Understanding HCI in Nature through Inductive and Deductive Research

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Abstract
Introducing interactive computing in nature changes the human experience of being in nature. These changes are both significant and not well understood. Fortunately, the computer-human interaction (CHI) research community has developed a set of research methods for understanding interactive computing in specific settings. In this paper, we divide CHI research methods into inductive and deductive methods and describe how each have been applied to the study of interactive computing in nature. We give examples from recent published work. Careful application of both inductive and deductive methods will lead to new and important insights into how interactive computing can enhance, enable and detract from the experience of being in nature.

Keywords 1
Research methods, nature, interactive computing.

1. Introduction

Introducing interactive computing into nature changes the experience of both being in nature and interacting with a computer. Understanding the impact of interactive computing on the experience of users in nature is a difficult problem with vague questions and, perhaps, unexpected factors. In this paper, we argue that the CHI research community is well-positioned to conduct research that generates deeper understanding of HCI in nature from the perspective of people who use computers while in nature. It would be a pity to preserve a physical setting we call "nature" only to have the experience of being in such a place ruined by the use interactive computing systems that diminish the experience of being there.

Understanding HCI in nature is particularly important during the COVID pandemic. In some parts of the world, such as the United States where we live, more people have found themselves outdoors in nature more frequently and in many cases bring a smartphone or other device as a companion. Understanding the experience of HCI in nature will help designers image systems that enhance and enable positive outdoor experiences rather than detracting. Understanding this impact is important because people often benefit from time in natural spaces.

1.1. What is "nature"?

First though, we develop a definition of what we mean by the term "nature". When we think of being in nature, we think of being outdoors in a place where natural processes dominate the experience. In this definition, nature is a kind of outdoor setting but not all outdoor settings are in nature, or natural. For example, standing on the corner of a busy intersection in a crowed city would not be considered "being in nature".

Proceedings of the NatureHCI 2021 workshop, co-located with the CHItaly 2021 conference, July 12, 2021, Bolzano, Italy.
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In this paper, we take the position that "being in nature" means being in places where evidence of natural processes dominates. For example, being in a forest is often being nature because tall trees, shrubby undergrowth, small creatures and noisy insects dominate the experience. However, being in a city is often not being in nature because, in most cases, human processes such as traffic noise, buildings and paved sidewalks dominate the experience. On the other hand, city parks are often in nature because natural processes dominate many urban park settings—even if those processes are manicured or cultivated by people.

Our definition of nature is different than Kaplan and Kaplan's classic definition in their seminal work on the experience of being in nature [1]. In their definition, nature is a space "where plants grow." Kaplan and Kaplan list parks, abandoned fields, backyard gardens and street trees as examples of nature. Our definition is different in that we include other natural process beyond plant growth such as animal life, erosion, weather and other natural processes. For example, we call standing in a field of sand dunes a natural experience even though no plants may be visible. We also require that natural processes dominate the experience rather than being a small part of the experience. In our framing of nature, a city tree growing in a sidewalk next to a busy road surrounded by tall buildings is not a nature experience because natural processes are present but do not dominate the experience. In this sense, the human-built environment is only called "nature" if natural processes (such as plants growing) appear to dominate the scene.

1.2. Understanding interactive computing in nature

Given that nature is a setting where natural processes dominate the experience, what does it mean when interactive computing enters nature? It could be that interactive computing enhances and enables these experiences or it could be that interactive computing degrades these experiences. It is likely that the actual impact is more nuanced than such a simple either/or proposition.

Progress has been made in understanding how interactive computing impacts the experience of being in nature. Several workshops over the past few years have brought together HCI researchers to discuss results and frame questions [2-5]. We recently assembled a collection of papers that capture much of this work in a single volume [6]. However, much progress remains to be made.

Fortunately, the HCI research community has developed techniques for formulating and eventually answering questions related to interactive computing in specific settings. These techniques have been used to understand interactive computing in nature, but we more work is needed. We divide these techniques into inductive and deductive methods. Inductive methods involve collecting data and then inductively defining themes or hypotheses from that data. Inductive work is often subjective and situated in a constructivist framework. Inductive work can, among other things, identify what hypotheses to test. Deductive work starts with a hypothesis and collects data to support or refute that hypothesis. Deductive work can include studies that describe an activity, establish a relationship or establish causation. Deductive work often includes objective analysis of data and is framed in a post-positivist setting.

In this paper, we highlight the utility of HCI research methods in nature by highlighting several examples of inductive work, deductive work and work that combines both. Our intent is to inspire addition research that leads to deeper understanding of HCI in nature.

2. Inductive research

We begin with a two examples of inductive research methods for HCI in nature. Inductive research involves gathering data and building a theory or hypothesis directly from that data [7] such that hypotheses emerge bottom-up from the data. Inductive research involves constructing meaning from data and is often discussed in terms of constructivist epistemology [9] in which truth arises from our engagement with the world in our social and historical context [8].

When studying interactive computing in a new domain, such as nature, inductive methods can be a good starting point because these methods allow the researcher to collect data through observation, interviews and other means and then to identify important themes or concepts in the data. The themes

or concepts that arise from the data can be influenced by the authors' experience and background. Inductive work can lead to hypotheses which are later tested using deductive methods.

The first example involves walking around Wales and the second involves experiencing the rural in the west and Midwest of the United States. While these two studies both use the methods of self-observation, that is not the only method that can be used in an inductive study. Other methods for inductive research include interviews, observation, and surveys.

2.1. A walk around Wales

From mid-April to the end of July in 2013, Alan Dix walked around the country of Wales in what he called a "perambulatory" research project in order to understand issues at "the margins" of society [10]. Much of the walk took place in nature between towns and cities. Dix writes that "the 'results' of this are as much questions as answers." Research that ends with questions can be important when studying technology in a new context.

Completing the walk involved traveling 1700 km by foot. The walk involved sleeping at bed and breakfasts in towns along the way or in a campervan which was used as a base vehicle. Dix wrote journal entries during the walk, spoke with other people he encountered along the way and collected an extensive set of biometric data using a variety of sensors. He asked other walkers about the technology that they used.

As a research project, "the walk held an open agenda, looking for fresh questions and issues that arose along the way." Dix approached the research with "ontological subjectivity" in which meaning arises subjectively from one's own experiences and the experiences of others. A specific purpose of the walk was to understand information technology issues of other walkers and local communities. The practice of walking for multi-day long distance travel spans many centuries. Dix' project begins to explore how information technology impacts this pursuit.

Based on his experience during the walk, Dix identifies several issues that relate to HCI in nature. First, it is difficult to use handheld touch screen devices in damp and cold conditions. In these conditions, devices with physical buttons were more reliable and easy to use because they could be navigated using touch alone. Second, poor network connectivity renders some apps useless. For example, Dix reports that Twitter failed to load or send Tweets in low connectivity situations while email worked more reliably, just slowly. Perhaps because email was designed "from the outset for slow and often intermittent networks."

2.2. Experiencing the rural in the Western and Midwestern United States

Su writes about the rural based on his background in the West and Midwest [11]. While we hold this work up as an example of inductive research, this work does not follow the usual pattern of collecting data, reflecting on the data and then coalescing the data into a set of themes. Instead, Su explicitly "invites the readers' active, generative engagement" of the text. In our writing about Su's experiences, we point out several questions involving interactive computing and nature. Other readers will draw other questions from his experiences.

Su writes about his personal and professional experiences in two geographic areas. First, his experiences in the San Martin valley in California, United States. The San Martin Valley is a rural community south of San Francisco. Second, experiences in rural area of Indiana. These experiences are presented as a series of 39 short vignettes written in third person. Su writes about himself in third person to "remove authorial authority."

Nature appears in Su's experiences but is not the focus. Our discussion of his work will make inferences that extend beyond his text. Compared to his writing, our inferences put more focus on interactive computing and nature than appears in the text. We will be clear about what is Su's experience but the boundary between his writing and our inferences is left ill-defined.

Hunting, guns and animals appear in Su's experience more than they appear in the body of HCI research. For whatever reason, CHI research ignores guns and hunting as part of the experience of being in nature. In one experience, interactive computing and hunting clash. Hunting is allowed until sunset and "Bob's smartphone tells him it is sunset." However, someone points out that the sun is still up.

Perhaps an overreliance on technology leads people to miss situational cues in nature—such as the sun being up in the sky. Technology could have mediated the government regulations that govern this experience in nature but failed to correctly report the time of sunset.

Su describes dove hunting, deer hunting, field dressing a carcass, and learning shooting safety. In all of these, interactive computing is missing. Perhaps because Su omitted those details or perhaps because interactive computing is simply missing. What is the role of interactive computing in hunting? Are their ethical boundaries related to animal welfare? Are their biological issues related to wildlife management? Are there social issues related to preserving mastery of a difficult skill while making that skill more approachable to novices?

A short footnote to the last of 39 experiences raises a complex issue. In the footnote, Su refers to Finney and writes "the outdoors is frequently radicalized as white." This footnote appears as part of an experience related to race and stereotypes. What is the role of race and nature? As interactive computing enters the experience of nature, how will that impact marginalized races who often lack access to both interactive computing and nature?

3. Deductive research

Unlike inductive research, deductive research begins with a hypothesis and "deductively test[s] the hypothesis" [7, p. 17]. The scientific method is a kind of deductive research in the "researcher begins with a theory" and then "collects data that either supports or refutes the theory" [9, p. 6]. Based on the results, the researcher may revise the theory and conduct additional tests.

The hypothesis can describe a phenomenon, establish a relationship between two phenomena or establish a causal relationship between two phenomena [12]. A challenge in deductive research is formulating the hypothesis. Inductive research can help identify which hypotheses are worth testing and which are not. In this section we present a recent example of deductive work in the context of interactive computing in nature.

3.1. Children, mobile phones and time in nature

Kawas et al. carried out a study to determine if a mobile application could get children to spend more time outside [13]. Results from studies like this can increase confidence in relationships between interactive computing and nature. To answer this question, they built a mobile app called NatureCollections (NC) that supported children building and sharing photo collections. They used NC in a 3 week deployment in which 28 children participated in the study. 15 children used the NC app and 13 used a basic photo app. The study was carefully designed to reduce confounding factors. As part of the study, children and their parents kept a diary of time spent outside. The diary was kept before children starting using either app in order to establish a baseline. The diary was also kept during 2 weeks of using the app in order to measure the impact of the app on time spent outdoors.

Statistical analysis of the time spent outside for each group of children during each time period showed that children in both groups spent similar amounts of time outside, 2 hours and a few minutes, *before* the intervention. Interestingly, children in the group who used the NC app spent more time outdoors *during* the intervention than before and children in the group who used the standard photo app spent about the same amount of time outside *during* the intervention.

These results suggest that the NC app did get children to spent more time outside. However, a single result from a deductive study should often be applied narrowly to the context in which it was carried out. Additional studies in other settings may further strengthen this result and may also suggest other factors to consider. For example, conducting the same study during monsoon season in a tropical climate may produce different results. Similarly, conducting the study with children from a population with different socioeconomic factors may also produce different results.

4. Conclusion

The experience of being in nature is an important part of the human experience. As interactive computing becomes part of these experiences, it is important to understand the impact of interactive computing on being in nature from the perspective of people who use computers in nature.

The study of interactive computing use in nature will likely uncover new and important relationships. The CHI research community has developed a set of research methods that are well-suited for studying these questions. Open-ended inductive methods can help determine what questions to ask or hypotheses to test. Carefully executed deductive methods can be used to test hypotheses. Said another way, inductive methods help us ask the right questions and deductive methods help us generate credible answers.

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