Literature Review

Prepared for the Technology & Nature Summit

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Children, Technology, and Nature:
Examples of Technology Assisting With the Introduction of Children & Nature

We are pleased to present this joint document of the Westcave Outdoor Discovery Center and the Technology and Nature Summit Planning Team:

This document presents an overview of the most recent and relevant research related to technology and its role in reconnecting children to the outdoors. Articles presented in this annotated bibliography focus on technology and the outdoors as they relate to: Parents, Teachers, Informal Educators, Associated Barriers, and Children's Play. In this document you will find both peer reviewed studies and relevant articles. Included in each abstract is an executive summary of the article, general implications, and a citation.

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Article: Parette, Howard P, Amanda C. Quesenberry, and Craig Blum. "Missing the Boat with Technology Usage in Early Childhood Settings: a 21st Century View of Developmentally Appropriate Practice." ***Early Childhood Education Journal*****. 37.5 (2010): 335-343. Print.**

1. Technology in school can help students make significant gains in literacy skills, phonemic awareness, word recognition, concepts about print, alphabetic principle, and comprehension along with basic math concepts. This article looks at the interaction of family members and children using technology and attempts to determine if the involvement of family (particularly parents) while using educational technology helps to inspire a child's interest in learning, and ultimately make strides in the children's educational development.

   This study was done through a series of interviews and research references. The article identifies that technology can be beneficial for early childhood development, but also that many childhood classrooms are lacking in the utilization of developmentally appropriate technology methods. Often teachers believe that technology should be left outside the classroom as it is regularly used for entertainment. Early childhood education settings develop basic skills needed for the future such as (1) successfully transitioning into public schools (2) participating effectively in the curriculum and (3) demonstrating achievement in key content areas. However, the world that children will have in the future requires a drastically different set of skills that includes the involvement of technology.

   The largest problem that the article identifies is the resistance that some teachers have toward using technology in the classroom. This can be due to the fact they don't know how to use it or because it can be considered a distraction or 'interferes' with a teacher's relationships with children. The article does not make any references toward the use of technology in the environment for educational purposes. It does recommend the use of technology as a positive learning experience for children which may lead to the assumption that it could be beneficial to use outdoors as well.

   Aricle: Wartella, Ellen A, Elizabeth A. Vandewater, and Victoria J. Rideout. ***Electronic Media Use in the Lives of Infants, Toddlers, and Preschoolers*****. Thousand Oaks, CA: Sage Publications, 2003. Print.**

2. This study covers young children's daily use of technology and how it pertains to AAPD (The American Academy of Pediatrics) recommendations on the amount of time per day children should use technology or interact with digital media. AAPD recommends that children ages 0-2 should not be involved with any form of media (television, video games, computers etc.). AAPD also recommends that older children 3-6 should not use media related devices more than two hours a day.

   The study was performed by telephone interview with 1,045 parents of young children between six months old and six years old. Children ages 0-2 (n=412), children ages 3-4 (n=304), and for children aged 5-6 (n=329). The phone numbers used were gathered through random-digit telephone dials. Calls were staggered out through different times of day and different days of the week.

   Research found that above all, television is the most used and abused form of technology/media for children. Thirty two percent of children (ages 0-2) fell outside of AAPD guidelines (zero hours), 44% of children (ages 3-4) fell outside of AAPD guidelines, and for children (ages 5-6) 30% fell out of AAPD guidelines.

Above all television was the most widely used form of technology among young children with 63% (0-2), 82% (3-4), and 78% (4-6) who watch television on a typical day. On the contrary only 2%, 13% and 16% for the same ages respectively played video games on a typical day. What researches found more surprising was the amount of children who had televisions in their bedrooms with 18% of 0-2 year olds ($1/5^{th}$), and more than $1/3^{rd}$ of 3-4 year olds and 5-6 year olds with televisions in their bedrooms—making television a more isolated experience further lessening the educational benefits. This is also an issue because televisions placed in children's bedrooms are associated with a less social, academic, and active lifestyle.

A significant problem that researchers seemed to find was that parents were unaware that the AAPD had guidelines for media use. A lot of parents viewed television as a technology that was "helpful" for both children and parents. Parents also often encouraged the use of technology because it kept children preoccupied providing parents with an opportunity to tend to household tasks. It was also found that televisions were most often placed in children's bedrooms in order to free up other televisions for other family members. Due to children's independent use of technology they are generally proficient in its use (e.g. knowing how to get a movie into the VCR, use a mouse on a computer, and turn on the television). It was also found that time spent watching television without parents were related to significant reductions in time spent interacting with parents.

Article: Shultis, John. Consuming Nature: The Uneasy Relationship Between Technology, Outdoor Recreation and Protected Areas. The George Wright Forum, 2001. Print.

3. This article was written through interviews, research, and observation on people's attitudes about technology and its use in the environment both from the perspective of users and landowners who manage areas where recreation takes place. It is noted that technology brings people into the environment to use their technology (e.g. four wheelers, snow mobiles, jet skis), but the question still remains as to whether or not it stimulates any appreciation for the environment in which it is being used.

   Increased concern over technology among outdoor recreationists seems related to: (1) the accelerating rate of technological innovations affecting outdoor recreation and the speed at which they enter the mass market; (2) the increasing amount and level of social (conflict, crowding, and displacement) and environmental (increased erosion and disturbance of wildlife) impacts created by these accumulating technologies; and (3) the impacts that this synergy of new technologies may be having on the outdoor recreation experience and thus (4) the very structure and cultural roles of parks and nature itself. Concerns from land managers mostly seem to be related to the fact that they cannot keep up with evolving technology that is used on landscapes. Further concerns center on themes that technology may increase congestion, conflicts, environmental impacts, and commercialization in parks.

   The article states that keeping technology out of the parks can be counterproductive since it often brings people outside. Technology increases outdoor experiences and invites people outdoors, but it does not necessarily evoke any environmental awareness or desire to decrease environmental impacts from technologies recreational use.

Article: Kim, Mijung. Science Technology and the Environment: The Views of Urban Children and Implications for Science and Environmental Education in Korea. Environmental Education Research, 2011. Print.

4. This case study was performed on 86 sixth grade students from public schools in Korea. The article starts by identifying that there are 44 boys and 42 girls all of whom are well resourced for school life and have Internet access and many other high-tech and modern conveniences in the home. The study was done in order to see how children perceive technology—how they use it, whether they view it as good or bad, and what they identify as its impact on the environment.

   The students were asked a series of questions and answered either through verbal response, writing, or drawing. For example, one question asked was "What is the environment?" over 80% of those surveyed stated that it was a natural site such as mountains, rivers or the ocean, rural places such as where their grandparents live and that they 'visited' the environment about once or twice a year. Most students chose to answer their questions through drawings. Some students included writing on their pictures to better explain the ideas they put in pictures.

   After the drawings were finished and analyzed it was easy to see that children offered different perspectives on technology's use and environmental impact. Some children had completely positive outlooks on technology and believed that it could be used to help advance societies and their economies. Some students stated that they could build a city in the sky, live on another planet, or clone the earth. Other students expressed positive ideas about technology use such as the fact that it could help societies advance, allow people to get out into the environment, entertain recreation seekers, and even help with health concerns in many countries.

   Although many students described positive perceptions of technology students also stated that the advancement of technology could cause death among people and animals, or that humans might need oxygen tanks in order to breathe air polluted by its use or manufacture. Students even identified pollution problems closer to home such as nuclear waste systems. More than one-third of the students expressed environmental concerns. In the end it appeared that 97% of students believed that technology would help enable society and the development of nations, and a surprisingly high number of students – 87% – expressed that technology negatively affected the environment.

   After viewing the children's drawings and engaging in group-discussion the children's ideas were categorized into four main groups:

- Residential Areas in Terrestrial Space (communities in the sky, undersea, and flying vehicles)
- Living/Travelling in Extraterrestrial Space (space ships, space stations, living on another planet, etc.)
- Innovative home and workplace environments (robots in the home/workplace, computers, other advanced devices etc.)
- Others (violence, vanishing humanity, laziness, and destroyed earth)

   Most Students prepared drawings showing that science and technology would enhance resources, promote efficiencies, and further the convenience of human lifestyles and living concerns. Thirty three percent depicted residential areas in terrestrial space, 30% drew innovative home and workspace environments, 23% of drawings were about travelling in extraterrestrial space, while the remaining 14% focused on other themes.

Article: Atkinson, Nancy, Amy Billing, Sharon Desmond, Robert Gold, and Amy Tournas-Hardt. "Assessment of the Nutrition and Physical Activity Education Needs of Low-Income, Rural Mothers: Can Technology Play a Role?" Journal of Community Health. 32.4 (2007): 245-267. Print.

5. This article provides a perspective on how technology can help low income mothers to find health information. Of course, if these low-income mothers have access to this technology then it allows their children to gain access as well.

   The focus group for this study was low-income mothers particularly those using food stamps and living in a rural area. Researchers wanted to learn how these mothers maintain their health and whether it could be improved by simple Internet access. The researchers first studied the group by asking them questions about their health such as what they did for physical activity, if they considered themselves to be in good or poor health, what barriers to physically active lifestyles existed for them, and whether or not they generally try to use healthier foods when cooking.

   After the researchers performed interviews it seemed that most mothers believed that they were in better health than they really were. About two-thirds of the group was overweight, 12.2% were in fair to poor health, and 15.8% reported experiencing hunger. Keep in mind that most of these mothers with their children are living on an average annual income of $15,000. Mothers expressed that a lot of the healthier foods were more expensive, or that food stamps wouldn't cover healthy foods, or that food stamps weren't accepted at grocery stores in which healthy foods were available for purchase. A lot of the mothers considered themselves physically active, but didn't report doing any physical activity other than keeping up with the house and children, and many believed this to be ample daily, physical activity. Some mothers stated that working out was time consuming, and they did not have time for it while taking care of their children. The researchers as well as some of the mothers thought that internet access could be beneficial to their health in order to look up and understand more about healthy eating habits and to gain information on physical activities that they could do while performing housework.

   Article: Holloway, Patricia, and Carol Mahan. "Enhance Nature Exploration with Technology." Science Scope. 35.9 (2012): 23-28. Print.

6. This article identifies specific methods that teachers can use that include technology and enhance nature exploration. Researchers propose specific class projects with details on how to prepare for and perform them while making the projects educational in the classroom.

   This article acknowledges specific ways that students can learn about nature while interacting with technology. This case study more resembles a list of ideas and proposals on how technology can be used with nature than a study of how it can be beneficial. Some of the example projects they proposed include: (1) digital story telling performed by photographing a subject and writing about it or researching it, (2) engaging with nature by reading stories that spark student's interest in nature, (3) or taking students on nature walks where they are asked to observe sights, sounds and smells.

   The digital story is an interesting idea because it allows for students to pick a nature theme or subject of their choosing, to engage with nature by going out and looking for their research subject, then photographing it, learning how to use and create a storyboard about it, then using the Internet to research the subject and the computer/tablet to write about the subject, and finally, suggests the students do a recording of what they have written after the digital editing process has taken place. When students have finished their projects, presentations can then be scheduled. This project gets students outdoors and

gives them the task of observing what is around them before using technology to help further their interest and knowledge about the subject.

This article suggest that family members should be brought into students research (possibly at presentation time) and outdoor exploration as much as possible because it helps to strengthen the emotional connection that children will have not only with the environment, but also with technology.

Article: Louv, Richard. "The More High-Tech Our Schools Become, the More They Need Nature. " Science and Children Guest Editorial. 2012: 8-9. Print.

7. Richard Louv expresses concern over the fact that children spend more time indoors using technology, rather than spending time outdoors with nature in a more physically active environment. Louv isn't the only person who finds this subject pressing.

   The biggest issue with getting kids outdoors that this article identifies, is possibly the fact that school staff and administrators don't see the educational means in getting children outdoors in order to learn. Technology has not only made a place for itself in preliminary education, but has in fact replaced more traditional means of learning even in areas like science where understanding used to come from outdoor experimentation.

   Louv calls for a need for change in the early education system. Ideas are offered on how time can be spent outside during school in an effective fashion that promotes learning, and physical and social activity. Some ideas include studying on green spaces, performing outdoor projects, and going outside to observe. These activities have been shown to improve social activity between all kids, and improve skills in social studies, science, language arts, and math.

Article: Burniske, R W. "Sharing the Sacred Fire: Integrating Educational Technology Without Annihilating Nature." ***Techtrends: Linking Research & Practice to Improve Learning*****. 49.6 (2005): 50-52. Print.**

8. There is a need for balance between the high touch and the high tech environments in the education system. Burniske starts by identifying the question he and fellow researchers are asking; ultimately, how might education help preserve nature while introducing networked technology to the classroom for teaching and learning about globalization? The study group consists of students from Sao Paulo, Brazil. Researchers wanted to study their connection to the natural world, and how nature can be learned about in school while implementing new technology simultaneously.

   From the start of the study many students identified that they did not have much of a connection with the natural world around them even though they live in an impoverished community that offers limited access to computer technology. The aim of the study was to bring about a greater appreciation and understanding for and of the environment that resides in student's own backyards.

   The study starts by using learning activities that get kids (ages 13-19) outdoors. This process was initiated through a series of scavenger hunts before students were to give a presentation about the respective life forms they found. After the outdoor experiment, students went on to research the living things that they had discovered. Research would reveal scientific names, medical purposes (plants), and

myths and legends derived from indigenous cultures. Throughout the article the idea to balance technology with "high-touch" learning is emphasized.

In one of the activities, students did a walk through the woods where one student later stated that it was one of the most wonderful things ever experienced. Not all students were as enthused about the activities, but the activity still provided an opportunity to learn, to be social, and most importantly to get outside.

Other forms of study are encouraged such as story telling by a campfire or making a class garden. Learning outside through experience helps to cultivate understanding before learning about a subject through research. It is important to helps students see the connection between technology, nature, and learning.

Kim, Paul, Teresita Hagashi, Laura Carillo, Irina Gonzales, Tamas Makany, Bommi Lee, and Alberto Gáarate. "Socioeconomic Strata, Mobile Technology, and Education: a Comparative Analysis." ***Educational Technology Research and Development*****. 59.4 (2011): 465-486. Print.**

9. A total of 160 grade school students from two different communities in Baja California, Mexico were used as a study group to analyze how technology can be implemented into the classroom and to find if it improved students learning capabilities. One of the schools studied was located in a rural area with less access to technology, but more parental involvement in children's learning. The other school was in an urban area where families had a lower annual income and less parental involvement in children's learning, but greater access to technology.

   Researchers brought in mobile devices called 'TeacherMate' that were preloaded with 18 short-story e-books with a first grade Spanish reading curriculum. The mobile device allowed students to record their own narration as they were asked to read aloud, and then replay their own recordings. The students also had to answer various questions (fill-in-blank and matching). Teachers and principals were given surveys on their attitudes toward technology in the classroom, mobile devices, and how they felt about alternative learning techniques. Before using the mobile devices in the classroom, all of the students were given a pre-test of the material that would be studied to see if they improved when administering a post-test.

   The results overall showed that the students improved their literacy skills. However, it was concluded that the use of technology had a fundamentally different effect in the rural school than it did the urban school. The students in the rural village benefitted more from the technology than the students did in the urban areas. Perhaps this is due to the fact that the students in the rural area had greater parental involvement as well as an initially lower experience with technology so it possibly piqued their interest more. The rural and urban communities also had more or less money respectively, which raises the question as to whether the socio-economic status of students had any effect on their learning capabilities. The teachers in the rural area, however, seemed to have more of an aversion to the use of technology in the classroom than the teachers in the urban schools. In conclusion, the technology overall helped students with literacy skills, but the results varied. It should also be taken into consideration that other subjects should be tested through the use of technology such as science and math.

Article: Zita, Adam. "Technology Works in the Outdoors." Pathways: the Ontario Journal of Outdoor Education. 20.2 (2009): 8-10. Print.

10. This article starts by asking the question of how we define technology today. This can be confusing to answer because at one time a pencil could have been considered an innovative piece of technology where as today it doesn't compare to the power of a computer. This article promotes the use of technology with children and education. The purpose of the article was written to show the learner that technology is capable of increasing their appreciation, understanding and knowledge of the natural world.

    The focus of this study had three main purposes: (1) discuss how GPS technology can be integrated into the Ontario curriculum (2) instruct the group on the basics of a GPS unit and (3) introduce the study group to geocaching. The study group consisted of students in seventh, eighth, tenth, eleventh, and twelfth grades. The students were to follow longitude and latitude coordinates to a specific location on Earth. After students followed the coordinates to the specified location, a discussion is then facilitated to talk about how this technology can be used to protect the environment. Essentially this study uses geocaching to promote students' outdoor involvement. Using this technology helps to get students outdoors and into the environment through a familiar medium.

    The benefits of this activity include (1) the obvious one—getting people outside, (2) increasing physical activity especially in children, (3) helping to educate students about health and wellbeing, and (4) allowing for children and families to get outside together and re-discover the out-of-doors. This activity promoted students to (1) learn to read and program a GPS handheld unit, (2) demonstrate knowledge of a GPS by following an orienteering course, and (3) investigate and discuss various issues in conservation. The article doesn't discuss student's reaction to the use of the GPS system and geocaching, but presents how it could be used and why it could be beneficial.

Article: On the Design of Camelot, an Outdoor Game for Children. ACM, 2006. Internet resource.

11. This article uses a few different games to understand how children play and how technology can be used during outdoor play. Four different games were used in the test study for 16 children ages 7-10. The games tested were (1) Witches and Wizards, (2) Quatro, (3) Catto, and (4) Camelot. The children seemed to enjoy all of these games even though each one was fundamentally different from the next. All of these games can be performed in safe areas both indoors or in outdoor spaces such as playgrounds.

    The first game, Witches and Wizards, was played on an open green space and allowed for children to collaborate as a group on their individual teams as well as partake in physical activity. The game used a crystal ball that the children would hold and run to the other side with in attempt to not get tagged by the opposing team members. The children seemed to enjoy the game and discussed tactics in between games. Often they would have the fastest person carry the crystal ball and give them the highest rank in order to better their chances of winning the game.

    Most children stated that they enjoyed the Quattro game. Some of the children cheated in this game and added cards to their deck when they had a full hand already. This game did not encourage students be outdoors or participate in any physical activity.

Catto was a similar card game that required no physical activity, but could be performed outdoors. However, children were still often found cheating when they were supposed to complete a waiting time before grabbing another card.

Camelot on the other hand was enjoyed by all students and allowed for some physical activity when students had to pretend to build a castle and carry resources from different places back to the construction site. This project could be performed outdoors where a mobile device was used to collect virtual resource items and bring them back to the construction site where students would build a physical castle.

These games encouraged social interaction, physical activity and some educational experiences as well. The Camelot game did not allow children to cheat due to a timer on the mobile device that kept them in a certain area for a certain amount of time. However it did not seem to bother the children because they knew that no one else could cheat either which provided a healthy environment for peers.

When students were also asked to create a collage of their favorite games the results showed that physical activity, excitement and suspense, role-play, and continuous involvement were the most frequently presented important aspects of play from the children's perspective.

Article: Flett, M R, Rebecca W. Moore, Karin A. Pfeiffer, Joyce Belonga, and Julie Navarre. "Connecting Children and Family with Nature-Based Physical Activity." American Journal of Health Education. 41.5 (2010): 292-300. Print.

12. This study was intended to provide a needs-assessment and recommend design for a community outreach program. It was conducted with six focus groups in rural Michigan including both parents and children.

    This study was conducted through a series of interviews where parents and children were first asked some ice breaker questions to get to know one another before directly asking for opinions on nature based physical activity. Part one asked questions such as: what activities do you like to do outside? What do you like about being outside or about nature in general? And what do you not like about being outside or about nature in general? Part two asked questions such as: what activities would you not want your child to partake in? If your child were to be involved with an outdoor program what time of year would be best and for how many weeks could they be involved?

    The results were summed into five different categories: (1) general parent and youth interests, (2) barriers and dislikes about outdoor physical activity, (3) activity preferences, (4) opinions about geocaching, and (5) health and wellness education. The first sub theme included the general interests of youth and parents. The study found that youth enjoy nature, but could be more active and engaged as they often chose activities that don't encourage them to fully interact with nature. Participants' favorite less-active pas-times included spending time with animals, simply being outside and enjoying the environment and scenery. A few other favorite outdoor activities that involve the use of technology in some sense include snowmobiling, dirt biking, and the use of all-terrain vehicles. The second sub theme sought to get a general opinion in rural areas about engaging in nature based physical activity. Most barriers expressed by parents included safety concerns but also natural barriers such as bad weather, lack of comfort, and getting dirty. The third sub-theme discussed physical activity preferences, social/family preferences and specific program design preferences. The most surprising outcome is that both parents and youth thought that physical outdoor activities should be competitive, and the children felt even more strongly about this aspect than their parents did. The study group also thought it was important that the activity kept most individuals engaged for the majority of the activity. Children collaboratively stated

that they thought physical activity was more enjoyable when their friends were involved. The youth emphasized the need for fun and variety while parents were more concerned with safety factors. The fourth sub-theme discussed general opinions that both youth and parents expressed about geocaching. While everyone seemed to support the idea with enthusiasm it was also pointed out that geocaching can be frustrating when the 'treasure' is hard to find. The last sub-theme discussed health and wellness, and it found that youth receive inadequate education on the value of a healthy lifestyle with only three of the youth members expressing that they had strong wellness education at their schools. Most of the students expressed that their health education came from sports teams, but there was a clear deficiency of school-based health education.

Article: Clough, Gill. Geolearners: Location-based Informal Learning with Mobile and Social Technologies. n.p, 2009. Print.

13. This article starts by describing the concept of geocaching and its various forms like earth caching and virtual caching. A total of 659 people who use geocaching were interviewed to obtain their opinions on how they gain informal learning opportunities through geocaching. Individual involvement in geocaching was divided into four different categories: reader, contributor, collaborator and leader. All interviewed geocachers had found between one and twenty geocaches.

    Geocaching promotes informal learning—any form of learning that takes place outside the formal curricula of schools or higher education. Informal learners make their own choices both about what they will learn and what techniques and technologies they will use to support their efforts.

    The results gained for geocachers informal learning were placed into five different categories. The first category was intentional learning such as looking at geocaching forums to find answers about geocaching. This could include how to better find a geocache or how to use your GPS. The second form of informal learning is active learning where geocachers actually use the forum answers and apply them to what they are doing. The third form was categorized as constructive learning that was gained through experience. This could include learning how to better place your geocache or how to find a hidden one. The fourth is authentic learning where geocachers learned practical skills such as how to use a map or compass and other various problem-solving skills. The last form is cooperative learning where knowledge is built with and off of other geocachers' ideas. This study presented various ways in which people would learn through geocaching. For instance geocachers could come to a historic place looking for a treasure and find fascinating background knowledge that they later delve into further, or perhaps they would see a plant or animal that they wanted to learn more about and on various occasions geocachers explained that they would buy books on these numerous subjects to gather more information.

Article: Deborah, J C. "Youth Day in Los Angeles: Evaluating the Role of Technology in Children's Nature Activities." *Children Youth and Environments*. 19.1 (2009): 102-124. Print.

14. This study was done to see if technology would promote youth to get outdoors. The focus group attempted to use children between the ages 10-13, but ended up with 38 participants that were between the ages of 6-17. This research study was interesting because they used a total of four different activities to see how the youth responded and what their opinions were after performing them. Two of the activities used technology and two did not. It also uses a wider range of ages after stating that there is a large decline in physical activity through adolescence.

The four activities that all group members completed were: (1) a camera safari, (2) an etchings and rubbings activity, (3) a geocaching activity, and (4) a nature scavenger hunt. When the activities were completed the youth groups were asked to rate how they felt about the project using a green, yellow, and red color scale. Green represented that the individual enjoyed the activity, yellow meaning it was alright, and red meaning that they didn't enjoy it. Other data was collected through observer's notes by activity, photos from the camera safari, and facilitator feedback.

For the camera safari each member was given a camera to take pictures of things they found interesting along a short nature hike. Meanwhile observers took notes of youth interest and involvement in the activity. After the photos were taken they were all downloaded and categorized into four different categories, however, a photo may contain more than one category. The categories were listed as: (1) vegetation/natural views, (2) wildlife, (3) human-influenced views, and (4) humans. Out of 346 photos there were 565 items available to be categorized. There were 59 vegetation photos, 28 wildlife photos, 9 human influenced views and 4 humans. The facilitators noted that the younger children were interested in the activity itself, seeing animals, and chasing lizards, but seemed to be less interested when they were tired. The facilitators stated that the older youth seemed to be more interested and had more ease when using the cameras. There were few negative comments about the activity and votes were as follows: 0 red, 14 yellow, and 86 green votes. Observers stated though that it seemed some enthusiasm came from the camera itself.

For the second activity the groups was asked to make etchings and rubbings on paper of natural surfaces of their choice. Observers stated that the younger children seemed to be much more interested than the older youth who often pounded their fists instead of rubbing. However, observers reported that this activity seemed to greatly improve social interactions for all members of the group. When the youth was asked to vote on the activity there were 0 red votes, 38 yellow votes, and 62 green votes.

The third activity involved the use of a global positioning system in order to geocache, or to find hidden treasure. Based on facilitator feedback both the younger and older youth seemed excited and interested even though the activity was more complicated and required further explanation. Facilitators said it seemed that the geocache activity made some groups work together and made some groups more competitive. Overall, it seemed that the kids really enjoyed the activity. The vote counts recorded were 0 red, 8 yellow, and 92 green. Facilitators stated that no one wanted to be left out and all wanted to sign in the logbook. Some negative feedback included that the GPS wasn't always accurate or the younger kids became confused when they didn't immediately find the treasure.

During the last activity the kids were given a list of items to locate along a trail in a nature scavenger hunt. The results varied when observers were asked what the overall level of interest appeared to be. Some thought the youth seemed to enjoy it while others thought the overall interest was low. However, some seemed to be very interested in the wildlife or consumed by the hunt. Observers stated that it seemed childish to some of the older youth. It was also noted that it did not promote as much social activity. When the youth was asked to vote there were 3 red votes, 21 yellow votes, and 76 green votes.

Overall, the kids seemed to have an optimistic outlook on every activity. Technology did have a higher percentage of green votes than non-technology related activities. Ninety-two percent voted green for the geocache activity, 86% voted green for the camera activity, 76% voted green for the scavenger hunt, and 62% voted green for the rubbings and etchings. Observations differed when some thought that the older youth enjoyed technology based activities more, and others noted that the older kids seemed to enjoy all activities regardless of dependence on technology.

Article: Freeston, Jennelle. "Lessons from the Field: Environmental Education and Outreach Initiatives to Connect Families to Nature." Print.

15. This article was mostly made as a reference for upcoming organizations that are trying to get children more involved in the outdoors. It starts by stating some of the facts they found such as: 85% of mothers involved in the study group think that their children spend less time outside than they had, there has been a 50% decrease in outdoor activity over the last twenty five years, and the average outdoor enthusiast is now 55 years of age. The problem isn't just that kids aren't spending time outside, but that with more time indoors and increasingly sedentary lifestyles obesity has doubled for children ages 6-11 and tripled for preteens and teenagers ages 11-19. In effect, there has been a large decline in youth support for conservation as well. Within all of this bad news, however, there is opportunity to guide parents and caregivers to get their kids outdoors.

    Spending time outdoors can reduce stress, improve family bonds, and create lasting memories. In many surveys it has been seen that people who have had frequent childhood experiences in natural spaces are more likely to visit such places as adults. The article identifies the audience that this message should be aimed toward: children, parents and/or caregivers, minority groups, teachers and health professionals. Most of the reasons parents and caregivers gave for why kids spend less time outdoors include: safety concerns, stranger danger, technology, structured activities, organized sports, busy family schedules, and a lack of access to open space. Most reasons for schools and organizations included: inadequate funding for programs, disparities among underserved youth, misconceptions about the safety of being outdoors (mostly concerning strangers), intensive schedules and competing interests, a lack of access to nature, and a lack of knowledge about opportunities and need for more awareness about the benefits of being outdoors.

    When giving advice to upcoming organizations lessons were divided into four sections:

    - Lesson #1: Learn from other organizations that are making progress
    - Lesson #2: Identify barriers for the target audience
    - Lesson #3: Focus on health benefits of nature and outdoor play
    - Lesson #4: Identify a way to get ideas out and respond to messages

Article: McKnight, Marguerite D. "Socialization into Environmentalism: Development of Attitudes Toward the Environment and Technology." 1990. Print.

16. Three questions are asked throughout this study: (1) do attitudes toward the environment and technology differ among college students preparing for various professions? (2) If differences exist, what are the formative influences on attitudes at various life stages? (3) What meanings do nature and technology have for individuals? How do people think about and discuss their values? The focus group consisted of college seniors majoring in environmental studies, engineering or business. This study was conducted through two different stages. The first stage surveyed the focus group to determine their environmental attitudes and current activities (including environmental activism and to ascertain the effects of personal experiences and socialization agents hypothesized to influence attitudes). The second stage was preformed through life history interviews of subsamples of students in each major to identify additional influences and to explicate the meanings of nature and technology.

    The results of student's attitudes toward the environment and technology differed among majors, as well as the meanings which nature and technology held. Environmental studies majors had the most positive attitudes toward the environment and the most negative attitudes toward technology. They were also

more engaged in nature, appreciative of environmentally pro-active behaviors, and were often influenced and motivated by long term, positive personal experiences of nature. In addition to environmental studies majors, those who had explored nature as children tended to hold that nature had more complex meanings in comparison to others who had simply listed components such as birds and trees during interviews. In contrast to environmental studies majors, engineering majors had the most positive attitudes toward technology, and they also were heavily influenced by formal (secondary) education, and more business students preferred social and competitive group activities.

By graphing about "value orientation" (where societal values stand) it is visible that mainstream (majority) value orientation of American society emphasizes material and economic growth expressed in increasing production and consumption, spurred by large-scale technological solutions to problems, and is fueled by consumption of natural resources. Concurrently there is a second value orientation that stresses limits to economic growth, advocates for "appropriate" technology, utilizes social change to solve problems, and encourages decreased consumption of natural resources, and non-economic valuation of nature which is often labeled environmentalism. While the mainstream orientation is mastery-over-nature, that of environmentalists is harmony-with-nature.

When studying American attitudes toward environmentalism and technology an international comparative study that was conducted in 1981 showed that most Americans (68%) believed that the benefits of scientific research are greater than the risks, but are less supportive of some specific technologies such as genetic engineering and nuclear power. However, since the early 1970s, unqualified support for economic growth has diminished. As well, the majority of Americans (55%) are "sympathetic" to the environmental movements and less than half (39%) of Americans identify themselves as environmentalists. In other studies, several sociologists have suggested that sector type of employment is more highly correlated with environmental attitudes than are occupational prestige or income. For instance, people employed with "nature-exploitive", "production", or "thing"-oriented occupations are less likely to be environmentalists than those who are employed in "non-exploitive", "service", or "people" –oriented occupations. Though most Americans believe that human harmony with nature is necessary for survival, they are almost evenly divided on the issues of preserving nature versus using nature to produce goods for consumption.

Article: Wesson, Mark. "Connecting Children to Nature: Integrating Technology Into Nature Programs and Incorporating Environmental Education Into an Urban After-School Program." 2011. Print.

17. Through two different studies on the use of technology and environmental education, this article observed new methods that could be implemented into modern day schools and other children's organizations. The two studies in this thesis were based on: (1) participation with the North Carolina Wildlife Resource Commission to investigate how values held by children influence participation in and satisfaction with an environmental education program that integrates technology to learn about Eastern box Turtles, and (2) the effective adoption of an environmental education curriculum in an after-school program in a highly urban area in Bronx, New York.

    There is no denying that children spend less time outdoors than ever before, but there has not been enough research to confidently assert specific reasons on why this drastic change came about over the last few decades. This thesis states two possible reasons for why children spend more time indoors: (1) there has been a trend toward global urbanization where people move to cities and have less access to outdoor spaces, and (2) an increased use of technology such as television, computers, video games, and mp3 players keeps youth indoors.

This lack of outdoor activity is risky not only for conservation reasons, but for the health and wellbeing of children in many ways. A few positive reasons to getting kids outdoors include: (1) children who play in nature are more balanced and healthier, (2) children going to schools that promote environmental education into curriculum generally perform above average on state exams and report increased enthusiasm in learning, and (3) research shows that positive experiences in nature as a child lead to increased environmental awareness, knowledge, and action as an adult. With this, society must put a greater emphasis on methods for increasing exposure to environmental education and natural places. The purpose of this thesis is to inform organizations involved with education of effective methods for involving underserved populations in environmental education.

A different perspective is offered in this article where it questions whether technology keeps children indoors, rather than assuming that it does. There is a great deal of rhetoric stating that technology is a large contributor to children's lack of outdoor play, and those facts have to be looked over and accounted for no matter which end of the bargain they support. One thing can be asserted with confidence—this spreading trend suggests that continued lack of exposure to natural areas will result in a negative impact on environmental conservation. However, there has been a recent outburst in research concerning technologies used to get people outside. There have been numerous ideas such as the Fit Bit, Map my Run, and Geocaching. This thesis refers to four different studies that implement technology into the outdoor learning experience such as the use of mobile phones to identify trees along a nature hike, or the use of computers with a wireless network that can be used outside to collect, search, edit and share information. Another study gathered kids to perform four independent outdoor activities to see which they enjoyed more: the two activities with technology and two activities without. The two using technology gained overwhelming support. The last study used cameras to take pictures of a river while examining the health of the water. This allowed students to go back and observe things that they may have otherwise missed or forgotten about.

Article: Reynolds-Blankenship, Tara. "An Action Research Study Investigating Children's use of an iPad During Free Play in a Kindergarten Classroom: An Exploration of Teaching Pedagogy and Children's Learning, Social Interactions, and Digital Literacy." 2013. Print.

18. The purpose of this study was to examine the introduction of an iPad during free play in a kindergarten classroom as a means to enhance both teaching and learning, social interactions and the support of digital literacy. This study was also performed to better understand any recent changes used in teaching in order to develop the best practice methods when using the iPad in the classroom.

    All data was taken through qualitative field notes, observations, audiotapes, interviews, and a research reflective journal from a teacher and their 25 students over a three-month period.

The research reported that activity mediated by the iPad brought about a sense of community and a transformation of teaching and learning. The iPad facilitated turn taking among students and encouraged students to collaborate and compromise. When using the iPad, the teacher ceded control allowing for the children to mediate conflict and become active participants of their own learning. Technology can be used in the classroom or through a mobile device and both allow children to explore, create, solve problems, research, observe, and investigate new ideas. Through this research it is easily visible that the old paradigm of teaching is increasingly difficult for teachers to navigate, as students are more often the facilitators of their own learning, and not dependent upon teachers to supply access to information.

Article: Geiger, Warner and Klar, Bernhard and Ruchter, Markus. "Comparing the Effects of Mobile Computers and Traditional Approaches in Environmental Education." 2010. Print.

19. This study was conducted by gathering groups of people to take on the same hike using different forms of tour guides. Three different guides were used: (1) a mobile prototype called MobiNag, (2) a paper-based guide, and (3) a human tour guide. The tour was made with the aim to determine the differences in supporting the achievement of environmental education goals. The aim of the study was to find if different forms of tour guides worked differently in their ability to teach people about the subject matter. Every group was to stop at specific places on the trail in order to examine and learn about a tree in that area. The focus group contained both children and adults. This included families and school classes. Both the kids and adults were given pre- and post-test questionnaires. There were a total of 185 kids with an average age of 11 years, and 76 adults with the majority being in their 40's, 40% of them took the human-guided tour and one-third of them had an academic education.

    The first group used the MobiNag prototype as a guide. There was only one PC prototype per group that was connected to an external GPS through a Bluetooth connection. It displayed a map of the natural area where the hike would take place and highlighted the user's route. When a group would reach a specific tree they would be notified via the mobile device before information on the tree was sent through a text message. One group member would usually volunteer to read at each spot.

    The second group used the paper-based guide. It contained 17 pages of text and color images with a fold out map. The path was highlighted along the map and references for stations were placed accordingly. After reaching an observation point information about the tree could be obtained through observing the reference page and photographs of the tree.

    The third group had a person as their tour guide. They did not have to worry about navigational aspects due to the guidance by the educator. The tour guide would give oral presentations at each station based on the same context used in the mobile device and paper-based guide.

    The pre- and post-tests measured different environmental literacy components including: knowledge, attitude, values and concerns, along with behavioral aspects. The tests showed that the children showed a significant increase in knowledge, but there was no significant difference between the different types of media used. However, age as well as degree of alienation away from nature had significant influences on children's knowledge of the subject. The children that went to advanced-track schools scored significantly higher, but had the smallest increase in knowledge. As well, there was an increase in knowledge with an increase in age and a decrease in alienation from nature. The mean attitude score was lowest for children with the highest degree of alienation, and the attitude for children who attended the basic school was significantly lower than those on the advanced track. Surprisingly, the lowest increase in knowledge came with those who used the mobile guide.

    For adults that participated in the study there was a significant increase in knowledge especially for those without an academic education, but showed no significant differences between the different media groups. Socio demographic variables exerted influence on individual's environmental literacy. Adults that had reported spending time with nature often had a significantly higher knowledge of the out doors. The post-tests showed a significant increase in attitude for all adults. An interesting factor was that adults working in the life-science field had significantly higher attitude ratings than those in engineering professions. The mean behavior showed a significant increase in the post-test.

    Adults with an academic education enjoyed the brochure guide the most, the mobile guide second, and the human guide the least. It should be noted that the same human guide was used on every tour in order

to decrease variation. In contrast, the adults without an academic education enjoyed the human guide the most, mobile navigation second, and the brochure the least. The mobile device all together provided a new opportunity to learn about environmental education. It had the capacity to achieve similar results as traditional interpretive media with regards to influencing environmental literacy. This study also confirms the strong influence of socio demographic factors and alienation factors on components of environmental literacy.

Article: Lin, Ming-Sheng and Liu, Tzu-Chien and Peng, Hsinyi and Wu, Wen-Hsuan. " The Effects of Mobile Natural-Science Learning Based on 5e Learning Cycle: A Case Study." Print.

20. This study took place in Taipei City, Taiwan at an elementary school that involved the participation of 46 fourth grade students. This study aimed to answer two questions: (1) what are the effects of mobile learning activities on students' knowledge levels and understanding levels of aquatic plants? And (2) what are the perceptions that students have with regard to the learning environments and the mobile learning technology? There were a total of 5 phases implemented throughout this study including: Engagement phase (E1): The teacher assesses students' prior knowledge and engages students in learning a new concept. The teacher also helps students make connections between prior and present knowledge, and helps to organize students' thoughts about the learning outcomes of present activities. Exploration phase (E2): The teacher provides students with a common base of activities reflective of present concepts processes, and skills. Students complete activities by using prior knowledge to generate new ideas, to explore questions and possibilities, and to execute a preliminary investigation. Explanation phase (E3): The teacher focuses students' attention on a specific aspect of their "engagement" and "exploration" experiences, and provides opportunities for students to demonstrate their understanding or skills. The teacher can also use direct instruction and guide the students toward a deeper understanding of a concept. Elaboration phase (E4): The teacher challenges and extends students' conceptual understanding and skills. Students learn to develop broader and deeper understanding and skills, through the above three phases. Evaluation phase (E5): The teacher evaluates students' progress toward achieving the instructional goals. Students learn to assess their understanding and abilities. This study had three purposes: (1) To design a mobile natural-science learning activity that rely on the 5e learning cycle, (2) Understanding the effects of and students perceptions toward learning activities, and (3) Discussing factors underlying learning effects and students perceptions.

    For this case study the mobile device was designed, developed and implemented into learning activities to enable students to observe, learn, and exchange information on an ecological pool they had been studying in class. This study was done over a 14 week period in an after school science club where all 46 students participated voluntarily. Data regarding student's performances, perspectives, reflections and opinions about the instruction was collected and analyzed. The mobile technology could be used for four class activities including: (1) class instruction, (2) outdoor inquiry, (3) lab activities, and (4) individual or small group study and assessment. The mobile technology allows for students to view pictures and virtual representations of the ecological pool, it lists plants and provides more information in a glossary, and provides downloadable activity sheets.

    Six qualitative and quantitative data sources were taken through the study: (1) a pre and post knowledge test requiring students to name and categorize plants into "free floating type", "Floating leaf type", and "emergent type" where students were given 0 points for not identifying either the plant name or type, 1 point for identifying the plant name but incorrect type, and two points for naming both the correct name and type of plant, (2) an understanding pre- and post-test with 24 multiple choice questions, (3) a post learning-activity survey to test students' perceptions, (4) all students learning activities were observed and videotaped, (5) students were interviewed at the end of club meetings, and (6) reflective journals were kept by all students.

Results showed that the mobile learning helped to improve both knowledge and understanding. The before mean score for the knowledge test was 10.3 where the post-test had a mean score of 26.04. The pre-test for understanding showed a mean score of 15.63 and an after mean score of 19.04. Students reported enjoying activities and feeling a sense of accomplishment when finishing an activity or learning more about the ecological pool. They reported loving to make observations and share inquiry. Sixty four percent of students reported liking to greatly liking the activity, and 36% reported moderately liking the activity. Forty nine percent said that the tablet was a source of motivation and 36% said being able to interact with real plants is essential. Some students perceived the tablet as a tool for studying while others saw it more as a handy and mobile dictionary. More than half (56%) of students preferred the mobile activities to lectures, 21% reported liking both the mobile learning and lectures, and 23% preferred lectures. Some students who enjoyed the activity used the words "personal", "collaborative", and "hands on" to describe their experience with mobile learning.

Article: Bodzin, Alec M. and Peffer, Tamara Elizabeth and Smith, Judith Duffield. "The Use of Technology by Nonformal Environmental Educators." ***The Journal of Environmental Education.*** **2012. Online.**

21. In an effort to uncover perceptions held by environmental educators about technology in their field a 40-question survey about practitioner demographics, technology use in practice, and beliefs about technology was sent out to 3,000 participants where 406 answered and completed all survey questions. This included people from almost every state in the US, as well as participants from Canada, Australia, Japan, South Africa and Turkey. All participants worked with non-formal environmental education programs—this includes both people with and without teaching certificates. The survey was divided between multiple choice, open-ended response, and likert-type scale questions. This research study aims to answer the following questions: (1) what technology tools are utilized in non-formal environmental education (NFEE)? (2) How prevalent is their use? And (3) what influences non-formal environmental educator program's (NFEEP) decisions to incorporate technology?

    The project is organized into three steps including survey development, small group validation trial, and full-scale study where data is collected at this final stage. The survey consists of four different sections: (1) gather demographic information of NFEEPs which includes educational services provided and populations served, years of experience, and degrees or certifications, (2) examine program formatting, necessary curricular materials utilized, and factors that influence decisions to integrate technology, (3) include items that explored NFEEPs current technology use and training experiences, and (4) explore the Technology Attitudes, Perception, and Support (TAPS) scale that consist of 15 likert-type scale questions that were designed to collect information on NFEEPs' pedagogical philosophies about technology use, self-efficacy, and perceived obstacles to technology integration.

    The results of the study varied showing significant differences between people with and without a teaching certificate, and among various job titles. The top five most common job titles were as follows: Education coordinator, environmental education specialist, curriculum developer, naturalist, and aquatic or marine educator. When asked what technology participants most often used the three most freqently reported were: for email communication (98.3%), information distribution (87%), and instructional presentation, calendar tracking and organization (68.5%). In the survey 95.3% of respondents said that they used word processing (Microsoft Word) most often for studies, 77.1% reported using spreadsheets such as Excel most, and 65% said they used publishers such as Adobe most often. Environmental educators used technology to study a wide range of subjects, but the top three subjects reported were environmental impacts (57.4%), watersheds (53%), and biodiversity (49.5%). The TAPS scores indicated a neutral to slightly positive response to technology in environmental education. Eighty-two percent of respondents reported being comfortable using technology as a tool, 67% said they were

encouraged to use it, 85% stated that they were willing to participate in professional development focusing on the integration of technology in environmental education, and 56% agreed or strongly agreed that technology inhibits learning in natural settings.

Article: Chen, Wenli and Looi, Chee-Kit and Sen Kee Seow, Peter and Yew Lee Tan, Nicholas and Zhang, Baohui."Handheld Computers as Cognitive Tools: Technology-Enhanced Environmental Learning." Learning Sciences Labratory, National Institute of Education. 2008. Print.

22. In Singapore there is an increasingly large issue about what is to be done with solid waste. In an effort to raise awareness this study was conducted among a group of 79 fourth grade students with an average age of ten. Through this study students investigate how solid waste is produced and what impact the use of the 3Rs (reduce, reuse, and recycle) can have on the environment. Students were divided into groups of four; each group had one high achiever, one low achiever, and two average students based on the results of their science continual assessment. The report states that pre and post-tests were conducted on the knowledge and understanding of the 3Rs concept as well as students opinions on the use of the handheld devices in their curriculum. The set up of the study was conducted through five different steps: (1) Challenge: The teacher presents background knowledge needed to preform the assignment, and proposes questions to help students understand the concepts of what they are going to learn. (2) Experience: Students preform the various assignments to demonstrate the concepts through a practical approach. (3) Reflecting: After performing the assignments students are asked to reflect on their experiences. This entails asking questions about the assignment, and sharing what happened during the project. Reflecting helps students to develop their thoughts and opinions as well as share their ideas with peers. (4) Planning: This step asks students to explain how these ideas can be related to their everyday lives, and asks how they can better implement the 3Rs into their homes and communities. (5) Applying: This step helps students to contextualize their learning. Step five asks students to explain how they can apply what they have learned to similar or different practical situations.

    Students are asked to preform three different activities: (1) Students are given a handheld computer before they are taken to a supermarket where they are asked to observe and take pictures of the materials used for food packaging, (2) The students are directed to stand by checkout counters to collect data about the number of plastic and reusable shopping bags used over a ten minute period, and (3) Students use their handheld device with preprogrammed questions to interview customers about their use and knowledge of the 3Rs approach. After completing the assignments students are asked to type their reflections into the handheld device. Students share their experience before including their group discussions on what families can do to create a less adverse impact on the environment. They then discuss and enter into the handheld computers plans on how these ideas can be carried out in practical situations. After some time is spent ruminating on and brainstorming about ideas students then generate a report of all collected data and upload it to the handheld computer so that ideas can be shared and discussed among all of the students. The students then upload their reports through a “shareportal” where they can also ask other students questions about the concepts and assignments, or they can direct their questions to experts at the National Environmental Agency (NEA). After working on group projects students are asked to present their ideas.

    Pre and post-tests on students understanding of he 3Rs concept show positive results. In the pre-test 41% of students reported knowing the details of the 3Rs approach, and 74% report knowing the details in the post-tests. For the open ended questions students answers are scored on a scale of 0-3; 0 meaning they do not know the answer, 1 point is given for having a sense of the concept, 2 points are given for a partially accurate answer, and 3 points are given for an accurate understanding. The mean score for the pre-tests was 1.95, and the post-test jumped to a mean score of 4.07. The report does not show any responses from students about their perspective on the use of handheld devices in their school projects

prior to performing the assignment. However, results of student's attitudes are recorded after the students have completed all three assignments. Students reported that the use of the handheld device allowed them to be more organized, record information better, share reflections more easily, and to transfer information more conveniently. About 3/4^{ths} of the students reported that they were interested and motivated by the use of the handheld device, and also agreed that it helped them to learn the content better. More than 90% of students stated that they enjoyed using the mobile device. One discrepancy in this study was that students were less affected by the study that required them to observe and take pictures of food packaging. They often took pictures for fun and had less input on this subject. Researchers propose that more in depth questions about this subject should be asked to help students gain a better understanding of why excessive packaging can pose a prevalent environmental problem.

Article: Alemanne, Nicole D. and Clark, Amanda and Douglas, Ian and Kazmer, Michelle M. and Marty, Paul F. Maurya, Manisha and Mendenhall, Anne and Sampson, Victor and Schellinger, Jennifer and Southerland, Sherry A. "Scientific Inquiry, Digital Literacy, and Mobile Computing in Informal Learning Environments." Learning Media and Technology. 407-428. 2013. Online.

23. This research documents the digital literacy skills that elementary students use while participating in a Habitat Tracker project that enables students to explore the connections between scientific inquiry practices and digital literacy skills. This study was performed over a two-year period and includes research over observations made by almost 2,000 4th and 5th grade students across 12 different urban, rural and laboratory schools. Students that partake in the activity use an iPad application that guides them through the process of collecting data during a field trip to the Tallahassee museum in Florida. At the museum students observe native animals such as wild turkeys, panthers, alligators, bobcats and skunks.

The project starts in a formal classroom setting where students essentially learn how to think like a scientist. They perform activities that demonstrate scientific inquiry, practicing making observations, using observations to make inferences, and understanding the rules of creativity and subjectivity in scientific research. Students learn how to conduct investigations, promote hypotheses, explanations, predictions, and research questions, and how to collect observational data. Before taking a field trip to the museum students use the Habitat Tracker to explore content about the ecosystems they will observe, browse observational data collected by other students on previous field trips, and develop and record questions in their online journals. The iPad helps students to record three types of data including animal, habitat, and weather observations.

Students then use the iPad to introduce new questions and read other's posts that they can make comments on. Back in the classroom students discuss observations, questions, and journal entries. The Habitat Tracker tools can later be used to analyze data in order to create graphs, charts, and tables using not only their own information, but also data from students across participating schools. After completing the field trip and assignments students create and present their reports. Research findings reveal that the Habitat Tracker provides the tools needed for students to learn about the nature of science and scientific inquiry while simultaneously encouraging the use of digital literacy skills. In conclusion devices such as the Habitat Tracker, which combine activities in the classroom and field, can help foster relationships between scientific inquiry and digital literacy for elementary students in formal and informal learning environments.

Article: Gleason, Mark and Harmon, Laurlyn K. "Underwater Explorers: Using Remotely Operated Vehicles (ROVs) to Engage Youth with Underwater Environments." ***Children Youth and Environments, vol.19 No. 1, Children in Technological Environments.*** **2009. Online.**

24. Three study sites were used to engage young people (ages 10-15) in underwater exploration through the use of robotics technology for the purpose of environmental education. This study aims to find youth perspectives on the advantages and challenges of using ROVs to study underwater environments, as well as to observe variability of youth interest in the activity dependent upon sex, and weather or not the individual observed or operated the ROV. The three sites used for observation and experimentation were located in: (1) northeast Maryland in Chesapeake Bay, (2) in the Baltimore area of Chesapeake Bay, and (3) off the coast of Fort Pierce, Florida.

Every morning for two weeks groups of 18-24 participants boarded a boat in Chesapeake Bay off the coast of Maryland to reach a research site where students were then divided into two groups. The first group collected samples of bivalves while the second group flew the ROV to view the habitat where bivalves had been collected. Before actually performing the tasks researchers led an educational program to discuss bivalves as filters. After one hour the boat moved locations and the groups switched activities. On the trip back home students completed a questionnaire.

The second study located near Baltimore involved 31 students that participated over a three-day program. Individuals were divided into 3 separate groups. The first group operated an ROV to observe an oyster habitat, the second group collected water samples in the habitat, and the third group participated in a history lesson regarding oysters and collected oyster samples. Each group spent about 90 minutes at each station before switching stations.

The final study group took place off the coast of Fort Pierce, Florida where a total of 86 students participated in a one-day program. 30 young people were taken out at a time and divided into 5 groups. During this program students only spent about 20 to 30 minutes at each station before rotating. Students collected data about water and habitat, performed observation with the ROV, sampled the ocean floor, and completed knot tying and maritime heritage stations. After completing the activities students were given a five-page questionnaire to complete.

In the completed questionnaires participants were asked to identify what they liked best and least about the ROV based programs, and to indicate the possible advantages and challenges when using this technology. Results showed that participants were generally in agreement about the positive aspect of using the ROV. Some reoccurring positive statements made by students include thinking it is interesting to watch others operate the ROV, finding it easy to use, being comfortable using it, and that it is helpful when trying to understand oceans and nature better. It was found that program 1 was less likely to agree that the ROV helped people interact with the underwater environment, conversely program 3 was more likely to agree that the ROV was interesting to operate when someone else is using it, and program 2 was more likely to agree that it helped them understand natural resources better. Two primary categories that students liked best included: (1) controlling the ROV, and (2) the ROVs ability to provide visual access underwater. Four categories for advantages of using the ROV included (1) visual access underwater, (2) ROVs ability to facilitate environmental education, (3) it has minimal impact on the environment, and (4) potential for in depth exploration. Challenges presented by students included: (1) the ROVs could disrupt the underwater environment, (2) the ROVs are expensive and fragile, (3) the propeller could get caught in seaweed, and (4) using the ROV required practice and visuals could be impaired by murky waters, rainfall, and ocean currents. There were no differences in perceptions except that participants who operated the ROV were significantly less likely to find the activity boring. Male and female perceptions show that prior to operating the ROV males had an increased likelihood to state

that they were comfortable using the ROV, but both male and females were predominantly in agreement that using the ROV was not boring at all.

Article: Lovaszova, Gabriela and Palmarova, Viera. "Mobile Technology Used in An Adventurous Outdoor Learning Activity: A case Study." ***Problems of Education in the 21st Century. Vol 44.*** **2012. Online.**

25. Before performing an actual case study this article helps give the reader an understanding of what is going to come through explaining the use of mobile technology in education, and expanding on two different forms of learning that implement the use of a GPS including geocaching and Wherigo. Geocaching and Wherigo are similar activities where users are directed to a specific location though the use of a GPS that assists them in navigating to a latitude and longitude coordinate position. The difference is minimal; Geocaching leads to a tangible "treasure" and Wherigo can take you to find an actual object, but also often leads users to fulfill a task or to find, collect and use virtual or real objects. The activity studied in this paper creates a combination of these two activities.

The main purpose of this research study was to design and examine an outdoor learning activity that would be:

- Mediated by mobile technology
- Focused on fundamental concepts behind satellite navigation
- Suitable for using in lower secondary education
- Game-based
- And Collaborative

The study was conducted through three phases: (1) Learning about the GPS: Students went through a 45 minute session in a computer laboratory to help them understand the fundamentals of satellite navigation through activities with worksheets and digital maps, they were also given an introduction about Geocaching and instructions on how to follow an outdoor treasure hunt. (2) GPS adventure: Students spent a total of 90 minutes in the schools surroundings in teams of 2-5 where each team was given a GPS to navigate tot a total of 4 caches. Each cache held a problem that needed to be solved in order to get the coordinates of the next geocache. (3) Victory ceremony: This is the last phase which lasts about 45 minutes where students share the treasure's content, and their own experiences and reflections before students answer questions about geocaching.

There were a total of 10 participants ages 10-14 from an elementary school in Nitra Slovakia. The younger pupils formed Team A and the older students formed Team B. Students first performed an indoor activity that included a free talk session about GPS technology and its use in everyday life, The use of Google Maps to localize several different places, a role playing game for students to perform a "search and rescue" where they find a lost person's location on a map, and then they are given the instructions necessary for the treasure hunt before starting the competition. The maps in the lab were used to help locate where caches would be located along the hunt to help students understand the representation of geographical data. Before finding the cache that is represented on the map students must solve a problem in order to get the coordinates.

Throughout the activity pupils had to: (1) search for information inside the university building, (2) solve logical puzzles, (3) search for information on panels situated on the terrain, (4) calculate new coordinates after getting values for substitution, and (5) collect small artifacts discovered in caches.

Students were given a final question that they had to collaborate on after finishing the scavenger hunt. After solving the riddle that they were given the students were given coordinates to find the last cache containing several dozens of chocolate ducats. Team B found the ducats first thus winning the competition, but they were polite enough to split them up in order to share with team A as well as with the teachers.

An active researcher, and a non-participating teacher that took pictures and notes on students' interest guided each team. The researchers had four main questions they wanted to answer through the collaborative journaling of students, researchers, and teachers including: (1) did pupils enjoy the learning activity? (2) Did pupils learn something new? (3) Was the learning activity beneficial from the social-constructivist point of view? And (4) were there any significant differences between the older and younger pupils?

The results showed that all participants enjoyed the learning activity. All students were ambitious and involved throughout the activity approaching every problem seriously, and discussing the hunt and final riddle when walking from one location to the next. There were no technical problems reported involving the GPS. The fact that the competing teams could not see one another might have added extra motivation to move quickly because it was unknown as to who was winning. Students seemed interested in trying out Geocaching with family and friends outside of school. All students were able to explain the fundamental idea behind the GPS technology and using the GPS was quick and easy for pupils to learn. In both teams, peers collaborated constructively. Each team had a captain who was responsible for recording all hints and solutions on a worksheet. Overall, the adventurous and competitive nature of the activity resulted in high intrinsic motivation to learn so the educational objectives could be reached effectively. The activity brought about a sense of community through group collaboration, and involved outdoor physical activity that promotes a healthy lifestyle.

Article: Cantrell, Pamela and Knudson, Mark S. "Using Technology to Enhance Science Inquiry in an Outdoor Classroom." ***The Haworth Press Inc.*** **2006. Online.**

26. This study offers an interesting perspective as researchers create an activity for teachers to utilize technology in outdoor scientific inquiry. Researchers gathered 17 teachers who had been educating kids from as little as one year to as long as 18 years. Teachers were divided into groups of four to five. Jobs were divided amongst the members. One member of the group was trained on how to use the pocket PC while other members were shown how to use digital cameras, GPS units and how to preform sampling procedures. When the group reconvened they showed each other what they had learned. When teachers went out to the field they were able to save information to files and send it back to a server located 1500 meters away.

Before the study took place all of the teachers were administered a technology survey which assessed their baseline use and familiarity with hardware and software that would be used in the experiment. It asked participants to rate their level of proficiency when using the technology. Respondents could state that they were at early level, emergent level, fluent, or proficient when using each device. Other data collected included a post field experience survey that teachers were to fill out on the last day of the field experience. Questions on the post survey covered teachers use and attitudes about the technology during the study. Researchers also examined files on the server to see the extent that teachers used the pocket PCs for data collection and analysis, and also went through journals that teachers kept throughout the experiment.

One-third of the participants rated themselves as 'early" level on 16 skills that were listed on the survey. Only 14% stated that they were on the fluent level and 53% on the emergent level. About one-half of the

teachers returned their pocket PC on the second day and said that someone else in the group was going to operate them. When researchers analyzed the data they could see that three of the participants used the wireless network to transfer three or more files to the server, seven participants accessed the server to download the daily schedule on behalf of their group, and two teachers used the pocket PC to enter data into spreadsheets. When the teachers were asked what technology they felt like they had learned to use 37.5% reported learning the digital video camera, 50% learned to use word, 43.8% learned how to use Excel on the pocket PC, 81% spent time learning how to use the GPS, and 43.8% reported using digital still cameras as well as learning to transfer files using infrared technology. In the post survey participants were asked whether the technology assisted or interfered with their learning experience; half of the group responded one way and one-half the other. Teachers ultimately came out divided on their perspectives toward technology when 44% of teachers reported that learning the technology was stressful and 56% reported that learning how to use the technology was exciting to them. On average the teachers reported that 10% of their time was spent learning the technology and 59% was spent doing science inquiry.

When researchers analyzed the pre-study survey that went over teacher's proficiency levels and analyzed the post-study survey over teacher's attitudes they found an interesting difference. Teachers that reported being at an early level of proficiency when using most to all of the technology had the most positive outlook. They most often reported feeling stress about using the new technology, but they took it in steps to make it easier and more comfortable to learn and seemed pleased to have learned new skills. Teachers who had reported being at an emergent level tended to report stress and allowed it to turn into a negative experience. Further, teachers who reported that they were fluent in the use of some to all of the technology were the most critical and often stated that they felt coerced or forced to use the technology (though it was repeatedly stated that they didn't have to use the technology) and explained that they needed more time for advanced training.

Article: Anderson, Mary A. "Geocaching for Fun and Learning." ***The Media Center.*** **2008. Online.**

27. After Anderson gives some of her own examples as to how she has discovered, learned, and gotten physical exercise while having fun Geocaching she expands on other's examples to explain how Geocaching could be beneficial in an educational setting. Before immediately delving into examples other than her own she gives a quick explanation on geocaching and its various forms such as virtual caches that are more like monuments or historical markers, there are also microcaches that may be small treasures hidden in a film canister, and even multicaches that require a user to solve a puzzle possibly through a serious of hints or questions hidden at each coordinate spot. Anderson states that geocaching has obvious alignments in school curriculum including:

    - Math, geography, and map skills-understanding directions, topography, and the numbers associated with latitude and longitude.
    - Life sciences—Identify plant and animal life found in different habitats.
    - Earth sciences—Identify soils, rocks, landforms, and earth patterns.
    - History—What happened here? Who are these people? Why are they important?

    Another example Anderson gives is how teachers in Rollingstone Community Elementary School used geocaching to make connections in their community. By using grant funds to get 10 GPS units, compasses, an instructional video, topographical maps, and curriculum resources teachers were able to take students to find caches in a nearby wooded area and throughout the community. Later they intend to get older students involved to show younger pupils what else is available close by.

Anderson also talks about a woman named Loar who developed a geocache activity for her senior high special education students. The high school is luckily located near a lake and a creek that can be used during the activity. The caches Lora creates may include earth and science questions about rocks or minerals in a printed packet or motivational breakfast snacks. Lora has created activities like Santa Caches that require students to bring a $1 gift and it exchange it for another gift through geocaching, or geocache hikes where students pick up trash on the way. The rules require students to stay on campus and not put caches on private property. Both of these curricular projects illustrate how geocaching does the following: (1) supports ways of learning and real-life learning, (2) promotes community connections and the potential use of primary resources, (3) provides connections to tools such as Google Maps and Google Earth, and (4) promotes interdisciplinary and collaborative learning.

Anderson also points out that geocaching coincides with several strands of the updated "National Educational Technology Standards for Students: The Next Generation" such as standards 2 and 4. Standard 2 promotes communication and collaboration, and standard 4 promotes critical thinking, problem solving and decision-making.

Article: Bledsoe, Kathleen. "STEM Day in the Park." *Recognize Excellence.* 2012. Online.

28. This article is less of a study and more of an example for what schools can do in the future to involve students in science and technology while simultaneously getting outside and learning with their families. The introduction goes over the processes it took to set up STEM (science, technology, engineering and mathematics) day such as: Acquiring funding possibly through donations, collecting materials which also involved donations from the community, finding a proper and safe space for STEM day to take place (YMCA center worked in this example), finding volunteers including both students and teachers to set up and supervise the event, and finally getting the word out so that people actually attended the event. A total of 250 children and family members gathered for STEM day.

For STEM day there were three events set up for elementary school kids and another three events for middle school students. The three stations for elementary school students included: (1) *let it shine*: students used common objects to perform tests, record observations, classify materials, and draw conclusions about how well those objects transmit light, (2) *wind speed*: pupils investigated the winds ability to create propulsion by designing, building, and attempting to fly a kite at various wind speeds, and (3) *compressed air*: introduced students to the use of compressed air as a means of propulsion where students designed and built a car to discover the relationship between the amount of compressed air and the distance a vehicle is able to travel. The three stations designed for middle school students included: (1) *warm home solar style*: students investigated how solar energy could be used to warm a home when they designed and built a model home and attempted to heat it with solar energy. They considered how the materials and colors used impacted the warmth of the home and explored how the position of the sun and length of sunlight exposure affected the design. (2) *Electric motor*: used scientific inquiry to develop an understanding of how an electric motor works when students had to identify the major components of a DC electric motor before building an electric motor powered by one AA battery. (3) *It's not rocket science*: explored rocket flight and identified major factors that affected the altitude a two-liter bottle rocket can reach, and students designed and built a rocket for maximum altitude before launching their rockets to test designs.

All of these experiments are problem-based learning experiences that engage students in scientific inquiry and the engineering design process, and include standards and safety procedures outside of requiring that a parent or guardian is present at each station simultaneously promoting family learning. After the activities were performed it was found that the two most popular were testing and building the rockets for the *compressed air* activity (elementary students) and *it's not rocket science* activity (middle

school students). All of the lessons had minimal safety concerns except for *it's not rocket science* where several precautions were taken such as roping off the area where rockets were launched and requiring goggles and supervision when the rockets were launched.

Article: Arnold, Gwen. "Enhancing College Students' Environmental Sensibilities Through Online Nature Journaling. *Environmental Education Research. Vol. 18. No. 1.* 2012. Online.

29. This article first presents the idea that members of todays "Net Generation" have a significant disconnect from nature while they are talented at multi-tasking and absorbing information. The idea of nature blogging allows for students to slow down and look at nature through a mechanism they are familiar with. Arnold quotes how journaling could be used for students to learn about their immediate environments. Blogging in an academic setting can be useful for helping students construct everyday meaning from course materials, connect course materials with everyday life, pay attention to details, ask questions and investigate answers. Arnold starts with three reasons as to why using online journaling can be a useful tool for students of the net generation when learning about the environment. These include: (1) It bridges the gap between the known and the unknown, (2) It still makes students study their immediate environment not areas that are far away such as the rain forest, or far off deserts, and (3) online learning can help spread the word to encourage offline learning.

There were three goals listed to nature journaling including the following: (1) get students outside during the semester at least 15 additional minutes weekly, (2) foster among students greater environmental awareness, (3) challenge students' misconceptions about the environment, (4) enrich and reinforce classroom concepts, and (5) encourage students to spend more time outside in the future. This journaling project was assigned among 60 students in an environmental studies course where 79% stated they were there because they had to take it or it was placed on their schedule. They used a free online forum called Blogger where there writings were only viewable by themselves, a teaching assistant, and the professor. Students were instructed to pick a natural site from a list or they were allowed to pick their nature spot if they requested it and were granted permission. All students were given journals, prompts, and a grading rubric and they had deadlines, but could journal sooner if they pleased. The assignment asked for writing reports and almost always required pictures or sketches to be uploaded as well. Students were to examine their nature site for at least 15 minutes a week.

All students were given an eight-question survey at the start of the final class period. It was optional and had about an 83% response rate. The survey showed that the project did meet its goal of getting students out at least 15 additional minutes per week. The median respondent reported that they spent 11-20 minutes outside observing their site. Twenty percent spent less than 10 minutes outside, 42% spent 11-20 minutes, 30% spent 21-30 minutes outside, 4% spent 31-40 minutes outside, and 4% spent more than 41 minutes outdoors with their nature site. This shows that there was a 4.6% increase in the average students' weekly self-reported nature exposure of 5.66 hours. Most students (74%) stated that the journaling project increased their awareness of nature somewhat to a great deal. For those who did not report increased awareness there was no statistically significant correlation between students' post-journaling nature awareness and the amount of time they reported spending outdoors. Sixty-eight percent said that the journaling project changed the way they thought about nature somewhat to significantly. Other students indicated that their thinking was generally and positively affected. Fifty five percent saw a connection between journaling and the course, 56% reported having an increased outdoor interest, 38% reported that the project had no effect on their perspective, and 6% reported that they were less interested in nature after performing the project.

Article: Smith, Wendy. "Seasonal Change Investigations." *Heldref Publications.* 2008. Print.

30. Through a simple school project third-grade teacher Wendy Smith gets her students outside for a safe and easy science project that helps her students to draw conclusions; make cross-curricular connections between science, mathematics, reading, writing, listening and speaking; and think broadly about Earth science concepts. Smith writes about the steps she took to lead her class through an outdoor experiment at nearby North Ponds Park. She relates the project to the third grade curriculum that introduces students to seasonal cycles and patterns of change by studying natural factors at the park and observing how they change before having students ask and attempt to answer questions about what those changes impact.

Smith states that her goal is that students' role in the project would help them to learn to ask and answer questions about the natural world. The first trial project that Smith walked her students through asked "how do seasonal changes of the temperature and amount of daylight affect the quality of the water and the aquatic organisms living in it at North Ponds Park?" To start studying this question Smith first introduced her students to probe ware and handheld computers through conducting classroom investigations. She had students categorize the tools between observational and tools used for measurement before showing students how to use a temperature sensor to investigate the question "does shade affect water temperature?" To study this question students took two containers of water and placed one in the shade of a tree and one in direct sunlight. Students measured the initial temperature and then took the temperature at two ten-minute intervals. Smith's class found that the temperature difference was greater than 20 degrees Fahrenheit. Smit explained to students that riparian vegetation was an important factor to keeping bodies of water cool and that different water temperatures support different life forms. Then Smith had her students break into small groups where they could discuss additional factors that may affect water temperature such as: depth of body of water, width of body of water, seasonal conditions, and speed at which body of water is moving, time of day, and amount of sunlight. For the last section of this assignment students answered three journal prompts: (1) what tools do scientists use to measure temperature? (2) What are the common units that temperature is measured in? And (3) when would it be necessary or important to report water temperature data?

Once students were proficient in collecting data Smith took her students to North Ponds Park where she used similar procedures to teach the class how to take air, water, and soil temperature data as well as to test PH levels and dissolved oxygen. She also had students make observations and take notes on positive or negative human impacts, seasonal changes, and connections between living organisms and their nonliving environment. Some students created drawings or field journals on their own. The class visited North Ponds Park to perform these tests in the fall, February, and then again in May.

Once students were back in the classroom they would record, report and graph data in order to grasp larger concepts of change, cycles, and interdependence. Students then asked questions about the health of any particular body of water and how dissolved oxygen levels affected it and whether or not temperature affected these levels. Students used probe ware and handheld computers to find temperature and dissolved oxygen levels of two containers of water: one that had been warmed and one that had been cooled.

After collecting experimental evidence Smith encouraged the class to share their findings on the class website. Students broke into small groups in order to make presentations through creating e-books, podcasts, and video presentations. This project allowed Smiths' students to use their natural curiosity to apply scientific inquiry to everyday material. Smith's project got students outside and asking questions at an early age through the use of technology and basic scientific inquiry.