Interpretative design with technology in mind: Facilitating integration of technology into nature-based education programming

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Approved by advisory committee:

Zakiya Leggett, Chair
Kathryn Stevenson
Lincoln Larson

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Lauren Lintz, Zakiya Leggett, Kathryn Stevenson, Lincoln Larson

Introduction

In the current Digital Age, readily available and rapidly expanding technology is shaping nearly every aspect of daily life. Technology can improve home life through advanced security systems, cleaning with automated vacuums, and energy-efficient appliances, lighting, and heating and cooling systems. Time and distance are no longer obstacles when it comes to communication due to cell phones, social media, video conferencing, and emailing, with 96% of Americans owning cellphones according to the Pew Research Center's survey in 2019 (Demographics of Mobile Device Ownership and Adoption in the United States). In addition, information can be accessed from virtually anywhere among the world's 3.9 billion global internet users (Statica, 2019).

Despite numerous benefits to technology use, it may be negatively impacting people's relationships with nature. For youth, the rise of technology has been identified as a key contributor to the decline in nature-based activities and connectedness with nature (Larson et. al., 2018; Larson, Green, & Cordell 2011; Pergams & Zaradic, 2006), which can negatively impact children's affective and cognitive development (Chassiakos et. al., 2016; Kellert, 2002). Excessive technology use can also lead to troubling health and behavioral problems, such as attention difficulties, increased risk of mental illness, trouble sleeping, and obesity (Chassiakos et. al., 2016; Walter, 2013). In nature, technology can generate other problems by creating a false sense of security due to technological dependence, as well as loss of solitude and inability to "escape the grid" due to the omnipresence of technological innovations (Borrie, 2000; Dawson, 2007; Hendee & Dawson, 2001). For outdoor educators and interpreters, in particular, competition with screens is a becoming a major challenge. Technology often creates a major distraction during programming. (Cole & Stanton, 2003; Goth, Frohberg, & Schwabe, 2009; Naismith, Sharples, & Ting, 2005).

However, even with these troubling and cautionary findings around technology use, some researchers believe that technology can be an asset to nature-based recreation and a helpful (if not essential) addition to outdoor recreation, education, and interpretation programming (Bollinger & Shepard 2017). Technology has supported outdoor experience for many decades through improvements in transportation, comfort, safety, communication, and information accessibility by allowing recreationalists to experience nature in ways that previously had been unattainable. For example, smartphones alone can provide GPS for trail navigation, emergency calling and locating for search and rescue teams, and providing information on local plants, wildlife, and geography (Dickson, 2004; Ewert & Shultis, 2013). Technology can also be used to help individuals learn and reconnect with nature through live nature feeds and augmented reality, especially when authentic experiences in natural spaces are not possible (Kahn, 2011; Kaufman & McNay, 2017; Tarng & Ou, 2012). Mobile devices, if implemented as educational tools instead of focal points to lessons, can actually increase learning in informal settings, (Crawford, Holder, & O'Conner, 2017; Crompton & Burke, 2018; Eliasson et al., 2011; Kacoroski, Liddicoat, & Kerlin, 2016).

The positive and negative impacts of technology on the human-nature relationship leads to disputes about its appropriate use in natural settings. This philosophical conflict exists on many levels, but is particularly conspicuous across age groups. Older adults are typically less likely to embrace technology without clear benefits, are concerned about the technology's user-friendliness, their privacy, and their ability to ask for help when using the technology (Heinz et al., 2013; Vaportis, Clausen, & Gow, 2017). On the other hand, a 2018 Pew Research Center survey shows that 95% of teens own smartphones and 45% admit being on them 'almost constantly'. Four out of five students in a 2016 survey believe that technology improved their education, saved time, and boosted their grades (Hanover Research, 2017). This rise in technology has characterized an entire generation, commonly referred to as Gen Z, who have grown up in a world where technology has been intimately linked to nearly every aspect of the life experience. This prevalence of technology has driven how contemporary youth learn, think, and process information in ways that are fundamentally different from previous generations (Chassiakos et. al., 2016; Oblinger, 2003; Walter, 2013). The result is a cultural divide where older generations struggle to teach and communicate with the younger generations because youth are essentially speaking a different language: the digital language of texts, tweets, and instant messaging (Prensky, 2001). Conflicting viewpoints about the use of technology in nature make it difficult for site managers and interpretive planners to come to a consensus on its usage in interpretive contexts. Accordingly, research is needed to understand how different views of technology use in interpretation emerge and persist, as well as how these conflicting perspectives might be reconciled to enhance education and interpretation opportunities in outdoor settings.

Numerous studies have attempted to explain innovation acceptance and adoption. The most commonly used and widely accepted models may be the Theory of Diffusion of Innovation (DOI) (Rogers, 1962) and the Technology Acceptance Model (TAM) (Dibra, 2015; Scherer, Siddiq, & Taneur, 2019; Taherdoost, 2018). Though not technology-specific, DOI theory describes three major components important in predicting how innovations are promoted: adopter characteristics, characteristics of an innovation, and the innovation-decision process. Adopters can be characterized according to how quickly they adopt a new innovation. The first to adopt new innovations fall within the Innovator and Early Adopter categories, followed by the Early and Late Majority, and ending with the Laggards being the most resistant to new innovations (Rogers, 1962). The Technology Acceptance Model (TAM) sheds light on the innovation-decision process specific to technology use. According to Davis (1989), two key factors influence user's decisions on the use of an innovation: perceived usefulness, which pertains to the belief that the innovation will enhance the user's performance, and perceived ease of use, which pertains to the belief that the innovation is free of effort or easy to use.

Drawing on these two approaches, we explored potential opportunities and challenges of technology use in nature-based education and interpretation using a case study of an eco-community grappling comprised of predominantly older residents with whether and how to integrate technology into interpretive efforts. First, we characterized perceptions of technology use in nature as applied to environmental interpretive programming using Roger's (1962) adoption categories (Obj. 1). Next, we used Roger's (1961) and Davis's (1989) concepts of the characteristics of the innovation (e.g., adopter characteristics, perceived usefulness, perceived ease of use) to identify factors, such as societal pressures, individual values, and communal visions and goals, that influence perceptions and acceptance of technology use in nature (Obj. 2). After that, we used Ham's (2013) TORE (Thematic, Organized, Relevant, Enjoyable) framework for interpretive design to create and implement a technology-based interpretive product that attends group perceptions and concerns about technology (Obj. 3). Finally, we documented how this process changed perceptions of technology in interpretive settings (Obj. 4). Our study can be separated into two phases. Phase 1 encompassed objectives 1 and 2 by focusing on understanding participant perceptions of technology and what influenced those perceptions. Phase 2 addressed objectives 3 and 4 by applying the results from the previous phase to create and implement a technology-based educational tool and to observe and document community reactions to the product.

Methods:

Study Context

This study was conducted at Hart's Mill Ecovillage and Farm in Mebane, NC (www.hartsmill.org). This community is a regenerative farming community with 112 acres of fields, forests, streams, and nature trails. It intends to be a rural village; a close community with space to roam for residents of all ages and walks of life who are dedicated to environmental, social, and economic justice and regeneration. Members of the Hart's Mill community range in age, with most being 50 years of age or older, and having various occupations including retired individuals, teachers, farmers, business managers, computer technicians, artists, and musicians. Hart's Mill has adopted "sociocracy" as their governing model, meaning "governance by peers or colleagues." This model includes a governance structure organized by circle groups sharing a specific purpose or aim with consent decision-making and feedback loops, where policies are designed with timeframes and evaluation criteria. Their circle groups include the general circle, membership and marketing circle, land stewardship circle, planning, design, and development circle, financial and legal circle, and governance and training circle. With their governing model calling for power equivalency and consent-based decision-making, it is important for the community to come to a consensus regarding the implementation of technology within their community.

We were invited into this community to help design some kind of interpretive product for use by members of the community, potential members of the community, and visitors from the general public. In initial conversations, we discussed the use of technology in this product. It appeared there were a range of opinions on its role within the Harts Mill community. Understanding these conflicting viewpoints became the focus of research Phase 1, which covered the first step in Rogers' (2003) innovation adoption process (Figure 1). The second phase of our research covered steps two and three.

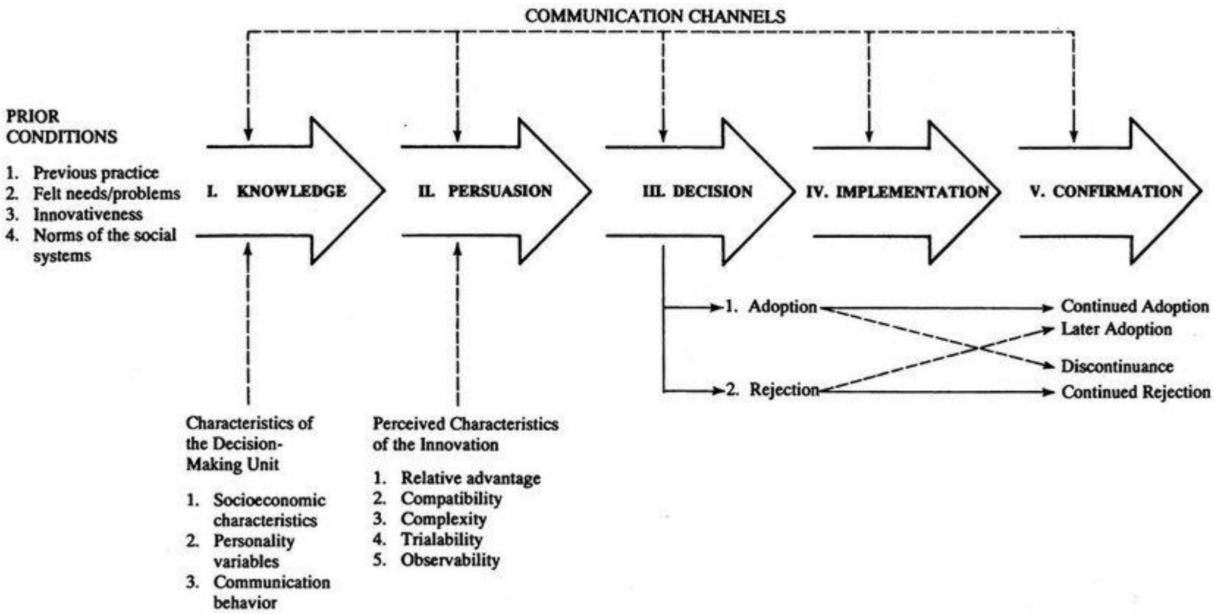

Figure 1: The Innovation-Decision Process Model (created by Rogers 2003) used to guide interpretive program design at Hart's Mill

Phase 1: Community Perspectives Regarding Technology in Nature

Phase 1 of our study was designed to address objectives 1 and 2, which characterized community perceptions towards the use of technology as an environmental education tool and the factors that influenced those perceptions. All members were invited via email to participate in an initial focus group to establish design priorities for an interpretive product for the community. With Hart's Mill being a small community, only six members agreed to participate. Even though it was a small participant group, members from the general circle, land stewardship circle, planning, design, and development circle, financial and legal circle, and governance and training circle were present allowing for a representative group of the community and their values. The only circle group not represented was the membership and marketing circle.

Prior to the focus group, we asked participants to complete an anonymous online survey using the Qualtrics platform. The survey asked open-ended questions regarding their favorite physical and cultural assets of the community, their intended audience for the interpretive product, and their opinions on the use of nature-based technology. The focus group re-addressed the same questions from the survey to facilitate group discussion and inform collective decisions for the use of technology within the interpretive program. The survey and focus group reflect the first stage in Rogers' innovation decision process (Figure 1) by assessing the baseline knowledge and attitudes towards technology. The focus group was audio recorded with personal notes taken during the meeting, resulting in 80 minutes of audio data. Both the survey responses and focus group conversations were transcribed and thematically analyzed using open coding and axial coding to identify individual themes related to technology use in nature and the rationales driving these perspectives (Peterson at al 1994; Miles et al. 2013). This coding technique allowed flexibility in organizing and describing the qualitative data, producing rich results without having to subscribe to a pre-existing framework.

Results:

Objective 1: Characterize how community members perceive technology use in nature

Even within the small group of participants, the data revealed three major categories of users based on Roger's DOI typology regarding the use of technology in nature: early adopters supporting technology use, laggards vehemently against it, and majority adopters who could be swayed in their decision. Those in favor clearly recognized the benefits of embracing technology in a rapidly evolving world.

> "I believe that the use of technology is important as the world becomes a more technological place."

> "I actually really like the idea of having technology available for those of us who can and want to use it. I mean I would have to learn. I have a smartphone but I'm not as smart as the phone."

However, others were adamant that this type of technology intrusion would simply be a distraction.

> "Minimize! In nature, we have the opportunity to use all of our senses, and in a wide, alert, many-directional way, that is just the opposite of being sucked into your phone. Don't try to use technology as a bridge, learn to swim in the real world! When my students visit, phone are banned completely."

> "It strikes me as one of [those] deeply seductive temptations. And my experience with young people is that the phone sucks you in and it's all over at that point."

Others were a bit reluctant to fully embrace technology but liked having the option, allowing themselves and other recreationists to choose how they engage with nature.

> "I'm open to [using technology in nature] provided that technology doesn't diminish the sheer enjoyment of the natural world."

> "I am fine with [technology] as long as there are a variety of learning options for those who prefer Luddite options."

Initially, the participants were far from consensus when it came to the use of technology in nature-based environmental interpretation.

Objective 2: Identify factors that influence perceptions of technology use in nature

Initial reactions to technology use displayed categorizations consistent with Rogers' (1962) categories of innovation adoption but said little about why individuals felt the way they did. Consideration of innovation characteristics that facilitate adoption such as adopter characteristics (Rogers 1961) and perceived usefulness (Davis, 1989) yielded insights on that front. Those older in age, belonging to the laggard category, tend to be more resistant to technology adoption and focused on traditions and how things have always been done. Among the participants, gender and profession played no role in adoptiveness. Those in the early and late majority adoption categories provide interconnectedness in the social networks by deliberating on the innovation before making a decision towards adoption.

While some participants were resistant to technology use in general, they did see its utility (or perceived usefulness) in attracting new members, and particularly young members. As a community, they hoped to encourage membership among younger people and families; therefore, in their view, they had to consider the use of technology to attract those particular types of innovation adopters. This shift reflected a change of perspective from one of personal usage to one acknowledging the value of technology for others.

> "I feel that if it's an entry for people to come in with their phones so they learn something and then they'll want to put their phone in their pocket and experience something. Then to me, that works."

"I feel like I would like something that would make us more relevant to the younger generations. I think we need that, and I feel like it's the gateway drug maybe." However, others believed that using technology would take away from the nature experience and should be discouraged among its members. They believed that technology contradicted the culture Hart's Mill hoped to instill, which revolves around direct experience with the land.

> "If you make it easy for people to go into the forest with their phones, then they will never go in without using [technology] as a way of seeing [nature]."

> "The part of the lesson is to precisely not bring the phone into the woods, rather than turn the woods into an adjunct world you access in the same way."

> "Can we start off with something non-technological? And upgrade when I die? I almost would rather it be less educational and more experiential."

To some community members, the idea of having any kind of technology displayed along the trails raised concerns about aesthetic impacts.

> "To me, walking through the woods and seeing [technology displayed] would be profoundly disheartening. The whole wild world is getting shrunk into something that is sized for technology and just a radical reduction. I wouldn't even want to do it."

Other members believed forms of technology could be useful for educating and providing current information dependent on how easy the technology would be to use by members and visitors.

> "Technology could be a resource to just let them use at their leisure. If they want to learn more, the resource is there and accessible."

> "This would be a way of having a website where one could go and [access] some other learning that is related to [what the visitors saw along the trail]"

> "What would be interesting too, is if over time we could work with it seasonally so that we can shift it to fall and spring."

In the end, regardless of rationale, there was a significant divide among participants on their stances in support or in opposition to using technology in nature. Due to their dedication towards consent-based decision making, the participants (some reluctantly) concluded the focus group with an agreement to attempt a "trial run" for incorporating technology into their new interpretive program.

<u>Phase 2: Integrating Technology into Interpretive Program Design & Implementation</u>

Phase 2 of our study focused on addressing research objectives 3 and 4 by building on the final steps in Rogers' (2003) Innovation-Decision Process model (Fig 1) and using results from the Phase 1 survey and focus group data to a) design an interpretive product for Hart's Mill and b) document how this process changed participants' opinions on the use of technology in interpretive settings.

Objective 3: Integrate beliefs about technology and interpretive design principles to design and implement a technology-based educational tool

To address objective 3, we applied interpretive principals laid out in Ham's (2013) TORE (Thematic-Organized-Relevant-Entertaining) approach to draft the main content and format for an interpretive program. Participants expressed a preference for a brochure linked to as interpretive trail as the final product, with mixed feelings on how or if technology should be used in conjunction with the experience. We drew from participants' survey and focus group responses from Phase 1 to identify physical and cultural aspects important to Hart's Mill members and the intended audience for the interpretive effort. In the survey and focus group, participants emphasized an active relationship, or partnership with the land, as an overarching principle. This thinking evolved into the following core theme: "Hart's Mill is a living landscape where humans and nature are interconnected." We located points along the trail to place markers that identified different ecosystems or points of interest at the site; these were organized within the brochure to tell a story for the visitors as they walked each trail. Each marker explained different sustainable management practices implemented by Hart's Mill to make meaningful connections and increase relevance with their interconnectedness with nature.

Given the differing views on technology, we chose to present the Hart's Mill members with two versions of the brochure. One included written and visual content associated with each of the 12 trail markers, along with a map of the trail (see Appendix A), but no form of technology integration. The second version was identical to the first but included QR (quick response) codes to provide additional information via a technological connection. This technology was chosen largely due to the fact that QR codes can be created via free online generators, can be utilized by anyone with a smartphone and wireless internet capability, require little training, and can be placed in areas where space is limited (Lai et al 2013). Working with participants, we elected to integrate QR codes at five of the twelve trail markers. These codes linked to additional resources on topics related to the specific stops on the interpretive trail (e.g., NC beekeeping, Hart's Mill's farming practices, slate geology). Because community members wanted to comply with interpretive best practices by appealing to different learning styles (Brochu & Merriman, 2012), QR codes linked to a mix of websites, videos, and informational guides (see Appendix A for a copy of the brochure).

After initial drafting of the brochure, we held a second focus group with the Hart's Mill members to obtain feedback and observe reactions to both versions of the brochure. The focus group was held outside on the trail system, which made participation in the focus groups feasible for more community members. Five of the six original participants were present, in addition to five more participants who ranged in membership levels and participated in different circle groups. At the beginning of the second focus group, participants were provided brochures with and without QR codes to refer to. The facilitator explained the purpose of the brochure and demonstrated how to use QR codes. Following the demonstration, participants discussed the brochures, provided feedback, and came to a consensus on which version they preferred to use.

The persuasion stage of Rogers's Innovation Decision Process (Fig. 1) occurred during the first part of the focus group as they were exploring and discussing the brochures and QR codes, while the decision stage occurred at the end when the participants collectively decided on which version to use. Due to the informal outdoor setting, only field notes were collected by the facilitator, in addition to any edits and comments that participants wrote directly on the brochure drafts. These field notes reflect the journaling style of data collection often used as an unobtrusive observational technique by researchers in park settings (Miles et al., 2013). Data from this second focus group and the corresponding field notes were again analyzed using open and axial coding.

<u>Phase 2 Results:</u>

Regardless of whether or not the brochure contained QR codes, initial reactions to the brochure were positive and enthusiastic. Members appreciated features of the brochure such as the trail map, brochure layout, color scheme, images, and overall informative content. When looking at the brochure with QR codes, some participants claimed not to notice them at first and asked "Where are they?" This is important to note considering many participants were worried about the aesthetic costs of using technology such as QR codes, fearing they would detract from the nature experience.

Upon further inspection of the interpretive material, one participant requested, "Could you tell me more about the slate geology? I don't know much about geology." Using the brochure with technology connections, the facilitator demonstrated how using the QR code would direct the user to more resources on the topic that could help answer these questions. With little difficulty, two participants were able to use their smartphones to get to the website embedded within the QR code describing the process as "neat", "cool", and "convenient." This provided positive firsthand experience for the participants on how the codes could be used to access additional information that would not fit within the physical brochure. Several participants acknowledge that the tangible technology-mediated benefits provided by immediate access to external resources far outweighed the minimal aesthetic costs.

After reading the brochure, a participant who had been strongly against the use of technology stated, "I personally wouldn't use them, but I didn't feel as if I was missing out on anything by not using [the QR codes]". This reassured other members, who feared that visitors without smartphones would feel excluded or not have sufficient information for each marker. Additionally, another participant noted: "I really think these QR codes will make us more inclusive among younger generations." Towards the end of the discussion, the facilitator demonstrated how the entire brochure could be converted into a QR code, resulting in one participant enthusiastically suggesting, "We should post that out here on the trail for those come to walk the trail but don't have the paper version."

Throughout the facilitator's demonstrations and group discussion, the participants progressed through Rogers' persuasion stage of the innovation diffusion process (Fig. 1) as they became interested in the innovation and gathered information about it. Successfully using the QR codes for the first time reinforced the perceived ease of use and low complexity of the innovation. In addition, the perceived usefulness and relative advantage of the QR codes was evident as participants noted the convenience of QR codes providing additional resources, the minimal space requirement within the brochure, the perceived appeal and inclusivity among younger generations, and ability to make the brochure available to anyone on the trail.

Collectively, these factors convinced many participants, including those who were initially reluctant, to support adoption of QR code technology into the interpretive brochure. Despite initial hesitation, the participants therefore reached the third stage of Rogers' innovation decision process (Figure 1) and came to a collective decision to use the brochure with QR codes.

Discussion

Results of this study advance understanding of conflicting perspectives regarding integration of technology in nature-based interpretive programming, including why those conflicts emerge and how their conflicts might be resolved. Even within a community deeply tied to nature, members could be grouped across a range of Rogers' (2010) innovation adoption categories, illustrating the complexity of views regarding technology use in nature-based interpretative settings. Some members of Hart's Mill could be considered "early adopters" based on their willingness to explore and adopt new technologies, while many members would fall into the "laggard" category when it comes to mobile technologies and their application in nature. Overall, Hart's Mill supported previous work suggesting older adults tend to be hesitant to adopt new technology without obvious benefits and held concerns over user friendliness (Heinz et al., 2013; Vaportis, Clausen, & Gow, 2017). At Hart's Mill, few community members owned smartphones and many viewed their ability to use their smartphones as limited. Members also viewed themselves as an older generation and used in-group/out-group terminology when referring to those younger than them (Stangor et al., 2014). Regardless of adopter category, however, our use of the innovation decision process enabled the community at Hart's Mill to move toward a collective decision to adopt technology use in nature.

Characteristics of the decision-making group and individual variations within adopter category characteristics set the stage for consensus building, allowing for conflicting perspectives to be addressed while moving towards informed and collective decisions. Members also rejected certain underlying socioeconomic assumptions (Rogers, 2003) that early adopters would be younger in age and laggards would have lower economic status and less years of formal education resulting in lower intelligence and literacy rates. These deviations in education levels and economic well-being support increases in one's willingness to adopt new innovations by increasing self-confidence, risk-taking behaviors, and receptiveness to novel information among adopters (Wejnert, 2002).

Wejnert's (2002) study on adopter characteristics also explains how Hart's Mill's social and governing style allowed them to act as a small collective entity with high rates of interpersonal communication and social interactions. Such factors likely increased their willingness to adopt innovations and expedited their rate of adoption compared to other contexts where individual decision making is the norm. Additionally, participants' social equivalence, network connectedness, and interpersonal relationships aided in their willingness to adopt new technology (Wejnert, 2002).

Our study demonstrated how iterative, community engaged interpretive planning can help build consensus around technology use and selection and adoption of "best fit" technologies, particularly when highlighting perceived usefulness and ease of use. Both the DOI and TAM models suggest that technologies with high usefulness and ease of use are more readily adopted than more complex technologies (Rogers, 2003; Davis, 1989; Scherer, Siddiq, and Tondeur, 2019). For example, Lai et al (2013) utilized the TAM method to evaluate teachers' willingness to accept and adopt QR codes in outdoor settings, showing that the ease of use and usefulness of QR codes had a positive effect on teachers' willingness to adopt them in the future. At Hart's Mill, participants quickly saw the extended educational benefits of the QR approach, which allowed for a deeper level of engagement with topics of interest for visitors who chose to pursue that kind of free-choice learning. Gates (2019) highlighted similar benefits, noting how technology can provide digital opportunities for visitors to engage with and learn from the interpretive program that extend beyond the site itself. The creation of two brochures, one with and one without QR codes, allowed for Hart's Mill members to experience the benefits of having the QR codes before making a final decision. It also allowed for a more confident decision by reducing the risk of adopting new ideas, which can increase the rate of adoption through trialability and observability (Rogers, 2003).

The marriage of technology with high quality interpretive principles could also help to explain adoption in this context. Studies show that mobile devices can increase learning in informal settings when implemented as educational tools avoiding oversaturation of technology (Crawford, Holder, & O'Conner, 2017; Crompton & Burke, 2018; Eliasson et al., 2011; Kacoroski, Liddicoat, & Kerlin 2016). This supports the notion that technology implementation must be done carefully and strategically. We used the TORE process (Ham, 2013) to determine the type of interpretive medium, identify the intended audience, create a core theme reflecting the community's goals and values, and locate relevant interpretive markers along the trails. This process helped create a mentality receptive to potential adoption and facilitate the diffusion of innovation process.

Lastly, throughout the innovation-decision process, participants were introduced to QR codes multiple times and were given multiple demonstrations on how they were used. Studies show that the rate of adoption increases as the novelty of an innovation decreases and familiarity increases (Wejnert, 2002). While this study concluded with the decision stage to adopt the QR codes, the final stages of Rogers' innovation decision process (implementation and confirmation) will occur as Hart's Mill uses the brochure and receives feedback from both community members and visitors. This feedback and evaluation could be used to inform future use of the QR-coded interpretive brochure or development and design of related products that may or may not incorporate technology.

Conclusion

Social trends suggest that technology will continue to increase, impacting both the time humans spend in nature and the interpretive programming designed to foster human-nature connections. Interpretive efforts must adapt and respond to these changes (for example, see InterpTech 2019). But how might this process be facilitated when many cringe at the notion of videophilia technology-mediated experiences in nature (Pergams & Zaradic, 2006)? Our analysis of the interpretive planning exercise at Hart's Mill demonstrates that individuals within the laggard category should not be discounted when it comes to technology integration, especially when a larger community network exists with diverse perspectives that could facilitate behavior change. Understanding where people are on the DOI spectrum should influence the choice of technology, leading to solutions that are compatible with the users' needs and abilities. While people may enter with polarized views regarding nature-based technology, the TORE planning process can help people see how specific technologies might be best integrated to achieve consensus and advance interpretive goals.

Future research opportunities could use a similar process to encourage technology-mediated interpretation, even in situations where initial opposition is high. The Hart's Mill example shows that many technology-resistant individuals may change their minds towards adoption if the DOI and TAM approaches are effectively integrated with interpretive best practices. Although our study focused on a small group of community members, other sites may consider implementing similar processes with larger groups of visitors - in addition to the planners and managers - to gain a broader understanding of people's preferences, attitudes, and concerns regarding the use of technology in nature-based interpretive programs. We focused on QR codes, but other technologies such as virtual reality, mobile apps, geocaching, or phone-guided tours could be more appropriate in different contexts (Crawford et al., 2017). Careful consideration of both adopter (e.g., age, ability) and innovation attributes (e.g., perceived usefulness, ease of use) will help inform efforts to integrate technology into nature-based programming without negatively impacting the educational experience. Such an approach could help open space managers, nature-based interpretive planners, and program leaders bridge generational gaps, augmenting existing experiences and creating positive educational opportunities for everyone regardless of their affinity for technology.

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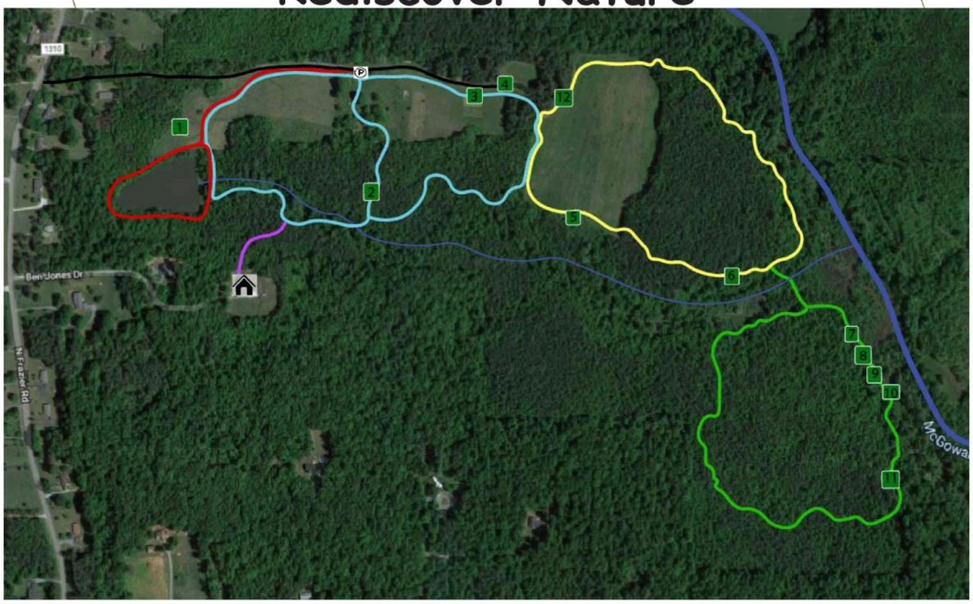
Appendix A

Hart's Mill Environmental Interpretive Brochure with Technology Implementation

Take the Path Less Traveled and Rediscover Nature



Hart's Mill strives to live in partnership with the land through sustainable management practices. This interpretive nature walk takes you through different ecosystems to help you understand what the land has to offer and what is being done to help it towards regeneration. Each marker will touch on a different aspect of nature to provide a holistic view of the interconnectedness of Hart's Mill.

1 Save the bees!

Here are some of our resident pollinators who help the crops, flowers, and trees grow. Honeybees rarely sting so if you see one flying by, don't be afraid! If you want to learn more about NC bee-keepers, scan the QR code with your mobile device!

2 Under the Bridge

This stream is fed by the water coming from the pond and water drained on the land. That is why the community has to be careful about where to build the village and other management practices to prevent any unwanted pollution. A treehouse and children's play area are to be built here.

3 Farm to Table

Annual and perennial vegetables and herbs are produced here to sustain and sustained by the Hart's Mill community. Low-impact, sustainable, and regenerative practices are used to restore the land back to full health. Use the QR code to learn more about our farming goals and practices.

4 The Pump House

This building was created by hand using clay and straw with a technique called "slip-straw". This is where a solar-powered pump pulls water from our community well. It is also being used for drip-irrigation on the farm!

5 Pretty Invaders

Invasive species such as Japanese Honeysuckle and Chinese Privet out-compete native species and take over. Here you can see the privet growing extensively and the Japanese Honeysuckle climbing up trees, cutting off nutrients and water flow. To learn more about invasive species, use this QR code!

6 Creating a Beaver Pond

Humans aren't the only ones who can change the landscape and sometimes you have to adapt because of it. This pond was created by beavers damming up streams and rivers. The ponds protect the beavers and other animals from predators like coyotes.

7 Bird Box Challenge

Shhh.. Above the water, there is a box where aquatic birds such as wood ducks make their home so they can nest. If you are quiet, you may be able to see them or hear their calls.

8 Carolina Slate Belt

Hart's Mill is located within the Carolina Slate Belt. This is a region where volcanic rocks were deposited on or near the surface and then metamorphized (altered due to extreme heat or pressure). This process results in rocks similar to this rock, which breaks into flat slates. Use the QR code to learn more about slate geology!

9 Who is Who?

Here are four large, but different hardwood trees. Can you figure out which is which by their leaves?

10 Wetland Engineers

Here is our local beaver dam! Beavers are known to completely alter their environment from forest to wetlands making the entire ecosystem to change with it, making them a keystone species. To learn more about keystone species, scan the QR code!

11 Forest after Fire

Moving away from the dam, you can see how all the pines are the same size and the thin hardwoods are crowded. This is how a forest grows back after a disturbance event, like forest fires. You can see evidence of this through the burned logs along the trail and in the forest.

12 Cob Haven

This cozing retreat was created in the same way as the Pump House by volunteers. Inside, a rocket mass heater was installed, which is a unique piece of furniture that also serves as a wood heater! Stained glass, windows, and rocket stove create a whimsical haven.