Engaging Diverse Young People in

Climate & Natural Resource Action

A Comparison of Field Trip Delivery Strategies: Evaluation Report

Submitted to The Corps Network and the National Fish & Wild Foundation



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Executive Summary

Digital technologies and nature learning or outdoor exploration apps are increasingly being employed by parks and other conservation sites to encourage children and families to explore and learn about these places, yet little is known about how these approaches compare with more traditional environmental education and interpretive approaches in effectiveness and enjoyability. This project compared student learning outcomes and connection to place through three different environmental education and interpretation field trip modalities: 1) traditional walks guided by rangers/interpreters; 2) self-guided walks utilizing brochures and signs; and 3) mobile technology (specifically using the Agents of Discovery App). Nearly 800 students from Prince George's County Public Schools (PGCPS) in 4th, 5th and 6th grades participated in this project, and all field trips took place at Patuxent Research Refuge, managed by the US Fish and Wildlife Service. The field trips and the evaluation data collection period were from April 16 - May 16, 2024. A pre-post survey was administered to compare outcomes of these different learning modalities, using previously established scales and items to measure constructs including: a) enjoyment; b) conservation knowledge, c) connection to nature; and d) stewardship intentions. The survey data was collected onsite via paper before their field trip experience as well as immediately after their field trip experience.

Results indicated that all modalities of learning experience on the field trips led to positive increases in all four of the outcomes assessed. Differences across the learning approaches were also assessed, and the only difference found was related to knowledge gain—students on the Guided field trips had a slightly higher knowledge gain than students on the other 2 learning approaches. Recommendations for improvements to future field trips, as well as further research, are discussed.

The similarity in outcomes found between the learning approaches is interesting and points to the potential that sites can use multiple/alternative strategies to deliver desired information during field trips, and if the programs are planned consistently and carefully, they can produce similar outcomes. This study did not identify a clear "best" approach to delivering quality field trips. It did demonstrate that technology aided experiences can deliver hoped for outcomes, and are not necessarily a distraction, or simply just "fun"—it appears well planned digital apps delivered in natural settings can deliver conservation learning successes, and even provide a means to increase a connection to nature. These findings should help dispel worries from both sides of the technology and nature divide—it appears there are multiple pathways to conservation outcomes.

Brief Project Background

The Corps Network (TCN) strives to connect youth with the Great Outdoors and protect our environment. It does this through its member corps and the nearly 25,000 diverse American youth who become corps members every year as well as through other partnerships and initiatives that promote conservation awareness and active outdoor fun.

TCN is passionate about developing effective ways to engage young people in conservation issues. In addition to physical efforts to restore public lands, TCN members develop ways to reach young people of all backgrounds. For more than six years, The Corps Network has actively supported efforts to deliver information about public lands, history and wildlife through interpretive/education efforts embracing innovative technologies and strategies that make visits to public lands active and fun.

One of TCN's primary initiatives has involved Agents of Discovery (AoD), a game-based learning tool now available in more than two hundred locations across the nation including areas managed by NPS, the USFS, the USFWS, BLM, state park agencies and more. Using technologies almost every family has (smartphones and tablets, and an engaging app), AoD enables innovative technologies to help reach, engage, connect, and educate young people about the outdoors and conservation. TCN is also partnering with state and local organizations to reach youth in California classrooms regarding wildfires and supporting other key educational efforts in cooperation with the Johnny Morris Foundation.

The purpose of this pilot project was to measure the effectiveness of different educational/interpretive strategies and the enjoyability of learning opportunities for students aged 9-12.

TCN received funding from the National Fish and Wildlife Foundation for an evaluation of alternative methods to share conservation information and encourage nature engagement with American youth. The purpose of this pilot project was to measure the effectiveness of different educational/interpretive strategies (including an AoD based conservation mission) and the enjoyability of learning opportunities for students aged 9-12. The evaluation was conducted by researchers from West Virginia University, a partner with key public and land resource agencies with proven expertise in education and interpretation evaluation efforts.



Entrance to Visitor Center

5



1 Wildlife and birding viewing station inside the Visitor Center

The field trips and evaluation took place at the National Wildlife Visitor Center and grounds at the Patuxent Research Refuge, managed by the US Fish and Wildlife Service. The rationale for selection of this site is based upon the national scope and stature of the Center and its personnel, its experience with Agents of Discovery missions, and its established relationship with local elementary schools. The research explored delivering conservation education information central to the Center purposes to visiting students through: (1) AoD missions using Augmented Reality and gaming technologies and physical tours of the Refuge, (2) interpreter led (guided) visits to the Refuge, and (3) self-guided brochures, etc. Using an iterative design process over a number of months, which included input and feedback by staff from TCN, Patuxent Research Refuge, AoD, and the WVU evaluation team, ensured that the field trip information delivered through the three learning approaches was consistent. As one of the few studies yet to assess outcomes across multiple learning modalities, this pilot project has great potential to help agencies, interpretive and conservation education practitioners, and researchers better understand any differences in outcomes being delivered. This will lead to better decisions about types of programs, outcomes to focus on, and the most effective and efficient means to deliver these conservation education opportunities to the next generation of stewards.

Literature Review

Spending time outdoors and in nature has been shown to have many varied beneficial results (Hungerford, 1996; McCurdy et al., 2010), especially for children. Time spent outside engaging with nature can positively increase physical health, mental and emotional health, increase happiness, improve learning, and promote stewardship for the environment (Berman et al., 2012; Chawla & Derr, 2012; Chawla, 2015; Clayton, 2012; Duerden et al., 2010; Kuo et al., 2019; Schilhab et al., 2018). In the last 20 plus years, studies have also shown a decrease in children spending time outside or in natural areas, and a concurrent rise in screen usage (Larson et al., 2011). Richard Louv's 2008 book "Last Child in the Woods" catapulted this idea of the increasing disconnect between children and nature into the mainstream media, and launched a renewed movement to bridge this divide. On the other hand, since the invention of the PC, the internet, and then mobile tech (tablets, smartphones, etc.), these various forms of digital technology have been introduced and embraced in classrooms and informal learning venues like museum and science centers.

Today, technology has been embedded into almost all facets of learning across our lifespans. Of course, technology is continually evolving and being adopted—advances in smartphones as photography and video tools, the rise of geocaching, and the current growth in smartphone apps focused on citizen or community science opportunities are but the latest ways technology can be used to encourage nature connectivity. However, just because these opportunities exist does not mean they are effective at connection youth (or adults) with nature, or moving people towards greater stewardship feelings, thoughts, and behaviors. Assessing the outcomes of these programs has generally lagged their existence and excitement of simply using them.

...the critical question has shifted from "should tech be allowed in nature learning experiences?" to "how can we best use tech to facilitate a connection to nature?".

Today the critical question has shifted from "should tech be allowed in nature learning experiences?" to "how can we best use tech to facilitate a connection to nature?". Although it is important to provide screen-free time for youth (whether inside or outside), there is clearly a need for educators and researchers to more thoroughly investigate the ways we can better incorporate technology into nature engagement activities, and the outcomes of those activities (Anderson et al., 2015; Coyle, 2017; Crawford et al., 2017; Fletcher, 2017).

Importantly, direct experience with nature has been found to have a greater impact on the development of pro-environmental attitudes than indirect experiences (Chawla, 2015; Duerden et al., 2010; Larson et al., 2007). This means getting kids and adults outside and into nature is a critical ingredient in forming a connection with nature. While indirect experience with nature is better than no experience, getting people actually outside and having positive experiences in nature (note—nature includes really any green space, and does not have to be "wild") are critical factors in forging connections with nature, as well as developing feelings of affinity towards nature, including stewardship. As Coyle (2017) described in a review of literature related to developing children's connection to nature, providing ongoing, recurring, and positive experiences in nature and about nature, with the support of a trusted and caring adult, is a strong pathway to nature connection for youth. These opportunities can be done with or without incorporating technology—but decades of debates continue as to the pros and cons of including or excluding technology into these nature experiences.

What is clear is the need to assess the technology to begin to answer the question of effectiveness. However, limited research has been conducted to examine differences between outdoor education and interpretive teaching modalities regarding generating enthusiasm for conservation learning, or the learning itself (Anderson et al., 2015; Crawford et al., 2017; Drader, 2014; Ren & Folta, 2016; Ruchter et al., 2010; Van Winkle, 2012). As new technologies like smartphones and apps become increasingly embedded in our lives, including during outdoor pursuits and learning opportunities, it is imperative we assess their efficacy. The goal of this project and evaluation was therefore to deepen the understanding of the effectiveness of mobile technologies as environmental interpretation and education tools, compared to more traditional learning opportunities.

Study/Evaluation Purpose

There is a critical need for an independent, peer-reviewed assessment of the effectiveness of nature engaging digital apps (such as AoD's missions), compared to more traditional means of environmental education and interpretation methods. The purpose of this study was to assess the effectiveness of different environmental education and interpretation modalities (delivery methods) for students on field trips to the National Wildlife Visitor Center and grounds at the Patuxent Research Refuge. The specific constructs assessed included outcomes related to enjoyment, conservation knowledge, implicit connection to nature, and commitment to conservation and stewardship intentions.

Program Objectives & Research Questions

The specific project objectives were to:

- 1. provide participants with an enjoyable experience,
- 2. increase participants' knowledge related to the Refuge resources,
- 3. increase participants' interest in and appreciation for nature and resource(s) they engage with at the Refuge,
- 4. increase participants' level of resource-focused environmental stewardship intentions.

Reframing the objectives noted above, our two broad research questions were:

- 1. Overall, did participation in a field trip to Patuxent Research Refuge increase student:
 - a. Enjoyment
 - b. Knowledge of Refuge resources
 - c. Appreciation for and Connection to nature and the Refuge
 - d. Stewardship intentions towards Refuge resources
- 2. Were there differences in the above outcomes based on the type of interpretive/education delivery method?



Data Collection Methods for School Field Trips

Survey

Pre and post field trip surveys administered on paper in person were used to collect evaluation data from the youth. The surveys were approved by the WVU Institutional Review Board (IRB Protocol # 2309843246) and through the Prince George's County Public School review procedures. Survey items measured constructs related to: 1) knowledge of the Refuge's natural resources (Knowledge), 2) enjoyment of the experience (Enjoyment), 3) appreciation for and connection to the Refuge natural resources (Connection), and 4) intentions related to conservation action (Stewardship). Knowledge questions were developed based specifically on the educational content covered within all three learning modalities. Previously established scales and items for Enjoyment, Connection to Nature, & Stewardship Intentions were used to compare to past research (Crawford et al., 2017; Eastep et al., 2011; Larson et al., 2019; Mullenbach et al., 2019; Nisbet, Zelenski, & Murphy, 2009; Powell & Stern, 2019). Each of these four constructs were assessed using a limited number of items per sub-scale. Due to logistical constraints and the need for survey brevity, this pilot project generally used shortened versions of the scales. Total time for survey completion was about 10 minutes, with the post survey being slightly longer. Pre and post surveys were administered immediately prior to and after the field trip experience. Field trips and survey data collection occurred on 10 different weekdays between April 16 - May 16, 2024.

Nearly 800 students from 6 different public schools in the 4^w-6^w grades in Prince George's County, MD, participated in the study.



Students taking the survey

Sample and context

Nearly 800 students from 6 different public schools in the 4^m-6^m grades in Prince George's County, MD, participated in the study. Of these, close to 600 provided usable surveys. Prince George's County Public Schools required approval of the study and permission by a parent. Participating schools were: Laurel Elementary School, Deerfield Run Elementary School, Montpelier Elementary School, Vansville Elementary School, Oakland Elementary School, and Eisenhower Middle School. The students from these schools have diverse populations and many represent low-income families, with 5 of the 6 schools qualifying as Title 1 schools. The students were a convenience sample, as the teachers from the different schools volunteered to attend—thus teacher interest played an important role in determining participation.

Teachers were enthusiastic about the experience, and throughout the study the TCN team was assisted by current and past Maryland Conservation Corpsmembers and a former Student Conservation Association alumni interning at the Refuge. Additionally, three staff members from The Corps Network assisted during various field trips.



Students getting onto the charter bus

Field Trip Program and Methodology Outline (including evaluation):

Survey Data Analysis

Changes in student responses on pre-post survey items were assessed to measure the impact of this project on knowledge of the refuge and connection to nature. Post field trips surveys also assessed enjoyment, overall learning, and stewardship intentions. The surveys had several items per outcome category. Specific survey items related to the research questions are detailed in the Tables in the Results section.

The survey data was entered into Google Sheets, cleaned and then imported into IBM SPSS Version 27 for analysis. Data was analyzed in a variety of ways. Research question #1 was evaluated first. For matched pre and post items, Paired sample t-tests were used to measure the overall impact across all students by measuring differences in mean scores (items measured on a Likert scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree). Additionally, for matched pre-post data that was nominal and dichotomous, McNemar tests were used to evaluate the change in the percentage of correct responses. The McNemar test is used to compare and understand the change in pre and post proportions for dichotomous nominal variables (in our case correct/incorrect responses to the content knowledge items). As opposed to a traditional chi-square test, the McNemar test is a non-parametric test specifically designed for repeated measures. To assess Research Question #2 (differences across the 3 interpretive delivery methods), ANOVAS and ANCOVAs (Analysis of Covariance) were used depending on the analysis required. The Analysis of covariance test is used to test the main and interaction effects of categorical variables on a continuous dependent variable, while controlling for the effects of selected other continuous variables, which co-vary with the dependent. The control variables are called the covariates, and in this case, the pre-test scores were used as the covariate. This controlled for any initial pre-test score differences between the three learning groups and provides a robust statistical test. Finally, simple frequencies were used to understand demographics as well as post-survey only items.

Limitations

Like all survey research, especially focused on youth, this project has limitations. First, the participating schools, teachers, and thus classes, were self-selected. They therefore were a convenience sample. There was no control group possible for this study. However, students were randomly assigned to the 3 different field trips groups as they arrived onsite. Self-report and social desirability biases are potential issues, as the youth filled out surveys on their own. We relied on all students' honesty, memory, and motivation to answer the pre and post surveys completely and accurately. Some needed help understanding some terms and ideas addressed on the surveys. The majority of student ended up being in the 4th grade (60%), and thus on the younger end of our originally targeted grades of 5th and 6th graders. Additionally, a small percentage of the students were native Spanish speakers, and their ability to understand and complete the surveys was limited. Consistency in field trip content and delivery is also a potential issue. We addressed this using an iterative design and review process to ensure content consistency across all 3 learning modalities, and used a limited number of guides to deliver the guided portion of the field trips. These surveys are also a point in time assessment, and not intended to be generalized over long time periods. The paired pre-post methodology does add rigor to our evaluation, allowing for stronger results than simple post trip independent samples.

A few specific survey issues arose during the first week of the field trips, and minor formatting changes were made to alleviate these issues. These issues impacted 2 specific survey questions (1 on the pre survey, and 1 on the post survey), and thus the number of respondents on those questions was less than on the other questions.

Survey Results

Nearly 800 youth from 6 schools participated in the field trips, and 596 pre-surveys and 594 post-surveys were attempted. Lack of parental approval for participation in the survey was the primary reason for the difference in the number of participants and survey responses. The pre and post surveys numbers were not equal because a few students did not attempt the post survey (for various reasons). Cleaning of the database included excluding any survey that was 50% or less completed. After database cleaning, this left 585 Pre surveys and 577 post surveys for analysis. From these completed surveys, we had 570 paired sets of pre and post surveys, resulting in a final response rate of 96% (from the overall survey pairs of 594). The total number of paired respondents for each question varied. The participants were separated into the three learning modality groups: approximately 200 students in the ranger-led group, 190 students in the AoD Augmented Reality group, and 150 students in the self-guided group. Due to surveys being incorrectly filled out, 24 post surveys were excluded because it was impossible to determine the learning modality the students were in.

From the completed surveys, we had 570 paired sets of pre and post surveys, resulting in a final response rate of 96% (from the overall survey pairs of 594).

Of these 594 respondents, 43% of the youth identified as male and 53% as female. Students were asked to identify their race (they could choose multiple races), and 4.6% identified as white, 44% as African American, and 39% as Hispanic or Latino, 4.2% as Asian, and 4.8% preferred not to say. Seventy-four percent identified as more than 1 race. Sixty percent were in the 4th grade, 19.5% in the 5th grade, and 21% were in the 6th grade.

RQ 1: Overall Impact of the Field Trip

The next section will go over the Results related to the first Research Question, which assessed overall impacts of the field trips on all students. That first research question was, *did participation in a field trip to Patuxent Research Refuge increase student:*

- a. Enjoyment
- b. Knowledge of Refuge resources
- c. Connection to Nature and the Refuge
- d. Stewardship intentions towards Refuge resources

Overall Results related to Enjoyment

Did the students enjoy their field trip experience?

Enjoyment was measured only on the post survey using a single item, "*How much fun did you have on the field trip today?*", and students were asked to circle one of five emoji faces that matched how much fun they had, and each face had a brief descriptor anchored using a five-point scale from "no fun" to "tons of fun". The overall mean on the post survey for all students was 4.35, the median was 5, and the mode was 5 (N=563) as well, indicating they experienced a high level of enjoyment of fun on the field trip.

Overall Results related to Knowledge Outcomes

Knowledge and learning were assessed in two ways. First, overall self-reported learning was measured only on the post survey using a single item, "*How much do you think you learned from this field trip, on a scale from 0 to 10?*". The numbers on the scale had brief descriptors anchored with "*nothing*" to "*a huge amount*". Second, the same six (6) true-false and multiple-choice questions were asked on both pre and post field trip surveys. This provided a more objective way of assessing learning. There was only one correct answer for each question, and responses were entered into the database as either correct or incorrect. Each correct answer was given 1 point and incorrect answers were coded 0, for a total of 6 potential points. The questions were specific to Patuxent Research Refuge and the topics covered on the field trip.

Did the students think they learned anything? (self-reported overall learning—post only)

On the single item measure of overall learning, the overall mean of all students who responded was 7.55 (SD=2.2; N=555), the median was 8, and the mode (most frequent response) was 10, indicating the students thought they learned a moderate to high amount.

Did the field trip increase actual knowledge for the students?

As noted above, a more objective measure of knowledge was also used. Changes between pre and post field trip for each of the 6 paired factual knowledge items were assessed using frequencies, and then with exact McNemar's tests. The Table below shows the percentage of students getting the correct answer for each item on the pre and post surveys. Results from the McNemar tests indicated there was a statistically significant difference on 2 of the 6 items (see Table 1 below). Looking at the changes to these two items (Monarch butterfly caterpillars; buying licenses for conservation) showed that there was a statistically significant increase in the number of correct answers from pre-post on those two items. Looking at the percentage of students who got correct answers on the other non-significant items on the presurvey show that a large majority of students initially got 3 items correct (bolded and italicized in the % Correct Pre column in Table 1 below), leaving little room for knowledge gain. This is known as the Ceiling effect (Cramer & Howitt, 2005). This reveals the students came to the field trip with knowledge related to those topics, or they were able to guess correctly on the True-False items. Thus our survey revealed a small change in overall knowledge when looking at each item. In the future, more knowledge questions, and specifically more multiple-choice questions, as well as more nuanced piloting of the questions, should be done to develop objective knowledge questions. Doing these things would provide a more robust ability to better determine knowledge gain.

| Specific Knowledge items | P value | % | % |
|---|----------|---------|---------|
| | (McNemar | Correct | Correct |
| | test) | PRE | POST |
| The goal of the US Fish and Wildlife Service agency is to protect | .701 | 98 | 97 |
| fish, wildlife, plants and their habitats. (T/F) | | | |
| Patuxent Research Refuge is unique among U.S. Fish and | .057 | 46 | 51 |
| Wildlife Service refuges—it is the only refuge established to | | | |
| (M-C) | | | |
| What special plant do Monarch butterfly caterpillars eat that | .001* | 48 | 74 |
| makes them taste bad to the animals that try to eat them | | | |
| (M-C) | | | |
| The Endangered Species Act helps protect animals and plants | .475 | 85.6 | 87.3 |
| that are in danger of going extinct. (T/F) | | | |
| Buying a fishing or hunting license is one way to support | .001* | 40 | 54.5 |
| wildlife conservation programs. (T/F) | | | |
| Species like crayfish and certain insects that live in freshwater | .105 | 74 | 77 |
| water are often important indicator species, which means they | | | |
| are very sensitive to changes in the environment and can help | | | |
| tell us about the health of that environment. (T/F) | | | |

Table 1. Overall Knowledge gain by all students, by item

* p < .001

In addition to assessing these knowledge items individually, an overall objective knowledge scale was created by combining the number of correct items on the PRE and

POST surveys for each student. A **paired samples t-test** was then run to assess the differences in the number of correct answers from PRE to POST. There was a statistically significant difference in the scores on the PRE Knowledge scale (M= 3.81, SD= .97, N=567) and POST Knowledge scale (M= 4.35, SD= 1.06), t(566)= -11.52, p < .001). These results show that across all students the overall knowledge scale went up after the field trip experience, demonstrating a small increase in knowledge in general.

Taken together, all the results related to overall knowledge gain across all students reveals there was a slight positive increase in knowledge, both perceived and actual.

Taken together, all the results related to overall knowledge gain across all students reveals there was a slight positive increase in knowledge, both perceived and actual. More nuanced survey questions in the future will allow this finding to be further tested.



Student using the brochure during field trip

Overall Results related to Connection to Nature and Refuge

Did the field trip increase their Connection to Nature?

Paired sample t-tests were first used to compare means on individual pre and post survey items with a Likert scale response format for all students. Additionally, the items that consisted of preexisting scales (groups of items) used from previous research were grouped appropriately, and an overall scale mean was calculated and analyzed as well. There were 11 paired survey items in this section—6 assessing overall Connection to Nature, 4 assessing Affinity for Nature, and 1 item assessing connection specifically to Patuxent Research Refuge.

Overall, 9 out of 11 (82%) of these paired nature connection items showed a statistically significant positive increase (Table 2 below). Five out of 6 Connection to Nature items, 3 out of 4 Affinity with Nature items, and the connection to Patuxent item showed statistically significant positive changes (increases in mean scores). Additionally, the Connection to Nature and Affinity for Nature scales also showed statistically significant positive increases.

Overall, 9 out of 11 (82%) of the paired Nature Connection items showed a statistically significant positive increase.

This indicates that across all students, their Connection to and Affinity for Nature increased, as well as their feelings toward Patuxent Research Refuge. An examination of the two items (see *italicized* items in Table 2 below) that did not show statistically significant changes revealed high pre-field trip scores, leaving little room for improvement or increase (the Ceiling effect again as noted earlier; Cramer & Howitt, 2005).

| Connection to Nature items | PRE | POST |
|---|------|---------|
| | Mean | Mean |
| 8a. I always think about how my actions affect the environment. | 3.84 | 4.06* |
| 8b. I feel very connected to all living things and the Earth. | 3.87 | 4.07* |
| 8c. My relationship to nature is an important part of who I am. | 3.87 | 4.05* |
| 8d. I feel it is important to take good care of the environment. | 4.57 | 4.54 |
| 8e. I have the power to protect natural and cultural resources in the | 2.06 | 1 1 1 * |
| environment. | 3.90 | 4.11 |
| 8f. Humans are a part of nature, not separate from it. | 4.17 | 4.29* |
| 8g. I like to learn about nature. | 4.10 | 4.24* |
| 8h. I like being outside in nature. | 4.22 | 4.26 |
| 8i. I would like to spend more time outside in nature. | 4.08 | 4.23* |

Table 2. Overall Connection to Nature by items and Scales

| 8j. I am comfortable being outside in nature. | 4.00 | 4.15* |
|---|------|--------|
| 8k. I care about Patuxent National Wildlife Refuge. | 4.24 | 4.35** |
| Connection to Nature Scale (6 items: a-f) | 4.05 | 4.20* |
| Affinity for Nature Scale (4 items: g-j) | 4.10 | 4.21* |

* p < .001; **p = .007

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree

Guide talking to students about a box turtle they discovered



Overall Results related to Stewardship Intention Items (Post only)

Did the field trip impact their Stewardship intentions?

On the post field trip survey, additional items assessed student perceptions related to increases in nature interest, learning, and stewardship intentions. Results indicated strong agreement related to wanting to visit other natural places, wanting to take better care of and protect nature, and an increased interest in learning about nature (see Table 3). Mean scores on all 5 items were 4.24 or higher, and the mode for each was 5 (the scale was 1-5).

Table 3. Overall Environmental Stewardship Results

| Environmental Stewardship items (POST only) | | Median |
|---|------|--------|
| 9a. Going on this field trip made me want to visit other places like this. | 4.24 | 5 |
| 9b. Going on this field trip made me want to take better care of this place. | 4.31 | 5 |
| 9c. Going on this field trip made me want to protect the environment and nature more. | 4.29 | 4 |
| 9d. Going on this field trip increased my appreciation for the environment and nature. | 4.24 | 4 |
| 9e. Going on this field trip increased my interest in learning more about the environment and nature. | 4.33 | 5 |
| Stewardship Scale (5 items) | 4.36 | 4.6 |

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree



Students using the AoD app on tablets in small groups

RQ 2: Comparisons across the three learning delivery groups

The next section addresses the second Research Question: were there differences in the various outcomes between the three different learning delivery groups—Guided, AoD, and Self-guided? Each separate outcome is discussed in the same order discussed in the section for Research Question #1 above for consistency.

Were there differences in *Enjoyment* levels between the 3 learning delivery groups?

A one-way ANOVA was used to compare the mean scores on the single Enjoyment item across the 3 different types of learning delivery. There was no statistically significant difference between the 3 groups: F(2, 538) = 2.444, p=.088 (see Table 4).

| <u>Group</u> | <u>Sample size (N)</u> | <u> Mean (out of 5)</u> |
|--------------------|------------------------|-------------------------|
| 1 (Guided) | 213 | 4.32 |
| 2 (Agents of Disc) | 180 | 4.46 |
| 3 (Self-guided) | 148 | 4.25 |
| Total | 541 | 4.35 |

Table 4. Difference in Enjoyment levels between learning groups

-Items measured on a five-point scale from "no fun" to "tons of fun"

Were there differences in *self-reported Knowledge* outcomes between the 3 groups?

A one-way ANOVA was used to compare the mean scores on the single self-reported learning item across the 3 different types of learning delivery. Results indicated a significant main effect between groups, F(2, 530) = 3.109, p =.045 (see Table 5). The results of ANOVA tests can only tell you if there is an overall difference between the group means, it does not identify which specific groups differ. A follow up post hoc test is required to determine this. Since the group sizes here were unequal, a post hoc test using Tukey's HSD was most appropriate to use (there are multiple post hoc tests to choose from). Using Tukey's HSD test, no statistically significant differences were found between the group means. These seemingly conflicting results indicate that the observed learning difference using the ANOVA test across the three groups was very weak—this can be seen in the p value, which was barely significant (.045). The Tukey HSD post hoc test is also a conservative post hoc test, and less likely than other post hoc tests to yield a false positive result (saying there is a difference when there is actually not). Additional research should investigate this further using more survey items and larger sample sizes.

| <u>Group</u> | Sample size (N) | <u>Mean (out of 10)</u> |
|--------------------|-----------------|-------------------------|
| 1 (Guided) | 211 | 7.85 |
| 2 (Agents of Disc) | 175 | 7.35 |
| 3 (Self-guided) | 147 | 7.41 |
| Total | 533 | 7.56 |

Table 5. Differences in Self-reported Knowledge between learning groups

-Items measured on a scale from 0 to 10, anchored with "nothing" to "a huge amount"

Was there a difference in *actual Knowledge* outcomes between the 3 learning delivery groups?

An overall knowledge scale was created by combining the number of correct factual knowledge items on the PRE and POST surveys for each student. A one-way ANOVA was then used to compare the mean POST Knowledge scale scores across the 3 different types of learning delivery. Results indicated a statistically significant main effect between groups, F(2, 541) = 12.36, p < .001 (see Table 6). Post hoc tests using Tukey's HSD test found a statistically significant difference between group 1 (Guided) and the other two groups (AOD and self-guided). The Guided group had a higher mean score (4.65) than the AOD group (mean= 4.2) and the Self-guided group (mean= 4.2) (see Table 6).

A statistically significant difference was found on knowledge outcomes: students in the Guided groups reported slightly higher knowledge outcomes than the other two learning approaches (Agents of Discovery app and Self-guided).

While the score differences are statistically different, practically speaking, based on this study it would be difficult to make recommendations to AoD or Self-guided field trip designers to improve their learning opportunities. Further research using qualitative methods, like participant interviews, could be conducted to discover why the Guided opportunities led to slightly greater changes in Knowledge.

| <u>Group</u> | Sample size (N) | <u>Mean (out of 6)</u> |
|--------------------|-----------------|------------------------|
| 1 (Guided) | 215 | 4.65 |
| 2 (Agents of Disc) | 180 | 4.2 |
| 3 (Self-guided) | 149 | 4.2 |
| Total | 544 | 4.4 |

Table 6. Differences in actual Knowledge between learning groups



Refuge staff leading a field trip

Were there differences in *Connection to Nature* outcomes between the 3 groups?

ANCOVAs was conducted to determine if there were significant differences between the 3 learning groups on the scores of the POST Connection to Nature scale, the Affinity for Nature scale and the single item related to connection to Patuxent Research Refuge, controlling for the PRE scores. As noted earlier, the Analysis of covariance (ANCOVA) test is used to test the main and interaction effects of categorical variables on a continuous dependent variable, while controlling for the effects of selected other continuous variables, which co-vary with the dependent. The control variables are called the covariates, and in this case, the pre-test scores were used as the covariate. This controlled for any initial pre-test score differences between the three learning groups and provides a more robust statistical test.

The ANCOVA results found no statistically significant differences between the 3 groups on the Connection to Nature scale, the Affinity for Nature scale, nor on the single item related to connection to Patuxent Research Refuge, after controlling for the PRE scores. Specific results for each of these tests are shown below, and Tables 7a-c report the mean scores for the three different learning groups on each scale or item.

There was no significant effect found between the three learning groups on the Connection to Nature scale, after controlling for the PRE scores, F(2, 520) = .742, p = .477 (Table 7a).

| <u>Group</u> | <u>Sample size (N)</u> | <u>Mean</u> |
|--------------------|------------------------|-------------|
| 1 (Guided) | 210 | 4.18 |
| 2 (Agents of Disc) | 172 | 4.189 |
| 3 (Self-guided) | 142 | 4.25 |
| Total | 524 | 4.2 |

Table 7a. Differences in Connection to Nature between learning groups (survey items 8a-f)

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree

There was no significant effect found between the three learning groups on the Affinity for Nature scale, after controlling for the PRE scores, F(2, 544) = .488, p = .614 (Table 7b).

Table 7b. Differences in Affinity for Nature between learning groups (survey items 8g-j)

| Group | Sample size (N) | Mean |
|--------------------|-----------------|------|
| 1 (Guided) | 216 | 4.18 |
| 2 (Agents of Disc) | 182 | 4.28 |
| 3 (Self-guided) | 150 | 4.2 |
| Total | 548 | 4.22 |

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree

There was no significant effect found between the three learning groups on the Connection to Refuge item, after controlling for the PRE scores, F(2, 539) = .105, p = .900 (Table 7c).

Table 7c. Differences in Connection to Patuxent Research Refuge between learning groups (survey item 8k)

| <u>Group</u> | Sample size (N) | <u>Mean</u> |
|--------------------|-----------------|-------------|
| 1 (Guided) | 214 | 4.34 |
| 2 (Agents of Disc) | 180 | 4.38 |
| 3 (Self-guided) | 149 | 4.37 |
| Total | 543 | 4.36 |

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree

Were there differences in Stewardship intentions between the 3 groups?

A one-way ANOVA was used to compare the mean scores on these post only stewardship items across the 3 different types of learning delivery. No statistical differences were found on any of the items, nor on the overall stewardship scale (see Table 8).

| Environmental Stewardship items (POST only) | Guided | AoD | Self- guided |
|---|--------|------|-----------------|
| 9a. Going on this field trip made me want to visit other places like this. | 4.2 | 4.27 | 4.22 |
| 9b. Going on this field trip made me want to take better care of this place. | 4.32 | 4.34 | 4.27 |
| 9c. Going on this field trip made me want to protect the environment and nature more. | 4.26 | 4.31 | 4.26 |
| 9d. Going on this field trip increased my appreciation for the environment and nature. | 4.27 | 4.24 | 4.21 |
| 9e. Going on this field trip increased my interest in learning more about the environment and nature. | 4.36 | 4.3 | 4.33 |
| Stewardship Scale (5 items) | 4.41 | 4.37 | 4.28 |

 Table 8. Mean score Differences in Stewardship intentions between learning groups

-Items measured on scale from 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, 5 = Strongly Agree

Other Findings—Qualitative and Anecdotal

This project also collected anecdotal evidence during the field trips and data collection efforts. These included observations and asking questions either to individual students or

Interestingly, most participants (students and teachers) had not previously visited, and they overwhelmingly expressed an intention to return.

teachers and groups of students. A short online survey was also sent to participating teachers, and 6 responded. These helped provide further insights and suggestions for improvements. For example, the surveys showed that most students enjoyed their visit, and wished to return to the Refuge. Five of six teachers noted the students really enjoyed being outside, walking around exploring nature, regardless of the delivery method. A few teachers also said some of their students had difficulties in reading (brochures, app, and survey).

All teachers expressed an interest in bringing their classes back for similar programs. Project leaders also spoke with students and teachers onsite about if they had visited before, and if they would like to visit again. Interestingly, most participants (students and teachers) had not previously visited, and they overwhelmingly expressed an intention to return. The field trips provided a positive first experience at the Refuge, which is an important first step in connecting to nature in general and a network of, federal, state and local lands covering nearly one-third of the nation's surface, and to potentially move them down the path of further engagement with conservation opportunities.



Students and teacher outside the Visitor Center

Discussion and Recommendations

The results of this study add further evidence to the literature related to how different environmental education and interpretive opportunities, including those using digital technology and smartphone apps, impact a variety of field trip outcomes for students.

Some of the major takeaways from this pilot study:

- 1. Well planned and delivered fields trips to natural sites like Patuxent Research Refuge are enjoyed by students and teachers, regardless of the type of learning strategy.
- 2. An important outcome was learning—students both believed they learned, and demonstrated an increase in learning. This result was found across all field trips types and student ages.
- 3. Connection to nature and care for the field trip site also increased.
- 4. Interest and intentions related to further nature learning and environmental stewardship were high after the field trip.
- 5. When comparing the four specific outcomes across the three different learning approaches, the only significant difference was that students in the Guided groups reported slightly higher (but significant) knowledge outcomes than the other two learning approaches (Agents of Discovery app and Self-guided).

The similarity in outcomes found among the learning approaches is interesting and highlights the potential that sites can use multiple methods to optimize the value of time and funds invested in field trips, and if the programs are planned consistently, they can deliver similar and likely synergistic results. The results indicated there was no clear "best" approach to delivering quality field trips. It did demonstrate that technology aided experiences can deliver hoped for outcomes, and are not necessarily a distraction, or simply just "fun"—it appears well planned digital apps delivered in natural settings can deliver conservation learning successes, and even provide a means to increase a connection to nature. These findings should help dispel worries from both sides of the technology and nature divide—it appears there are multiple pathways to conservation outcomes.

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These findings support previous research that noted more similarities than differences when delivering environmental education field trips using different media types (Crawford et al., 2017; Ruchter et al., 2010). The most comparable study to this one, Crawford et al. (2017), found few differences in field trip outcomes when comparing the same types of learning modalities (mobile platform nature app, guide, and self-guided learning opportunities). In their study, they found no differences in knowledge or connection to nature outcomes, but children using the mobile app reported higher levels of enjoyment. Our study did not find this difference between groups in enjoyment levels, but did find a small difference in actual knowledge gained.

Strengths and weaknesses of different learning opportunities

These findings highlight the fact that there are many ways to effectively deliver conservation education opportunities to youth. Traditional ways of leading field trips and engaging youth will need to be updated and continue to exist alongside new methods. Each type of learning opportunity—guided, self-guided via traditional means (such as interpretive brochures or signs), digital technology and apps, etc.—has strengths and weakness, and sites will need to think carefully about what type they can offer to achieve their targeted outcomes within the confines of their budgets.

A brief discussion will highlight these various pros and cons for the different modalities (Ward & Wilkinson, 2012). Face-to-face guided opportunities are generally valued highly by participants, as was the case here. The ability for participants to engage with a guide in real time and have them answer questions are key strengths of this type of field trip experience. The ability to respond to in the moment events (like wildlife sightings) and be flexible in delivery—both with the content and delivery methods—is another strength. Being able to tailor programs to specific targeted audiences ahead of time, as well as during a program if needed, is another important strength of personal programs (programs delivered in person). A few cons associated with guided opportunities are the high per person cost (they require hiring and training staff) and the need to keep group sizes small and manageable for the guide. Thus one guide can only deliver a few programs per day, and reach a smaller number of visitors than can be reached by more non-personal modes (brochures, apps, etc.).

Brochures and interpretive signs are still the most common self-guided type of nonpersonal (meaning there is no person delivery content in real time) mode of education and interpretation delivery at natural and cultural resource sites. They can provide information to anyone, at any time of day to engage with at the visitor's pace, and generally can last for years thus providing a more cost-effective way to deliver content. The content can also be presented in multiple languages and in a variety of formats. However, the disadvantages include the lack of personal contact with site personnel, the inability to take advantage of unexpected encounters, the need for maintenance and upkeep (damage to signs, printing and stocking brochures, etc.), the inability to potentially change content quickly, the high up-front cost to develop the content and media, and the ability of visitors to simply not engage with the content, leading to missed information and interpretation opportunities.

The use of digital forms of delivery methods brings new strengths and weaknesses. Use of digital methods allows new audio and visual means to deliver immersive content in highly tailored and engaging ways. Smartphones are now used by 97% of adults in the US, 43% of tweens (youth between the ages of 8 and 12), and upwards of 90% by age 16 (Radesky et al., 2023). This ubiquitousness of small screens in our pockets today enables sites to delivery content directly to the visitor on their own device when they choose, eliminating what was once a huge cost associated with sites buying and maintaining their own equipment for visitor use. Digital platforms like websites and apps can potentially offer more accessible content, such as content translation into almost any language, text-tospeech ability, and even haptic engagement abilities. Some important weaknesses to consider still include costs: cost of development (content and software platforms), potential cost of the delivery platform (screens in visitor centers, tablets, smartphones, etc.), and cost of maintenance—while all types of delivery modes have similar types of costs, digital platforms pose new cost challenges. Additionally, technology is easier to break then a sign, and providing cellular service via Wi-Fi to enable GPS to function seamlessly is still a challenge throughout the U.S., especially at natural resource sites. Additionally, different ages prefer different digital engagement opportunities so multiple versions of the content will still need to be developed and provided.

Recommendations for improvements

The results and findings point toward a number of recommendations for both the improvement of the field trip experiences, as well as future evaluation efforts. Suggestions for improving field trips will be discussed first, and then tips for evaluation.

Before field trips even arrive on site, it is critical to make sure the teachers and any other adult volunteers (parent chaperones, etc.) understand their responsibilities. Integrating adults into the field trips is critical to help engage students, keep them on task, and respond to any spontaneous learning opportunities. Creating a supplies list for both field trip activities and the evaluation is important. This was done for this project and proved to be critical to smooth running field trips. Even more important is testing the functionality of such equipment—this project ran into numerous small technical issues related to the technology used. A great deal of tech troubleshooting happened prior to the field trips, and even then, more was required during the first week of field trips. Doing this is paramount if digital technology (smartphones, tablets, internet connection, etc.) is used. Transportation costs have been a perennial issue for school field trip groups, and likely will remain so. Schools and field trip sites should work together to come up with ways to share the cost and seek external funds (small grants) to help reduce this barrier.

Researchers and evaluators should also undertake pilot testing of both the assessment instruments (i.e., the actual questions to be asked), as well as the methods to collect the data. Our study found limited positive results when assessing the Knowledge outcomes. Adding more objective knowledge items in general, more multiple-choice questions specifically (our survey had 4 true false and 2 multiple-choice questions), and items which students were not already familiar with would provide a more robust measure of knowledge, as well as aid in assessing knowledge outcomes. Pilot testing the knowledge items specifically with the various target age groups would also be useful. This project ended up with a slightly younger age group than originally planned. This caused issues with reading comprehension on some survey items. Additionally, this project engaged some students who were non-native English speakers, which created difficulties for those students in filling out the survey. Future efforts should try to deliver the field trip learning opportunities (brochures, etc.), as well the survey, in multiple languages if budgets allow. This project intended to use tablets or mobile devices to collect survey data from the students. However, issues with onsite Wi-Fi access, as well as the inability to know if all students had mobile phones, led to a pivot to using paper-based surveys to collect the data. Finally, regardless of the way surveys are collected (paper, online, etc.), it is important to have a few project staff members available to help proctor and assist with data collection efforts. Students needed help understanding some of the questions, navigating language barriers, and even being reminded to fill out all the survey pages by simply turning over the pages, etc.

Anecdotal reports during the survey collection indicated some students may not have understood which learning modality group they were in. While we printed the Pre and Post surveys on different colored paper to eliminate any confusion, perhaps each learning modality group should have a different color survey as well, and then a project member can hand out the correct corresponding surveys to the different learning groups as they arrive at the site, and then again after the field trip experience. We also created ID numbers for each student to match the pre and post surveys. Writing this ID on name tags and then having the students put it on their shirt or coat, etc. was helpful in making sure they wrote the correct number when taking the surveys. However, it is strongly recommended that the last digits of the numbers be different, rather than the first numbers, which is what our team did. This simple change helps with database management as the information is automatically aligned better when entered.

We also used peelable labels to create unique codes for each student participant. On our first day, we encouraged students to apply the labels to their clothing, and then learned that a substantial number of the labels fell off during the walk on the trail. We

subsequently applied the labels to the place the students initially sat, and told them to leave bookbags on lunches at that site and return to the same location after the experience. This was an improvement, but removal of the labels proved challenging and left behind an adhesive residue not appreciated by our hosting organization. Our ultimate solution was to tape the labels to each seating location with blue painter's tape, which left no discernible residue on the table.

We were fortunate that serious rain events did not impact our study. We did have 200 inexpensive ponchos available and used many for one event involving light rain. We also arranged for a worst-case situation – an indoor experience utilizing signs and QR codes for the self-guided and technology-aided groups – but luckily did not have to use this option.

Both self-guided and technology-aided groups divided into smaller groups of 2 to 4 students. This was planned to accommodate students with differing reading and technology skills and was validated in the field as helpful – and also proved popular with the students who appeared to enjoy discussions and sharing.



Students with tablets on a field trip

Conclusions

As nature and conservation-based sites and agencies continue to engage youth with nature to create the next generation of stewards, new methods to do this will need to be developed and assessed (Coyle, 2017; Crawford et al., 2017; Schilhab et l., 2018). The increasing pervasiveness of digital technologies in every facet of our lives, including children's, must be addressed by these agencies in ways that facilitate and increase connection to nature and the outdoors. The question is, how can we best harness the interest of youth in these new technologies, in ways that enable stronger and more meaningful connections?

Traditional ways of leading field trips and engaging youth will need to be updated and continue to exist alongside new methods. Each type of learning opportunity—guided, self-guided via traditional means (such as interpretive brochures or signs), digital technology and apps, etc.—has strengths and weakness, and sites will need to think carefully about what type they can offer to achieve their targeted outcomes within the confines of their budgets. Most importantly, in order to provide effective learning opportunities, providing relevant, engaging, reinforcing, and positive experiences are critical, regardless of the delivery methods.

This study found that with careful planning and consistent content delivery across platforms, all three approaches were able to increase youth enjoyment, conservation knowledge, connection to nature and stewardship intentions.

This study found that with careful planning and consistent content delivery across platforms, all three approaches were able to increase youth enjoyment, conservation knowledge, connection to nature and stewardship intentions. Few differences were found across the three modes of delivery, revealing sites can implement a variety of learning opportunities, and achieve similar conservation outcomes. Longer term studies are needed to assess these outcomes over time. These findings help advance our knowledge of the best ways to create and deliver environmental education opportunities for youth. The shared goal of creating the next generation of conservation stewards and leaders can only be realized through further in-depth studies employing rigorous evaluation tools and encompassing diverse audiences.

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