorable beliefs regarding learning about wildlife using this pedagogy?

The author hypothesized that; 1) initially (pre-treatment) students would self-report higher amounts of time spent indoors, in front of media screens and a general lack of interest for outdoors activities (hunting, fishing, hanging out with friends) than that of the post-treatment survey results. 2) Learning about wildlife by viewing trail camera photos and answering inquisitive, creative and thought-provoking questionnaires would indeed increase the appreciation for and amount of importance students felt in regard to wildlife conservation. 3) Students ability to identify wildlife species used within the curriculum would increase following completion of the treatment. 4) Students will feel familiar using technology to learn about nature in order to visualize and interpret what is going on in the wilds that surround them from trail camera photos. Thus, after completing this curriculum the author hypothesizes students will have increased favorable attitudes in regard to electronic environmental education.

**Study Program Description**

Classroom teachers were instructed to obtain administrator approval (exhibit C in appendix) as well as student assent forms (exhibit D) before participating in this study. Once proper documentation was received the classroom teachers administered the pre-survey (exhibit E) to all of their participating students. Pre-surveys were then sent to the author and entered into a Google Forms document.

In total, four lesson modules using trail camera deployment data were created. The first lesson was strictly informational and did not include any student worksheet. Student worksheets (exhibit A) were designed to serve as an assessment tool which would assist classroom teachers in facilitating student decision making, critical thinking, communication and problem-solving skills. Teacher answer guides (exhibit B) were produced in order to aid teachers by providing background information, evidence to support a variety of possible student claims and offer occasional supplemental lesson extensions.

Lessons were designed to accomplish a variety of Next Generation Science Standards (NGSS) including but not limited to:
MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

The basics of trail cameras were explored in this curriculum but deploying cameras such as was done in Tanner and Ernst (2013) TAO curriculum was not a primary objective. Species identification, camera components and other background information was covered in an initial lesson, called “Trail Camera 101”, as such it related to all mammals and questions that may have been encountered throughout the following three lessons.

All four lessons and associated student worksheets and teacher guides can be found here: https://drive.google.com/open?id=1YgwLVRd0z-V1EiTNwDATiHfKYxJsEFw

Lessons were designed to be as hands off for teachers as possible. Students could be paired together in a computer-lab based setting or the class could remain as a whole using a Smartboard or projector for all to see. With each pair or individual student responsible for answering each question on the #TRMRanchCam worksheet the slides would be advanced through one by one. As the slides progressed a story would be told right before students’ eyes. Time would pass, temperature would change, sun, snow and other weather patterns would come and go sometimes without warning.

Slides were edited from original deployment data by deleting those photos without wildlife or with recurring visuals so that an appropriate number of photos (200-300) could be viewed and analyzed in one class period.

Specific retention, inquiry, problem solving, teamwork and communication skills had to be developed in order to correctly answer questions and classify species in associated #TRMRanchCam student worksheets. Worksheets were not graded as participation in this study was optional. Classroom teachers were encouraged to do one lesson a week for four consecutive weeks. After the last module and worksheet was completed all study participants completed the post survey.

The categorical change in beliefs, knowledge, time spent outside and appreciation of wildlife conservation was captured in post-survey data by once again entering students responses into a Google Forms document and comparing it to what was found in pre-survey responses. 

Location of the Study

Trail cameras have been deployed on the Theodore Roosevelt Memorial Ranch near Dupuyer, MT since 2012. These cameras are routinely monitored and placed in strategic locations to capture a variety of species and seasonal movements across variable
ecotypes. Bushnell Trophy Cam and Bushnell Trophy Cam HD models were used. Photos used in this study were captured between January of 2014 and May of 2016.

Starting in November of 2019, previously developed slideshows and associated student worksheets and teacher guides were distributed to middle school science teachers across Montana. The Montana Office of Public Instruction (OPI) Science Instructional Coordinator helped to advertise the opportunity for teachers and their classrooms to participate in this study via email and social media. Over 30 teachers responded for more information. Six teachers completed all necessary steps to fulfill the study requirements, concluding in March of 2020.

![Figure 0. Illustrates the location of the Theodore Roosevelt Memorial Ranch (TRMR) and its proximity to participating middle school classrooms in Montana.](image)

Five different schools from all across Montana participated in this study. Populations of each community varied from a high of 8,393 individuals to a low of 106 individuals using the most up to date US census bureau data (census.gov).

**Methods**

This research followed a quasi-experimental, one-group, pretest-posttest design structure and included a sample size of 83 students. Students ranged from ages 10 to 14. This age group was specifically selected in order to capitalize on previously reported research such as that done by Larson et al. in 2010 that described a decrease in the attraction to outdoor related activities amongst youth entering their young teenage years. Randler, Ilg and Kern (2005) also identified that youth between fifth- to sixth grade (10-
12 years of age) can better understand ecological applications, comprehend ethical concerns and have acquired higher degrees of rational capacities than that of younger elementary age pupils. The study began in November of 2019 and was concluded in all schools in March of 2020.

Four Trail Camera Curriculum modules were created by the author. The first module was designed to be informative only, not requiring students or teachers to complete a worksheet afterward. The following three modules each contained 200 – 300 trail camera photographs presented each in a PowerPoint slideshow format which was shared with the classroom teacher by the author using Google Drive. Lesson slideshows and corresponding student worksheets as well as teacher lesson guides were attached in the same email to facilitate organization of lesson module components.

Teachers had the choice of presenting the material in front of the class as a whole (using a SmartBoard type of device) or dividing the classroom into groups with partners working through the material in a computer lab. While progressing through the photographs (PowerPoint slides) students were instructed to follow along with their associated “#TRMRanchCam Student Worksheet” (Exhibit A in appendix) and answer questions as the conclusive material presented itself. Each worksheet contained approximately 7 – 10 questions. Teachers were supplied with an answer key (Exhibit B) developed by the author for each lesson and could assist the students as needed.

Administrator approval letters (Exhibit C) and student assent forms (Exhibit D) were completed for each school and student, respectively, per University of Montana Institutional Review Board policies. Prior to beginning with the first lesson each classroom teacher initiated a pre-survey for each of the student participants to complete. Following the four lessons each student completed an identical survey to capture pre-treatment results.

83 pre surveys were completed. 83 post surveys were completed. On each survey student participants were asked to give themselves an identifying mark (first name, initials or student ID number) in order to match pre and post surveys for additional analysis if needed. Care was taken as to not share or expose any specific students or their answers.

Survey questions were transposed into a Google Forms page and survey results were entered and categorized as received into separate pre and post test results spreadsheets. Demographic data (age, ethnicity, etc.) was only entered in pre survey entries for analysis.

Results

This section will cover the results gathered via pre-test and post-test surveys comparatively. First to be reported will be the demographics of the participants from the study. Next the author will focus on the survey questions as they pertain to the aforementioned research questions and lastly teacher feedback will be listed in this section as well.
An identical survey (Exhibit E) was used as both the pre-test and post-test for each participating student to complete. This survey was designed to collect data regarding the following research questions A) Can viewing trail camera images indoors actually increase the amount of time students spend outdoors? B) Will learning about wildlife and science-based concepts using this methodology (tech) increase student’s appreciation and values of wildlife conservation? C) Are students more likely to identify wildlife species correctly after participating in this project? And lastly, D) Does completion of this curriculum increase favorable beliefs regarding learning about wildlife using this pedagogy?

Demographics
Basic demographic features of the students such as age, gender and rural or urban upbringings as well as an identification feature to match pre and post surveys were documented in the survey.

Race/Ethnicity of trail camera curriculum participants: (N= 83)

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>2 (2.4%)</td>
</tr>
<tr>
<td>Asian</td>
<td>1 (1.2%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4 (4.8%)</td>
</tr>
<tr>
<td>Native American</td>
<td>14 (16.8%)</td>
</tr>
<tr>
<td>White</td>
<td>62 (74.7%)</td>
</tr>
</tbody>
</table>

The age of the students participating in the trail camera curriculum project: (N= 83)

<table>
<thead>
<tr>
<th>Participant Age</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>
The Gender of test subjects:
More males (48) than females (35) participated in the study. N=83

Self-Reported Population Demographic:
Participants answered the survey question, “Would you consider yourself to be from an Urban or Rural area?

In order to best understand some of the activities students spent time participating in when in the outdoors, a series of informative questions were listed on the pre/post survey. When responding to the question, “In the past year have you gone hunting?” answers were split almost perfectly with 50.6% answering “Yes” and 49.4% answering “No” in the pre survey. Post survey results showed slightly different answers with 54% answering “Yes” they had gone hunting in the last year and 46% reporting they had not.

When answering the question, “Have you gone fishing in the past year?” nearly 80% of respondents said “Yes” while only about 20% said “No”, they had not gone fishing in the past year according to pre-survey data. This was very consistent with post survey data.

90% of all respondents, both in pre and post surveys results, answered “Yes” when asked if they “enjoy learning about wildlife”. 90% of post survey respondents also answered “Yes” when asked if they “enjoy opportunities to see rare or potentially dangerous wildlife species up close”. This was up from 83% of pre-survey respondents saying “Yes”, likely attributable to knowing they could have this opportunity electronically while maintaining a very safe distance!

The only question to get 100% unanimous answers was, “Do you enjoy spending time in nature, outdoors?”. All 83 participants said “Yes”, in both the pre-and post-survey results.
PRE

4) Do you believe you can learn about wildlife science by viewing series of photos?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>14</td>
</tr>
</tbody>
</table>

69 / 83 correct responses

POST

4) Do you believe you can learn about wildlife science by viewing series of photos?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>11</td>
</tr>
</tbody>
</table>

72 / 83 correct responses

Figure 1. Before trying out the electronic environmental curriculum almost 17% (14) of surveyed students did not believe that they could learn about wildlife by viewing a series of photos. After completing the curriculum about 87% of students believed that they could learn about wildlife science by viewing series of photos dropping the number of “non-believers” to 11 or 13.3%. N=83.
Figure 2. Prior to completing the instructional modules only about 15% of students rated themselves at an 8 or better (out of 10) as knowing their local wildlife species. Upon completion of the curriculum those students who rated themselves at an 8 out of 10 or better for knowing their local wildlife species increased to over 45%! N=83
Figure 3. Question 8 on the survey categorized students’ opinions on the importance of wildlife conservation and was largely unchanged following the treatment. N=83

Figure 4. Overall appreciation of wildlife reported by students also remained largely unchanged when comparing results prior to and after treatment. Appreciation of wildlife remained high however with over 80% of students ranking their appreciation levels at a 7 out of 10 or higher in both pre and post samples. N=83
Figure 5. Students overall level of interest in natural resource management increased over the duration of the treatment with a reported 33% of students reporting a "High" level of interest in the post survey compared to only 23% at the same level in the pre-survey. Conversely, about 3 students reported lower levels of interest in the post survey when compared to the same pre survey question. The total number of students in the “Low” interest level among post-surveys responses was 2 individuals or 2.4%. N=82.
Figure 6. Before completing the curriculum about 13% of respondents identified themselves to be “Extremely Likely” to be connected to the natural world. This number increased slightly with nearly 16% of students claiming to be Extremely Likely to be connected with nature following completion of the curriculum. On the other side of the spectrum, 6% of students identified as being “Extremely Unlikely” to be connected to the natural world which surrounds them prior to the curriculum. This number favorably decreased to 2.4% on post survey findings. N=83
Figure 7. Using photographs alone a beef cow and domestic dog were identified as a wildlife species by 34% and 23%, respectively prior to completing the curriculum. The rate of incorrect responses in regard to identifying a beef cow as wildlife decreased by 10% in post survey results while the number of incorrect answers identifying the domestic dog rose slightly (2%). The number of correct answers, identifying both a photo of a Grizzly Bear and a bull Elk as wildlife, rose by nearly 4%.
Figure 8. Prior to completing the curriculum nearly 80% of participants did not classify moose in the deer family and nearly 36% did not identify elk as belonging in the deer family. White-tailed deer and Mule deer both received exceptionally high and congruent responses in both the pre and post surveys remaining unchanged when comparing the before and after treatment results. The largest change was found when students correctly identified Moose as a member of the deer family, 42% of the time, in post survey results. This equated to a 20% increase in correct responses and is detailed moreover in the discussion section of this paper. N=83
Figure 9. Question 15 on the survey asked students to select the approach of learning in which they get the most out of in regard to understanding science-based concepts. While those that chose “Both”, lectures and self-inquiry, remained constant in the number of responses before and after treatment, the number of students that selected “Lecture Me” dropped by 50% after completing the electronic, self-inquiry-based pedagogy. N=83

Figure 10. Equal numbers of students answered that they either “Agree” or “Strongly Agree” that a basic understanding of natural processes in nature will help them be a better environmentally wise citizen, at 95% in both pre and post surveys responses. N=83
Figure 11. Prior to completing the trail camera curriculum over 43% of students reported that they either “Agreed” or “Strongly Agreed” with being bored during environmental science lessons. After completing an electronic environmental curriculum focusing on wildlife and their habitat, this number dropped by nearly 10% with 65% of student respondents either disagreeing or strongly disagreeing that they were bored during environmental science lessons. N=83

Figure 12. 15% of students either “Agreed” or “Strongly Agreed” that it is difficult the natural world around them in pre-survey results. Post survey results were relatively consistent with this finding as well as those that “Disagree” or Strongly Disagree” noting changes of only about 3% in each of those categories respectively. N=83
Figure 13. Students attitudes on whether or not they would like to work in a natural resource related field when they finish school were largely unchanged. Approximately 45% agreed and 55% disagreed with that statement in both surveys. N=83

Figure 14. Also largely unchanged was the overwhelming response (92% Pre, 95% Post) that students “Agreed” with or “Strongly Agreed” with the idea that every citizen should have some natural resource knowledge. N=83
Only students were considered as the population for this study, but teachers were asked for their feedback after the study had concluded. Those comments are shown on page 31.

**Screen Time and Family Time**

When asked how many hours per week students spent enjoying the outdoors survey averages came to show that about 54% of respondents spent 8 or more hours recreating in some fashion outside.

In comparison, the same question was asked in regard to time spent per week in front of media device (phone, tablet, TV, etc.) screens. Survey averages came to about 39% of respondents spending 8 or more hours per week on electronic devices.

The last question to report within these results and listed on the surveys was an open ended one. It read, “Do you come from a family background that regularly spends time outdoors?”; it offered “Yes” or “No” options to circle as well as prompts as to “How often” if answering yes, and “Why not” if answering no. On average between pre and post surveys 88% said Yes and 12% said No, they do or do not come from a family background that regularly spend time outdoors, respectively.

Reasons for their being in or out of doors varied from, “Yes, doing Native tribal things like pow-wows and sweats” to “No, my parents are mechanics”. Others had no clear interest in anything outdoors and wrote, “I’d rather go shopping” or “Cause (sic) my family is lazy”. While yet there was clear hope in many stating things like, “Not as much in the winter” or “I haven’t taken hunters education yet”.

**Discussion**

Routine exposure to, and more specifically, direct play in, nature have great benefits in developing such skills as problem solving, capabilities for creativity and overall intellectual and emotional development within the minds and hearts of children (Kellert, 2005). An especially important time for this to occur is during the “middle childhood” years or in this study’s’ case, ages 10 to 14.

Although this study did not physically get youth into the outdoors directly its intention was to create a form of “cognitive biophilia” in which students could experience nature vicariously using trail camera images and ultimately gain a deeper level of comprehension for what nature is and does. Offering a view into an outdoors setting which they were most likely not familiar with and showing biological processes and phenomena rarely witnessed by most middle-schoolers, trail camera photos worked perfectly to begin this process.

In synthesis, it was to be an end goal of this study to determine if comprehension was being achieved, did it also increase student’s appreciation and intrinsic understanding
of the importance for conservation of nature and wildlife? We will conclude this idea by answering the following four previously established research questions.

1) *Can viewing trail camera images indoors actually increase the amount of time students spend outdoors?*

Using pre and post surveys as the measurement tool it was discovered that in a typical week 22% of students spent 12 or more hours in front of a media screen. A media screen in this case was considered either a phone, TV or computer. 17% of students spent 8-12 hours of screen time per week while 43% reported 3-8 hours on devices per week and those claiming to spend 3 hours or less of screen time per week equaled about 18%. These numbers stayed very constant between pre and post survey data only varying +/-1% but appear to be significantly lower than the daily average of nearly 8 hours that Rideout et. al. (2010) had reported for 8 to 18-year olds.

In a study done by Larson et. al. (2019) examining rural youth ages 11-14, “results showed that most rural youth in South Carolina are spending time outdoors and that many of them are connected to nature. Yet, screen time was higher than outdoor time for almost every demographic group included in the study”. Question #16 of the survey was designed to compare just that.

When responding to the question, “In a typical week how many hours do you spend enjoying the outdoors?”, 25% of students reported spending 12 or more hours a week outdoors in both the pre and post surveys. An increase in the time spent enjoying the outdoors was seen across two other categories, 8-12 and 3-8 hours/week subgroups, with the amount of those students reporting spending only 1-3 hours a week enjoying the outdoors decreasing by 50% after completing the curriculum.

This evidence cumulatively suggests that following this treatment and design students did in fact spend more time outdoors. The relatively high number of rural participants may be part of the reason such low screen time figures were reported. However, students in this study still spent more time outdoors per week than on media devices and remained well connected to nature (Figure 6).

2) *Will learning about wildlife and science-based concepts using this methodology (tech) increase student’s appreciation and values of wildlife conservation?*

In order to answer this question, we will again look at several elements posed in the student survey while comparing pre to post treatment responses. The first observation to address *importance* was in response to question #8 in the survey, “On a scale from 1 (low) to 10 (high) how important is wildlife conservation?” Cumulative pre and post survey answers both came in at an average of 8.5 out of 10, showing that there was no change in the students’ opinions in regard to the importance of wildlife conservation after completing the treatment curriculum.
The next portion of results to look at to answer the question regarding appreciation was question #9 from the survey, “On a scale from 1 (low) to 10 (high) how much do you appreciate wildlife?”. Again, cumulative averages of pre versus post survey responses both came to 8.5 out of 10 suggesting that there was no overall significant change in the appreciation of wildlife students felt in regard to completing this treatment.

While this differed from the hypothesized conclusion the author believed he would see it is important to note that both importance of and appreciation for wildlife were very high and remained high before and after the study.

3) Are students more likely to identify wildlife species correctly after participating in this project?

To initially understand student’s general knowledge in regard to wildlife species question #7 on the survey asked each respondent to, “rate yourself on a scale of 1 (low) to 10 (high) as knowing your local wildlife species”. The cumulative pre-survey average equated to 6.3 out of 10 while the post-survey cumulative average equaled 7.1, showing some increase in at least the confidence level of students’ ability to identify wildlife species.

When actual trail camera photographs were used, such as in question #13 of the survey, students were asked to circle the images which contained an animal that they would consider wildlife. The four photos listed included a beef cow, a Grizzly Bear, an Elk and a domestic dog. An increase in the ability to correctly identify the bear and elk as wildlife was observed by 4% and 3% respectively when comparing pre to post treatment results.

Question #14 in the survey went beyond just identifying wildlife from domestic animals and looked at the deer family specifically. It read, “Circle all members of the deer family”. Included in the line-up of four photos was a cow and calf Moose, a White-tailed buck deer, a Mule deer buck and a bull Elk. While the white-tailed and mule deer each had high levels of correct responses (100% and 98%, respectively) in both the pre and post surveys, the amount of correct answers identifying a moose as a member of the deer family increased by 22% while the number of correct responses in identifying an elk as a member of the deer family increased by 12% after receiving the treatment.

Important to note is that each trail camera image used in the survey were from various camera deployments, as such, subject size, position to camera, angle, height and contrast varied significantly thus the task to correctly identify each animal took some diligence. Also, of notable significance is that wildlife identification and more specifically identification of members of the deer family orientation was provided in the very first module presented to students in their classrooms. This means that all of the students to label the moose as a member of the deer family retained that knowledge for no less than three weeks.
4) Does completion of this curriculum increase favorable beliefs regarding learning about wildlife using this pedagogy?

To establish baseline data in regard to this research question the author first wanted to establish whether or not students believed that they even could learn about wildlife science by viewing a series of electronic images. Compared to the traditional science textbook lessons which most students receive this could have been perceived to be too good to be true! Question #4 on the survey accomplished just that, showing that 83% of students did in fact believe that they could learn about wildlife science in this way (tech only) before the treatment while that number increased to 87% of students believing that they could learn about wildlife science by viewing photos after the completion of the coursework. Therefore, an increase in favorable beliefs in this type of curriculum was witnessed.

To categorize the effect upon favorable beliefs regarding method of delivery question #15 asked respondents, “Do you believe you get more out of a traditional (book, lecture, note-taking) approach or a non-traditional (tech-based, self-inquiry) approach to learning science-based concepts?” Responses to the answer “Both” remained steady when comparing pre and post survey data at 70%. Significant changes were found in the other two response options with those that favored “Lectures” dropping by more than half from 16% to 7%, pre to post survey, respectively and those favoring the “Computer” option increasing from 14% to 23%, pre to post survey, respectively. This confirmed the authors hypothesis that students would have increased favorable beliefs in regard to learning about wildlife science using the pedagogical method which was delivered in the scope of this study.

As tertiary evidence to support this claim survey question #10 shows a 10% increase in “High” levels of interest in natural resource management for students as completing this curriculum. This could suggest a link between the importance of students’ beliefs, their connection to ones attitudes and the ultimate effect on their interest level for topics that will ultimately affect their future lives and the future of entire ecosystems.

As Larson (2011) describes in Children’s Time Outdoors: Results and Implications of the National Kids Survey, “the success of future conservation efforts may depend on concerted efforts to facilitate growth in the time children spend outdoors and their involvement in nature-related activities”. What these activities are will depend on where the children come from, what types of resources are available to them, how often they can access safe outdoor spaces, and ultimately who will take them?
**Conclusion**

Now more than ever our school children, our country and our planet is in need of effective environmental education curriculum and nature based programs. Technology is a safe and affordable vector for communicating educational content with many platforms and applications already being implemented. Our world is currently experiencing never before seen measures in regard to social distancing and online based learning due to the COVID-19 pandemic. Electronic environmental education pedagogy could not be more important than it is right now.

In a time when travel restrictions, school closures and extreme isolation measures are commonplace educators already difficult jobs seem to only be getting harder. The curriculum evaluated in this study should serve as chasm of hope that meaningful, effective and engaging educational content can be shared with youth across all categories of demographics, between any border of experience levels and amongst any boundary of connectedness. If youth cannot experience, nonetheless literally see, the out of doors and are in possession of electronic media devices already we as educators must be ready and willing to turn even the most dire of times into a positive learning experience.

While this study sampled only a small portion of a relatively un-populated segment of our nation further developments in similar educational modules have the utmost potential in connecting individuals from all corners of the farthest away counties, countries and coffee table workstations. Trail camera images are easy to capture, relatively inexpensive to share and tell a story most people would never otherwise see.

Although this type of curriculum is not the answer to getting kids directly into the outdoors the byproduct of students successfully being able to identify more wildlife species after partaking in this type of learning experience may be. Additionally, the fact that students seemed to enjoy this type of delivery method also carries considerable merit.

It is the authors hope that this research will serve as a baseline for understanding how electronic environmental education can best connect youth with the outdoors. The findings regarding intrinsically felt connectedness towards, importance for and appreciation of nature and wildlife were most certainly found to be positive and uplifting. Efforts must still continue however for educators, developers, administrators and potentially even legislators to ensure the outdoors and wildlife science are accessible to all even if initially only offered within a confined indoor space.

The author would recommend that similar research occurs on a broader scale to more accurately define barriers that may exist within more heavily populated, urbanized communities where youth have far less opportunity to spend time outdoors, connecting with nature, as freely as most students in Montana do. Providing similar photographs of a variety of big game wildlife species in healthy western ecosystems may also prove to have a more drastic effect within the eyes of inner-city youth whom are not used to such abundant native creatures. Now is the time to get kids into the outdoors using technology.


Teacher Feedback

“As far as my overall impressions, the Trail Camera Project worked very well for my students. There was plenty of dialog regarding exactly what a trail camera was and what they can be used for. Plus, they learned how to observe and identify the various species, define whether they were predator or prey, discern feeding and resting habits, etc.

I would like to see more of these types of lessons.”

- Mr. T

“This activity was excellent for the NGSS practice of Engaging in Argument from Evidence and Analyzing and Interpreting Data. The rich conversations the kids had were great! I overheard phrases like “no it can’t be a black bear look at the hump and the face dish”, “that has to be a mule deer look at the tail and the antlers they are forked”, “I think it is a coyote, look at its size compared to the deer picture before it and look at the tail it is bushy and almost touching the ground”. These are just a few examples of how the students used evidence to support their claims it was wonderful!

Overall the kids really enjoyed working as a real-life scientist! The fact that these pictures were from Montana of real live animals lent validity to each activity. The questions led the students to look closely at the pictures which required their focus and teamwork.”

- Mrs. C

“They were really excited to have a unique lesson to partake in! Each lesson took about one 50-minute class period. Seeing slides of predators and the trespasser got students the most excited. We had a good discussion about how the bear scat appeared in the last lesson and how the cameras don't necessarily catch everything which was a good point to get across to students.

I thought the number of slides was appropriate. Too little and it would become too simple. Some of the hardest or maybe most tedious parts were counting large numbers of species.”

- Mrs. S
Appendix

Exhibit A – Student worksheet for Lesson 1

#TRMRCam Trail Camera Worksheet:

“The Grove”

1) How many different species did the camera detect? Which ones?

2) What day did a radio collared mule deer doe pass the camera? What do you think wildlife managers used the radio collar for?

3) Would temperature data be useful to have? Why?

4) Approximately how many bucks (male deer) did you see in this sequence of photos?

5) When did the first bear arrive on camera? How can you confidently discern which subspecies it is?

6) How many predators were caught on camera? Which species?
7) How would you best describe this location? (i.e. feeding area, bedding area, travel corridor etc.)

8) When do cow elk typically have their calves? Specify to the approximate week according to the pictures.

9) How long was the camera set for?
#TRMRanchCam Trail Camera Worksheet: “The Grove” TEACHERS GUIDE

1) How many different species did the camera detect? Which ones?
5: White-tailed deer, Mule deer, Grizzly Bear, Coyote, Elk

2) What day did a radio collared mule deer doe pass the camera? What do you think wildlife managers used the radio collar for?
5/08/14; Answers may vary. Radio collars on this particular mule deer population helped biologists determine where these animals wintered and summered and exposed new and unknown migration routes for mule deer. While tracking the deer, biologists could also determine location to a finite enough location to determine what plant species the deer was grazing on while inhabiting critical winter range habitat.

Further content regarding this study can be found at:
https://scholarworks.umt.edu/cgi/viewcontent.cgi?article=2211&context=etd

3) Would temperature data be useful to have? Why?
Yes. Temperature data can tell us (scientists) exactly how cold it is on a day-to-day basis. This can be an indicator as to how harsh the seasons are and therefore how much energy is needed for wildlife to stay warm in the winter seasons. Wildlife managers often limit human caused disturbances in areas where wildlife is susceptible to harsh, long lasting, severe weather conditions. Temperature data can also be compared from year to year for historical purposes.

Additionally, as temperatures warm the animals in these photos appear to lose some of their dense winter fur and gain a sheeny, bright coat in the summer months. The camera used here was a Bushnell Trophy Cam, the newer model; Trophy Cam HD has temperature sensing and recording capabilities.

4) Approximately how many bucks (male deer) did you see in this sequence of photos?
4, all in velvet. Some are hard to see, students may need to use a zoom feature in order to see them more clearly. Refer back to these dates if needed (5/30/14), (6/01/14), (6/03/14), (6/04/14), (6/06/14)

5) When did the first bear arrive on camera? How can you confidently discern which subspecies it is?
05/07/14; Grizzly bear, the shoulder hump and dish shaped face profile can be visualized.

6) How many predators were caught on camera? Which species?
6 Total, 3 Grizzly bear (5/07/14, 6/09/14 and 6/11/14) sightings and 3 coyotes (5/9/14) appear in this set of photos.

7) How would you best describe this location? (i.e. feeding area, bedding area, travel corridor etc.)

Answers may vary; all 3 are applicable with proper explanation however no photographic evidence suggests that any animals used this area for bedding. The fact that we can see animals casually grazing (in clear, sequential photo sequences) indicates casual and relaxed feeding. Blurred photos and only one or two photos of an animal indicates the animal was moving quickly through the area, not stopping to eat or bed.

8) When do cow elk typically have their calves? Specify to the approximate week according to the pictures.

Typically, around the first week in June, on 6/5/14 the first elk calf appeared on this camera.

More can be found on the life history of Elk here:
http://animalrange.montana.edu/documents/extension/elkmgmt.pdf

9) How long was the camera set for?

Students should use timestamp data (see slides 5 & 6) in order to determine the day the camera started and the day the camera ended taking photos. Start date = 2/08/2014 End date = 6/12/14. Correct Answers could include: Just over 4 months, 4 months and 4 days, or 124 days.

Use this site for easier calculations! https://planetcalc.com/274/?thanks=1
Exhibit C – Administrator Approval Letter

Dear Administrator,

This letter is to serve as a release for below signed teacher to participate in a Wildlife Trail Camera Curriculum pilot project at _________________________________ school. This project will include student Pre and Post surveys that will categorize effectiveness, interest levels, engagement and knowledge retention of students before and after learning about wildlife species and ecosystem dynamics happening on an actual ranch in Montana. Curriculum modules are designed to align with Next Generation Science Standards. Student information will be kept confidential.

Teacher feedback will be requested during and after the project at the willingness and availability of the teacher. No compensation will be given to teachers, schools or participants. Anticipated length for completion is 5-hours (1-hour per week for 4-5 weeks). Curricular material can be kept as a future school resource used as the teacher sees fit.

Teacher Signature__________________________________________ Date _________

Admin. (Principal/Superintendent)_____________________________ Date _________

Thank you for your time and help in this educational process, please feel free to contact me with any further questions or concerns.

Luke Coccoli
M. Ed. Student
406-590-2702
Luke.coccoli@umontana.edu

Teaching and Learning

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Exhibit D - Student Assent Form

Minor’s Assent for Being in a Research Study

University of Montana

Title: Using trail camera photographs to understand wildlife science.

Why am I here?

We are asking you to take part in a research study because we are trying to learn more about the effectiveness of digital science lessons. Specifically using trail camera (also known as game cameras) and the photographs that they take of wildlife to inspire and educate middle school students. We are inviting you to be in the study because your teacher has been selected by natural resource professionals as one who understands and appreciates the importance of nature and sees value in passing that knowledge on to his/her students.

Why are you doing this study?

We are completing this study to better understand what kind of options are out there to offer exciting, inspiring and effective science-based lessons. Not every student may like to take notes from a traditional book and lecture based format so we have created this digital platform to help keep you engaged with what is going on in class by having fun while seeing something new and hopefully learning all of the important concepts you would from a book but now in a more self-led, inquiry based method.

What will happen to me?

First, you need to take the pre-survey. This is like one of those quizzes you take at the first part of the year that your teacher says you can’t do bad on. Literally, there is no grade so don’t sweat it! Just answer honestly and do your best.

Next, your teacher will pull up the first PowerPoint presentation and you will run through the Trail Camera 101 portion as a class. Feel free to take turns reading all the fun facts about the different parts of a trail camera and wildlife species traits. Once you get to “The Grove” trail camera slides your teacher may
break you off into groups. It is important to first read through all of the #TRMRanchCam worksheet questions first before you start clicking through the slides so that you will be more prepared to look for certain things throughout the entire slide show. You can always go back through the slides and look for anything you may have missed.

Finally, after you have completed all four camera location slideshows and associated #TRMRanchCam worksheets you will need to complete the post-test. Good news, you’ve done this same survey before so just be honest and do your best!

Will the study hurt?

There is no anticipated discomfort for those contributing to this study, so risk to

participants is minimal.

Will the study help me?

Yes! This study and curriculum is for your enjoyment and benefit. We hope you learn something by completing these lessons and more importantly we hope you have fun doing it. You participating in this study will help give us feedback as to how to make science curriculum more fun and engaging in the years to come!

What if I have any questions?

You can ask any questions that you have about the study. If you have a question later that you didn’t think of now, you can call me in Montana at 406-472-3311.

Do my parents [guardians] know about this?

This study was explained to your parents [guardians] and they said that you could be in it. You can talk this over with them before you decide.

Do I have to be in the study?
You do not have to be in the study. No one will be upset if you don’t want to do this. If you don’t want to be in this study, you just have to tell me. You can say yes now and change your mind later. It’s totally up to you.

Writing your name on this page means that that you agree to be in the study, and know what will happen to you. If you decide to quit the study all you have to do is tell me or the person in charge.

______________________________
Name of Minor (printed)

______________________________                        ______________
Signature of Minor                Date

______________________________                        ______________
Signature of Researcher           Date
Exhibit E - Student Pre/Post Survey

1) In the past year have you gone hunting? Have you gone fishing in the past year? (Circle One) (Circle One)
   Yes       No       Yes       No

2) Do you enjoy spending time in nature, outdoors? (Hunting, fishing, hiking, wildlife watching, hanging out with friends, etc.)
   Yes       No

3) Do you enjoy learning about wildlife?
   Yes       No

4) Do you believe you can learn about wildlife science by viewing series of photos?
   Yes       No

5) Do you enjoy opportunities to see rare or potentially dangerous wildlife species up close and personal? (I.e. Grizzly bear, Mountain lion, etc.)
   Yes       No

6) Do you come from a family background that regularly spends time outdoors? If so, how often? If not, what do you believe prevents you from going outdoors?
   Yes       No

   How Often? _______________________   Why Not? _______________________

7) On a scale of 1 to 10 where would you rate yourself as knowing your local wildlife species? 1 = I know almost none. 10 = I know almost all wildlife I see.
   1 2 3 4 5 6 7 8 9 10

8) On a scale of 1 to 10 how important is wildlife conservation? (What is conservation?) 1 = Not very Important 10 = Very Important
   1 2 3 4 5 6 7 8 9 10

9) On a scale from 1 to 10 how much do you appreciate wildlife?
   1 = I could honestly do without most wildlife. 10 = Wildlife means the world to me.
   1 2 3 4 5 6 7 8 9 10
10) Where would you gauge your interest level in natural resource management? 
(Draw an arrow)

[Diagram with color scale from Low to High]

11) How likely are you to go hunting or fishing in the future?

Extremely Unlikely  Unlikely  Likely  Extremely Likely

12) How likely are you to identify as “connected” to the natural world that surrounds you?

Extremely Unlikely  Unlikely  Likely  Extremely Likely

13) Circle all of the animals that you would consider wildlife.

[Images of various animals]

14) Circle all members of the deer family.

[Images of different deer]

15) Do you believe you get more out of a traditional (book, lecture, note-taking) approach or a non-traditional (using technology and self-inquiry) approach to learning science-based concepts?

Lecture me and I’ll take Notes!  Both  Give me a computer, I’ll teach myself!
16) In a typical week how many hours do you spend enjoying the outdoors? (Circle one)

1-3  3-8  8-12  12 or more

17) In a typical week how many hours do you spend in front of a media screen (TV, phone, computer)? (Circle one)

1-3  3-8  8-12  12 or more

18) A basic understanding of natural processes that occur in nature will help me be a better environmentally wise citizen. (Circle one)

Strongly Disagree  Disagree  Agree  Strongly Agree

19) During environmental science lessons I am bored.

Strongly Disagree  Disagree  Agree  Strongly Agree

20) I find it difficult to interpret the natural world around me.

Strongly Disagree  Disagree  Agree  Strongly Agree

21) I would like to work in a natural resource related field when I finish school.

Strongly Disagree  Disagree  Agree  Strongly Agree

22) Every citizen should have some natural resource knowledge.

Strongly Disagree  Disagree  Agree  Strongly Agree

23) What is your Age______, Gender______, Race/ethnicity__________________?

24) Would you consider yourself to be from an Urban or Rural area? (Circle one)

Urban  Rural

25) Please list your first name, initials or student ID number. (This will only be used to match up results to be compared between pre and post surveys). Make sure to use the same identifying marks during both Pre and Post survey!