COMMUNICATING GLOBAL CHANGE: USING DIGITAL MEDIA FOR ENVIRONMENTAL EDUCATION

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This dissertation investigates experiments in innovative digital media narrative production processes and distribution mechanisms within the overarching context of environmental education. Three studies have been written and presented as three separate chapters. The first chapter, "Producing Real-World Problem-Based Environmental Education Videos," outlines experiments in developing a production process using digital video to tell stories that put the narrative power in the hands of communities confronting environmental challenges. It describes a methodology for video production that is a hybrid of traditional and participatory models of production. The second article, "Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge,*" experiments with using the web as a mechanism to exchange knowledge between students and practitioners working to protect critical environmental resources. Applying an authentic learning model within a web environment, *ConservationBridge* provides multimedia case studies to students and connects them directly to practitioner through practitioner led real-world problem statements. Tested and evaluated in 12 classes at Cornell University (N=159, 100% response rate), results indicated that the system was capable of increasing student motivation, understanding, and sense of self-efficacy while providing valuable information for practitioners. The third article, "Communicating Local Climate Risks Through Downscaled Climate Projections,"

represents experiments with coupling new web-based mapping technology with novel climate projection downscaling methods. A map-based visualization was produced and housed at ClimateData.US. The goal of the system was to reduce the proximity of perceived climate risks by showing local-scale projected impacts. Results of tests at Texas Tech's College of Media and Communication with undergraduate students (N=46) indicated that the site was successful in altering beliefs and attitudes about climate change.

BIOGRAPHICAL SKETCH

Jamie Herring is a digital media architect and environmental educator. Prior to attending Cornell, he received his M.A. in Sociology from the University of Ottawa and his B.A. from the University of Western Ontario.

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CHAPTER 1. INTRODUCTION

The stories we tell ourselves about who we are and what our world means affect how we feel and, ultimately, how we act. They inform how we understand the world, provide meaning to our lives, and help guide us personally and collectively through our choices and actions.

Stories shape how we see the world and, in turn, dictate how we shape it. They can compel nations to marshal billions of dollars and lives in support of war. In a speech before the United Nations, Colin Powell outlined a story of Saddam Hussein's weapons of mass destruction program, a narrative supported by the national media that provided public support for war (IPA, 2013). Stories can galvanize a collective identity. James Adams' (1931) story of the American Dream of a "better, richer, happier life for all our citizens of every rank" (p. 13) helped shape public policies and economic practices for generations (Cullen, 2004). Stories can shape how we consume and why we consume them. Corporations now see the most value not in the products they produce but the stories around the brands they use to sell them (Aaker, 2012). Stories can also alter how we transform our environment. For the Dongria Kondh of India, stories told about the Nyamgiri mountain range as the foundation that upholds the Earth was in direct conflict with an ecosystem services narrative that attempted to value its monetary worth. This narrative about the mountain's sacredness overcame that of money, leading to its protection from bauxite mining (Temper & Martinez-Alier, 2013).

Stories also shape the world inside us and, in turn, dictate how we shape ourselves. As Gottschall (2012) states:

> An average daydream is about fourteen seconds long and we on average have two thousand of them per day. We spend half our waking hours—one-third of our lives on earth—spinning fantasies. We daydream about the past: things we should have said or done, working through our victories and failures. We daydream about mundane stuff, such as imagining different ways of handling

> conflict at work. But we also daydream in a much more intense, story like way. We screen films with happy endings in our minds, where all our wishes—vain, aggressive, dirty—come true. And we screen little horror films, too, in which our worst fears are realized. (p. 8)

An increasing number of psychologists argue that this type of internal narration gives meaning to people's lives by allowing them to construct and internalize self-defining stories (McAdams et al., 2006). Narrative cohesion has become a marker of psychological health, as a person's ability to coherently narrate their life story provides the basis for identity, thereby allowing for the formation of unity and purpose (McAdams, 2001). The self, it is argued, comes to terms with its place in society through the stories it tells itself. These stories inform our outlook and our feelings about who we are, and they guide our life choices (McAdams, 2008)

In short, stories are powerful.

Digital media over the past two decades have transformed how we create, share, and consume stories. Digital media have decentralized both their production and dissemination. Amateur personal stories, focusing on the self, told through text, pictures, and videos have proliferated through blogs, social media, and video sharing sites (see Lundby, 2008). Education has been transformed with the promise of breaking down traditional institutional barriers and providing access to new communities (Van Dusen, 2014). Digital video has allowed new forms of expression and the distribution of ideas in a form that was once too expensive to be within the public's grasp (Block, 2014). The explosive growth of information and communication technologies as a mechanism to not only produce but also distribute digital content has increased the capacity of content producers to reach ever-larger audiences more cost-effectively and with increasingly sophisticated forms of information (Hammill, 2013).

What differentiates digital media as a concept is that it is not one thing, such as a camera or a computer. The concept of digital media represents all forms of information and communications technologies that leverage electronic technology to generate, store, and process data in terms of strings of 1's and 0's. As such, digital media itself is a fluid concept, as the creation of new technologies that leverage the digital are constantly being produced and upgraded and the applications of these technologies constantly developing. Digital media, therefore, provides a fertile landscape of ever-evolving tools and applications with which to create and test new forms of storytelling.

The dual idea that stories can be powerful motivators and that digital media provides a rich world of tools with which new storytelling approaches can be produced and tested is at the heart of this dissertation.

The three chapters[1] presented here represent attempts to experiment with digital storytelling forms and distribution mechanisms within the context of environmental educational. The first chapter, "Producing Real-World Problem-Based Environmental Education Videos," outlines experiments in developing a production process using digital video to tell stories that put the narrative power in the hands of communities confronting environmental challenges. The second chapter, "Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge*," experiments with using the web as a mechanism to exchange knowledge between students and practitioners working to protect critical environmental resources. The third chapter, "Communicating Local Climate Risks Through Downscaled Climate Projections," represents experiments coupling new

[1] This dissertation is presented as five chapters. Chapters 2 through 4 have been produced as draft articles for eventual publication in peer-reviewed journals.

web-based mapping technology with novel climate projection downscaling methods. An overview of the three articles is presented here.

Producing Real-World Problem-Based Environmental Education Videos

Video has been used for decades as a tool for education. The effectiveness of video as a teaching tool is well documented; video has been shown to improve learning outcomes and motivation by potentially introducing context, nuance, and multiple perspectives to a topic (Kay, 2012). The use of case studies has also grown in education. They too have been shown to be effective compared with traditional textbook learning by placing a student in a real-world environment to help them understand the importance of working in an interdisciplinary setting, process, and context (Foertsch et al., 2002; Kardash & Wallace, 2001). In environmental education, the use of both videos and case studies has grown as well. Solutions to the world's most pressing environmental problems require a workforce trained to understand the interdisciplinary nature of environmental issues. Thus, video-based case studies are a promising approach to environmental education, as they can situate students in the context of the real-world problems they will likely face in the workplace.

A challenge, however, presents itself when producing videos that link environmental concepts and theories to real-world problem situations. As environmental challenges involve human communities, the production of video-based case studies requires the involvement of members of the community in which the problem situation exists. This necessitates sensitivity to issues of visual representation, collaboration, and the need for mutual benefits between educators and the communities or members that are being represented. Furthermore, the concept of 'community' itself is a social construction (Suttles & Suttles, 1972) within which homogeneity of actors rarely exists. Thus, the choice of who is represented, and how, becomes an important consideration in the production of video. These considerations are not present in educational videos that simply describe technique, concepts, or theories. Real-world environmental education videos must do this as well, and they must do so within the context of depicting communities. Representing communities and distributing these representations to audiences outside these communities is fraught with potentially contentious difficulties (Braden, 1999).

The key storytelling challenge presented in this chapter, therefore, is how to create a video production method that places the narrative and representation power in the hands of the communities being depicted while still incorporating key environmental concepts that can serve the educators. Over the course of three years, a production method was created to do this. Part of a National Science Foundation (NSF) funded project called *ConservationBridge* and tested in undergraduate course at Cornell University, this production method is a hybrid of traditional documentary making and participatory video. This chapter situates this hybrid production method within the context of participatory video, explores three videos created using the process, and provides results of their effectiveness in a classroom situation.

Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge*

Academic institutions have historically been criticized as ivory towers disassociated from the world outside their boundaries (Etzkowitz et al., 2000). Despite this potentially unfair characterization (especially with universities that have a land grant mission), academia has undertaken various measures to break down the barrier between its walls and the 'real world' through various technology transfer programs, internships, and work exchanges. This is particularly important for applied disciplines that have social, economic, or environmental change as the basis for their existence. Conservation science is one such discipline. Conservation science has been defined as a 'crisis discipline' (Pullin, 2002; Wilson, 2002) where success is "measured not only by the quality or quantity of scientific work produced but also by the degree to which it helps conserve biodiversity" (Niesenbaum & Lewis, 2003). As such, education in the field of conservation science needs to produce an array of professionals capable of addressing this complex problem.

As conservation science education necessitates a connection to action, education in this domain requires that concepts and theories taught in the classroom be understood in their applied context. This is a challenge for several reasons. Academic learning has historically focused on teaching concepts and theories. This approach neglects the development of other skills such as problem solving, interpersonal skills, and teamwork skills (Bransford, et al., 1990; Brown, et al., 1997; Herrington & Oliver, 2000). Second, academic institutions have a long history of a strict mono-disciplinary focus and departmental silos. However, multiple disciplines must be integrated into conservation science in order to guide action (Easterling & Polsky, 2004; Force & Machlis, 1997; Lambin, 2005; Liu, et al., 2007; Machlis et al., 1997; Pfirman, 2003; Turner, et al., 2003; Young et al., 2006). Third, while conservation science itself is a global issue, species loss happens within local contexts and within human–ecological systems. Thus, it is critical to teach local forms of knowledge alongside Western scientific knowledge (Kassam, 2008). Therefore, conservation education requires novel approaches to academic education (Niesenbaum & Lewis, 2003).

An attempt to address this challenge is described in this chapter. The concept of authentic learning was applied to multimedia case study development within a web environment in order to create and distribute stories relevant to students and their future practice. Authentic learning is defined as an educational strategy that focuses on embedding students within a real-world framework that exposes them to complex problems (Lombardi, 2007). These learning environments are inherently multidisciplinary, as "they must bring into play multiple perspectives, habits of mind, and ways of working within a community" (Lombardi, 2007). While taking students on global field trips to understand the local contexts of various conservation science projects in action would be an ideal 'authentic learning' vehicle, this is out of reach financially for most students. Thus, *ConservationBridge* was built.

ConservationBridge is a storytelling platform conceived to leverage the web to virtually connect students to field locations and practitioners around the world through multimedia case studies. Its goal is to provide authentic learning experiences by connecting students to locally specific conservation projects and the people involved in them. This chapter explores the pedagogical framework within which *ConservationBridge* is situated and the surveyed results of its use with students, educators, and conservation practitioners.

Communicating Local Climate Risks Through Downscaled Climate Projections

While the vast majority of climate scientists agree that global warming is occurring, the general public perceptions of both its existence and causes are less robust. In the United States, only 66% of the population believe it is real, and less than half believe it to be caused by humans (Leiserowitz et al., 2014). Changing beliefs, understandings, and attitudes about climate change is key to mitigating and adapting to climate change (O'Neill & Nicholson-Cole, 2009). The narratives that we as a collective use to understand what is happening to the Earth's climatic systems must change as human perceptions of climate change reflect the level of public concern and motivation to act (Swim et al., 2010) and play a central role in mobilizing public engagement (Moser & Dilling, 2011).

Climate change, however, is a notoriously hard topic to communicate. Many climate communication researchers in the academic community argue that one of the most problematic issues involves the lack of spatial and temporal proximity in relationship to its risks (Freidman et al., 1999; Morgan, 2002; Slovic, 2000; Weber, 2006). Greenhouse gas emissions are not visible, and their impacts occur only as a result of aggregate emissions over time and space. Their impacts are also diffuse in the sense that they are felt not as an immediate consequence but rather as a series of events distant in both space and time. This is a problem for action on climate change, as human beings have a processing bias toward proximate threats, those that are concrete and immediate, over those that are conceptual, distant and abstract (Weber, 2006). Climate change communication, thus far, has been unable to reduce the proximity of risk to more local and personal levels.

A promising approach to solving the issue of lack of proximity is to rely on web-based interactive environments in which people can see what the impacts of climate change might be at a local scale that is meaningful to them (Sterman, 2011; Weber, 2006;). In order to communicate future risk, climate communication relies on climate projections. A climate projection is a scientifically informed “statement about the likelihood that something will happen in the future if certain influential conditions develop” (WMO, 2015). Led by a group of climate scientists, NASA launched a downscaled projection data set in early 2014 that provides climate projections for the continental United States at a resolution of 800 meters (about a city block). To test whether the use of these projections could be useful in narrating risks at local scales, NASA created a big-data mapping technology to transform these raw data files into visualizations. The resulting web-based interactive visualization allows users to navigate to locally specific areas to see the differences in temperature and precipitation change for their communities. This chapter seeks to test whether a tool specifically designed to address the issues of proximity can result in changes of understanding, beliefs, and attitudes about climate change.

The three chapters presented here all grapple with how to produce and share stories around environmental issues. The first article focuses on process and how to create production methodology that gives the narrative control of a storytelling vehicle (video in this case) to the communities the stories are about. The second chapter is about making stories that are relevant to the audience consuming them in order to better educate them and motivate them to enter the field of conservation science as a profession. The third chapter is about making stories out of complex data to render the climate change narrative more personally relevant. There is a saying in the digital design industry that 'the ink in digital is never dry.' Each of these chapters illustrates how the digital medium was used as a mechanism for the production and distribution of the stories being told. As all of the products described in these chapters are digital themselves, they too are works in progress and hopefully not 'dry.' These chapters, therefore, are intended to be snapshots in time that provide insights into the motivations behind their production and tests of their efficacy. It is hoped that, with luck, the products and methods described here will also continue to evolve and improve, and in so doing, contribute in some small way to improving the environmental condition of the planet.

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CHAPTER 2. PRODUCING REAL-WORLD PROBLEM-BASED ENVIRONMENTAL EDUCATION VIDEOS

Introduction

Over the past decade, there has been a boom in the production and use of educational videos both inside and outside of classrooms. While the use of video is not new in educational settings, the proliferation of available videos has grown as a result of web-based distribution and access. There are plenty of examples. *Khan Academy,* a website that uses short, descriptive videos to teach students in an array of disciplines, sees over 5 million first time users a month. *iTunes University,* which posts video lectures, has seen over 600 million downloads since its inception. *Lynda.com,* a web-based tutorial center for learning software, features over 1,200 video tutorials and has revenues of over $70 million a year. Online educational videos not only are popular, but are also big business.

Considering the educational benefits that video has to offer, it is not surprising that educators in many disciplines are trying to learn how to leverage its use in their classrooms. The effectiveness of video as a teaching tool is well documented (Kay, 2012). Research has shown that video can increase learning by allowing students to better prepare for class (Bennett & Glover, 2008), by increasing students' motivation to learn, and by providing easily accessible resources for students to reference (Fernandez et al., 2009; Foertsch et al., 2002; Wang et al., 2010).

As an educational tool, case studies have also been shown to be effective compared to traditional learning techniques at the undergraduate level, with their characteristic strong emphasis on memorizing facts (Foertsch et al., 2002; Kardash & Wallace 2001). Aikenhead (2006) argues that such learning techniques do not allow students to absorb course content meaningfully or to establish its relevance to everyday thinking. In contrast, the use of case studies in education employs actual or realistic problem situations to provide students with opportunities to engage with various sources of information in real-world contexts (Dori, Tal & Tsaushu, 2003; Herreid, 1994; Lundeberg, Levin & Harrington, 1999). A study conducted by *The National Center for Case Study Teaching in Science* (2006) reported that students who attended classes that used case studies demonstrated improved critical thinking skills, developed a stronger understanding of course concepts and their practical application, were able to make connections between multiple disciplines and content areas (Roth, 2006), and developed an enhanced awareness of historical and contemporary social issues (Hess, 2007). Faculty members observed that students exposed to case studies were notably more engaged in lectures, actively participated in class discussions and group work, and developed stronger peer relationships (Yadav et al., 2007).

Not surprisingly, case studies have become a central component of many environmental education courses. Environmental education in the 21st century must train future decision-makers to understand the complex nature of the environmental problems they will face. Solutions to biodiversity loss, to the degradation of ecosystem services, and to climate change necessitate the forging of links between social, political, and economic forces, making the subject inherently interdisciplinary (Kassam, 2008; Lewis, 2003). This is the essence of the growing discussion of “coupled” natural and human systems (Easterling & Polsky, 2004; Force et al., 1997; Lambin, 2005; Liu et al., 2007; Machlis et al., 1997; Pfirman, 2003; Turner et al., 2003; Young et al., 2006). Furthermore, human communities outside of traditional academic boundaries must also be brought into the fold, as the main causes of biodiversity loss, ecosystem degradation, and climate change are unsustainable development activities. Therefore, the behaviors underlying them must be understood and changed (Stedman-Edwards, 2000). The use of case studies for environmental education has therefore become an important component of post-secondary courses, as case studies provide students with real-world examples of how complex variables intersect and of what trade-offs need to be made.

Considering the documented effectiveness of both videos and case studies in the classroom, combining the two approaches into a coherent educational package seems like a promising approach to environmental education. The use of video in case study education could potentially offer students an even richer understanding of complex environmental problems than either tool could on its own. Videos are uniquely suited to demonstrating factors that cannot be shown in the classroom, such as historic events, geographically remote locations, or multifaceted environmental issues (Hess, 2007). A video-based case study could offer students the opportunity to compare their theoretical knowledge of an environmental issue with a visual representation of a practical scenario related to that issue (Stoddard & Marcus, 2012). Through the combination of reading and writing materials with video resources, students are likely to engage in class discussion and deliberation and to form critical opinions on complex environmental topics (Fisher & Fray, 2011). Video also appeals to visual learners and to those who digest information through a variety of mediums. It may also motivate students who are disinclined to read by offering them a visual representation of course material and encouraging them to probe their interest further (Fisher & Fray, 2011). Moreover, video's inherent tendency to invite debate and conversation is likely to generate class discussions marked by a flurry of opinions and perceptions that can build critical perspectives and encourage the consideration of divergent opinions (Stoddard & Marcus, 2012).

However, producing videos that depict key environmental concepts and theories and link them to real-world problem situations is a complex challenge. It requires the involvement of members of the communities in which given problem situations exist. This necessitates sensitivity to issues of visual representation and collaboration, and to the need for mutual benefits for educators and for the communities (or community members) being represented. Furthermore, the concept of 'community' itself is a social construction (Suttles & Suttles, 1972) within which homogeneity of actors rarely exists. Thus, the choice of who to represent and how to represent them becomes important in considering how best to represent communities as wholes. These considerations are notably absent from videos that simply describe techniques, concepts, or theories. That said, in order to produce the required learning outcomes for students and in order to be incorporated into curricula, real-world problem-based videos also need to be explicitly linked to such techniques, concepts and theories. Furthermore, they need to be produced within a budget range that is feasible within educational constraints.

In consideration of these complexities, this chapter focuses on a video production method developed over a three-year period as part of a National Science Foundation (NSF)-funded project called *ConservationBridge* (see chapter 3) which was tested in undergraduate courses at Cornell University. This production method, a hybrid of traditional documentary filmmaking and participatory video, was created specifically within the context of educational video production, in which budgets are constrained, community relationships are important to maintain, and educational outcomes on complex topics are required. This chapter considers this hybrid production method in the context of participatory video, explores three videos created using the process that was developed, and provides results of their effectiveness in a classroom situation.

Case Study Video Production

Over the past decade, with the cost of video production and editing equipment decreasing, participatory video has grown as a recognized methodology for the creation and development of videos that represent communities. Participatory video is defined as a “group-based activity that develops participants abilities by involving participants in the creative use of video equipment to record themselves and the world around them and to produce their own videos” (Shaw & Robertson, 1997, p. 1). Participatory video is less about the final product (the video) than about the process itself and the learning that participants gain from it: “In good practice, the technology becomes a mode for directing the attention of participants, rather than an audience, and activities revolve around” the needs of participants (Nemes et al., 2007, p. 9).

In this way, participatory video is closely related to participatory research methods. Barreteau et al. (2010) define participatory research as a method that “relies on stakeholder inputs to obtain its acclaimed benefits of improved social relevance, validity, and actionability of research outcomes” (p. 1). Born out of the post-modern critique of traditional social science methods, participatory research aims to bring the community being studied into the research process in terms of defining the goals of the research, the definition of problem statements, and the activities involved in the acquisition of knowledge (Barreteau et al., 2010). This is a direct reaction to the positivistic paradigm of social research that assumes that data can be gathered from a rigorous empirical position external to the community of study and that explanations of social behaviors can be constructed based on this data to reveal fundamental truths (Mertens, 2009). In contrast, participatory methods place the object of study in the central location of observer. The community being observed participates in all aspects of the research, including the formation of research questions, methods, writing, and reporting. In some cases, the community collaborators are also involved in reflective work on how the notion of the community itself is being constructed through the process of research (Whyte, 1991). According to the practitioners of this method, such involvement allows researchers to gain community access and insights that cannot be gleaned from direct observation or inference (Tolman & Miller, 2001). As tools for facilitation and direct community involvement, participatory methods emphasize the process itself as a mechanism for bringing a community together (Fraser et al., 2006).

The discourse around participatory video follows a similar line of argument, pitting its production methods against traditional documentary filmmaking in the same way that participatory research pits its methods against traditional, empirical research. The comparison is apt. Traditional documentary filmmaking, like traditional research methods, is focused on product rather than process (a video in the case of traditional documentary filmmaking and a journal article or report in the case of empirical research). Participatory filmmaking, in contrast, is intended to put the tools of production into the hands of community members, with a focus on the process of filmmaking as a means of bringing a community together to create policy solutions (Fraser et al., 2006). Nemes et al. (2007, p. 9) state: “Given that most filmmakers are habituated to the need to make good quality films, and academics to address their constituencies with what looks like good quality research, there is often a tension between technical and social competencies, which is expressed in the literature on participatory video in terms of discussions about product and process.” Participation is therefore distinguished from non-participation, as the participatory method’s focus is on the benefits gained by engaging a community within a production process rather than on the technical and storytelling quality of a final product, potentially at the expense of the interaction with the community (Shaw & Roberston, 1997). These differences are highlighted in Table 1.1.

According to practitioners of the participatory video method, its focus on process yields a number of benefits for the community, including self-reflection, improved group communication about issues facing the community, increased cooperation, and improved group decision-making skills, among others (Buchanan & Murray, 2012; Lunch & Lunch, 2013).

Table 1.1. Difference Between a Traditional Documentary and Participatory Video (adapted from Huber, 1999)

	Traditional documentary	Participatory video
Who shoots the video?	Documentary maker	Community members
Who writes the script?	Documentary maker	Community members
Who decides on content?	Documentary maker	Community members
What constitutes the audience?	Mass audience	Community, policy makers
What feedback is expected?	Mass audience, documentary distributors, television channels	Community members
What is the focus (process or product)?	Product	Process
What is the overriding paradigm behind it?	Objectivity, self-expression by the filmmaker	Pluralism, self-expression by the community

In the context of creating real-world problem-based environmental education videos, there is much that can be learned from participatory video in terms of ensuring community benefits, maintaining strong relationships with key community members, and safeguarding the community's representation to external groups. However, for several reasons, this focus on process presents limitations when creating educational videos.

First, while those producing educational videos that represent a community need to be cognizant of the community itself and how it is represented, educational videos must also be product-focused and fulfill the need to educate an audience. Thus, educational video producers need to balance the concerns of the community with the need to produce final products that are comprehensible and engaging for students. This delicate dance is further complicated by the fact that communities themselves are rarely homogeneous, and that the way a community is represented to the outside world can have tangible benefits for some actors over others. For those making educational videos, a balance needs to be struck by ensuring a multitude of community influences while remaining cognizant of time and financial constraints. Furthermore, educational video makers need to ensure that key concepts, theories, and learning outcomes that are tied to course work are embedded in the content of the videos. This is important so that the videos can easily be worked into curricula and lesson plans. This need can create tensions between what a community, or specific members of that community, perceives as a value for the video and what educators perceive as a value for their teaching.

Second, film and video have their own visual language that speaks to different cultures in different ways (Larkin, 2008). While such differences in visual expression can themselves serve to relay information about cultures, these differences can also serve as barriers to communication, much as differences in oral language can. One only needs to look at the differences between Hollywood and Bollywood productions to see how radically different audience expectations can be for story, editing structure, and visual language. Putting control of story structure and production style in the hands of a community may mean that key concepts and theories can be lost in translation. The experiences of the community must be represented in a way that can translate that experience into a form that the audience can relate to and engage with.

Third, participatory video is both time- and resource-intensive. For participatory video to work, key members of a community need to be given the training and equipment to produce videos. Facilitating and training community members to the point at which they have the technical skills to produce a quality product can take months. If the focus of the video is on the process, such an investment may well be worth it. However, in an educational setting where budgets and time are tight, this approach can be prohibitive (Mistry & Berard, 2012).

Audience is a much more important consideration for educational videos than for participatory videos and, as such, the final product itself needs to be more controlled. At the same time, the critique of traditional documentary filmmaking implicit in participatory video methods makes an important contribution to educational filmmaking. Community partners need to be empowered in the process of filmmaking, and need to contribute to production in order to ensure that their perspectives are properly represented. Thus, environmental case study videos involving communities need to focus both on the process and on the product and the students who are its main audience.

The Hybrid Approach

Considering this dual objective, as well as the constraints of time and funding that shape the production of educational videos, a hybrid approach was developed that balances the interests of three key sets of participants in the production: educators, filmmakers, and community members. This approach borrows methods from traditional filmmaking and participatory video in order to ensure a process that can empower community members and ensure that their voices inform their representation, while also ensuring that the final product can be useful within an educational context. This hybrid approach brings these three key sets of stakeholders into a production process within which each can contribute at various stages before the final product is completed. It is important to repeat here that communities themselves are rarely homogeneous. While valuable in any ethnographic representation of a community (video or otherwise), community consensus on how the community is to be represented is difficult to attain within the financial constraints of educational video production. To attain such consensus, months would have to be spent in the field, working with all community members to produce scripts and storyboards, and in post-production, ensuring that all community members approve of the edits. With the hybrid approach that was developed for *ConservationBridge*, a video is produced in conjunction with community leaders and depicts them as the main characters of the film. Thus, the final production is less a complete representation of the community as a whole than a representation of the prominent community members who partook in the production process.

With this in mind, the process works as follows.

Each stakeholder is given an equal amount of power and shares the roles of writer, director, and producer. Nine stages of production are outlined, which provide opportunities for feedback from each of the stakeholders. At each of these stages, the filmmaker is given the first opportunity to produce the specific deliverable associated with a particular stage, allowing the rest of the team to provide feedback and guidance. The process does not proceed to the next step until each of the stakeholders has agreed, thus ensuring equal control for all participants. This process and the deliverables associated with each stage are outlined here:

Stage 1: Determine Audience, Terms of Work, and Educational Outcomes: All parties involved in the video production need to agree upon the overarching educational level of the audience, anticipated educational outcomes, and key concepts and theories that need to be included and linked. Further, the tangible benefits the community is to receive from its engagement need to be agreed upon.

Stage 2: Treatment: A treatment is an overview of the main goals of the video; it provides a framework for the general story, characters, themes, and concepts that need to be present in the video. This treatment is shared with the educational and community partners for feedback

Stage 3: Script: After the treatment is accepted by all team members, a script is produced. This script provides a more comprehensive narrative than the treatment does. The script includes parts that can be used for voice-over and provides the overarching narrative structure that will guide production. This script is shared with the educational and community partners for input and feedback.

Stage 4: Production Plan: This stage provides a detailed production plan and includes a schedule for all interviews and all locations where footage needs to be shot based on the agreed-upon script.

Stage 5: Production: This stage is the execution of the production plan in order to capture all details laid out in the production plan and script.

Stage 6: Review of Footage: Once footage is captured, it is reviewed by all team members. Ideally, this happens on a daily basis so that production can be adapted during the process to incorporate feedback from both educational and community partners.

Stage 7: Final Script: A revised script is produced that more accurately represents the captured footage. Again, this is shared with all partners for feedback.

Stage 8: Rough Cut: A rough cut of the video is produced based on the final script. This provides team members with a final opportunity to provide feedback.

Stage 9: Final Cut: All the final feedback is incorporated into the video and the final video is exported.

Methods

This hybrid approach was implemented to produce three educational videos in collaboration with Cornell University (the educational partner), HabitatSeven (the video production team) and local community leaders in Alaska and Tajikistan. These locations were chosen based largely on access to community leaders by the main educational partner (Dr. Karim-Aly Kassam at Cornell University). Human–ecological systems was the main overarching conceptual framework that needed to be conveyed in the videos. These locations were thus also chosen because they exemplified close links between human and ecological systems. Dr. Kassam worked closely with the video production team in order to ensure that concepts related to the human–ecological framework were tightly woven into the video's narrative structure. Anticipated learning outcomes for students included a better understanding of the human–ecological framework and of the importance of multidisciplinarity in environmental conservation after engaging with the videos.

Three videos were produced within this context. The following describes the context for why these specific locations were chosen, how the community partners were selected, the benefits they received, and what the intended learning outcomes were.

Video Case Study 1: Climate Change, Food, and Sharing among the Iñupiaq of Wainwright, Alaska

Context: The *Iñupiaq* of Wainwright, Alaska are facing unprecedented social, economic, and environmental change. They have developed a system of ecological and social relationships with the animals and plants in their habitat; these relationships are necessary for their subsistence livelihoods and thus for their survival (Kassam et al., 2011). Kassam et al. observe:

> Although indigenous peoples of the Arctic have contributed little to the causes of climate change, they are among the first to feel its effects. Climate change threatens subsistence livelihoods by increasing the variability and unpredictability of wind, currents, and formation of sea ice. Changes in sea-ice jeopardize the safety of hunters and their access to marine mammals; and therefore, sources of food. (Kassam et al., 2011)

One of the *Iñupiaq's* most important activities for sharing resources and strengthening community relationships is called a *Nalukataq*. The *Nalukataq* is a festival based on the equal distribution and sharing of meat from successful Bowhead whale hunts. The festival is seen by the *Iñupiaq* of Wainwright as the central cultural event that defines who they are as a community and as the main mechanism through which critical protein is shared among community members.

While this festival has continued over millennia, the *Iñupiaq* community of Wainwright is facing unprecedented social and environmental upheaval as a result of climate change and the growth of offshore oil exploration within its traditional territories. The sea ice is critical to the Bowhead whale hunt, as whales are hauled onto ice floes where they are cut into pieces that can be transported back to the community. Without sea ice, the Bowhead whale cannot be hunted, and without the whale, the *Nalukataq* cannot take place. Thus, with sea ice projected to vastly shrink over the next 70 years (Stroeve, 2012), the community is concerned that *Iñupiaq* subsistence practices and cultural survival are at stake.

Community Partner and Benefits: The Wainwright Traditional Council was the main community partner in this collaboration as they had been long-time collaborators with Dr. Kassam and, therefore, provided access into the community. The council is made up of community elders and leaders with a mission to maintain their traditional culture and to lobby for their rights and interests as indigenous people. The council's members wanted to produce a video that they could use to show their potential partners (including oil and gas companies) the important role that the whale hunt plays in their cultural survival and well-being, and to produce a visual medium to document the process of the *Nalukataq*. It was therefore agreed that 500 DVD copies of the video would be delivered to the community after it was completed. John Hopson, a local whaling captain and member of the Wainwright Traditional Council, was selected to be the main collaborator to work on behalf of the council and to be the main character in the video.

Educational Learning Outcomes: After watching the video, students were expected to 1) understand the connections between environment and culture through the whale hunt and the sharing festival, 2) explain how sharing is integral to the health and sustainability of the community, and 3) describe how climate change is impacting the community's environment and culture.

Video Case Study 2: Nurturing Knowledge: Plant Biodiversity and Health Sovereignty in the Pamir Mountains

Context: The people of the Pamir region of Tajikistan and Afghanistan have withstood an incredible amount of social and economic change over the past centuries. The Pamir Mountains are a remote region at the intersection of China, Pakistan, Tajikistan, and Afghanistan. This location made the Pamir Mountains a strategically relevant area for the 'Great Game' between czarist Russia and England during the early part of the 20th century, a staging ground for proxy wars between communist Russia and the US and its Western allies (Hopkirk, 2006), and, more recently, a region heavily impacted by the US war on terrorism and the war in Afghanistan (Kleveman, 2004). These conflicts not only have destabilized the region politically, but also have left the region cut off from health care services, medicine, and medical facilities. Because of this isolation, medicinal plants and the knowledge of their use have played a central role in maintaining the health of these communities during times of social and economic upheaval. The keepers of knowledge of plants and their medicinal uses are called Tabibs. Tabibs are community healers who were banned from their practice while Tajikistan was under Russian communist control. Today, they work closely with Western medical facilities to develop treatments that use medicinal plants. Tabibs are also responsible for the care and protection of these plants, thereby conserving the plant biodiversity of the area.

Community Partners and Benefits: Two community partners invested in this project, the University of Central Asia and the Aga Khan Foundation. As with the video case study in Wainwright, Alaska, they were chosen because of a preestablished relationship between them and Dr. Kassam. The partners wanted to produce a video that could help explain to governments and funding agencies the importance of plants to the health sovereignty of the Pamir region and the crucial role of the Tabibs in identifying and protecting medicinal plants and in preserving regional biodiversity. Shozodaev Bozicha, a leading Tabib in the area, was nominated to be the main community partner, the main point of contact, and the main character in the video as he was the most willing to take time off from his practice to participate.

Educational Learning Outcomes: After watching the video, students were expected to 1) understand the connections between environment and culture through the use of medicinal plants, 2) explain how knowledge of plants and their uses are connected to their protection, and 3) explain the concept of health sovereignty within the context of the Pamir Mountains.

Video Case Study 3: Protecting the Sacred: Conservation of Three Sacred Sites in the Pamir Mountains

Context: In the Pamir region of Tajikistan, the sacred is physically embodied in sites embedded in the ecological landscape. These sacred sites, called Mazars, have been used, revered, and protected for centuries. Kassam (2012) observes, "The one constant about these sites over millennia is that they have witnessed constant socio-cultural and ecological change" as a result of centuries of war. However, despite the upheavals associated with these conflicts, Mazars have endured. Not only do Mazars embody the sacred beliefs of the local communities, but the rules that protect them as sacred places have also served to conserve important natural resources both within and surrounding the Mazars. Passing down knowledge of these rules is the job of local Khalifas who are both religious advisors to their communities and stewards of the Mazars.

Community Partner and Benefits: The University of Central Asia was the main partner on this project. Members of the environmental research community at the

University who were working closely with local religious leaders wanted to produce a video that could help explain the importance of sacred sites and rituals in the maintenance of healthy ecosystems in the Pamir region. Upon its completion, the video was shown to the Academy of Sciences of the Republic of Tajikistan, the highest scientific body in the country, in order to help present to its members the importance of cultural diversity in the maintenance and protection of ecological systems. A group of six different Khalifas were identified and approached by the University of Central Asia to be the main community spokespeople and characters for the video. Of those six, three were willing to participate: Orifshoev, Muborkqadam, and Yodgor.

Educational Learning Outcomes: After watching the video, students were expected to 1) explain how sacred sites function as mechanisms for bringing communities together, and 2) describe how human–ecological systems function to protect ecological features.

What follows are descriptions of three case study videos explaining how the pertinent theoretical concepts were woven into its narrative structure.

Video Production Outcomes

Video Case Study 1: Climate Change, Food, and Sharing among the Iñupiaq of Wainwright, Alaska

The final video depicts the events of the Nalukataq, a sharing festival in which the family that has led the whale hunt divides up the whale meat and shares it with the rest of the community. It follows the seven days leading up to the Nalukataq through the eyes of John Hopson, the whaling captain responsible for organizing the successful whale hunt.

The video can be viewed here: <https://vimeo.com/20972666>. The following provides a written description of each of the major sections in the video as noted by the time stamp in minutes:seconds.

(00:00–01:22): In the video introduction, John Hopson, his family and his community are introduced. The concept of sharing is relayed, as are some of John's concerns about climate change. The Nalukataq is described and introduced as an important part of the cultural matrix that makes up the Iñupiaq community in Wainwright, Alaska; this explanation helps to define the human–ecological connections at a theoretical level (see Figure 1.1).

Figure 1.1. Video still of whale meat being shared.

(01:23–02:23): The second part of the video geographically situates Wainwright, Alaska and the importance of whale hunting for the community. Particular attention is paid to whaling as a tradition that has been passed down for generations and to the dividing and sharing of whale meat as a central component of the Nalukataq (see Figure 1.2).

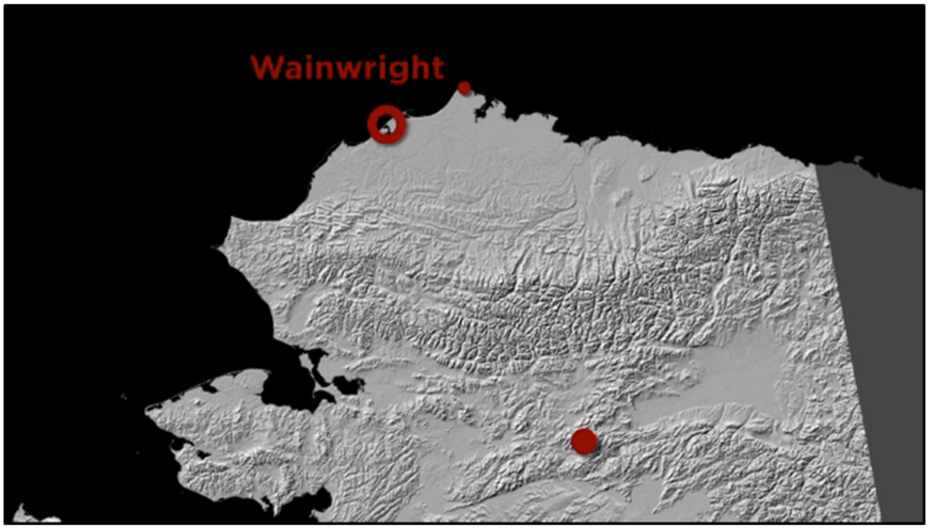


Figure 1.2. Video still situating Wainwright, Alaska.

(02:24–12:21): The body of the video takes the viewer through the preparations for the Nalukataq. These preparations include taking the whale meat out of the cellars and cutting it up for sharing, preparing other food, selecting an event location, and creating a blanket made of bearded seal skin for the blanket toss. Finally, the video shows the Nalukataq festival and the division and sharing of whale meat portions among community members (see Figures 1.3 and 1.4).

Figure 1.3. Video still of community preparing the whale for sharing.

Figure 1.4. Video still of John on blanket toss.

(12:22–13:11): At the end of the video, John narrates his feelings about the Nalukataq and reiterates the importance of the whale hunt to the preservation of community traditions and to ensuring the generational continuity of traditional knowledge. The human–ecological concept is therefore reinforced during this section by connecting the health of the community to the whale hunt in the past, present, and future.

Video Case Study 2: Nurturing Knowledge: Plant Biodiversity and Health Sovereignty in the Pamir Mountains

Description of Final Video: The final video depicts Shozodaev Bozicha, a local Tabib who works out of a hospital in Khorog, Tajikistan. The video follows Shozodaev as he treats a patient for a kidney problem and searches for plants to create medicine. Along the journey, viewers are introduced to the history of medicinal plants in the area and the intersection between plant knowledge and the conservation of biological resources.

The video can be viewed here: https://vimeo.com/42819213. The following provides a written description of each of the major sections in the video as noted by the time stamp in minutes:seconds.

Video at 02:18: The introduction to the video introduces Shozodaev Bozicha, a Tabib in the Pamir Mountains of Tajikistan, then introduces Tajikistan and provides a brief history of the social, economic, and environmental upheavals it has faced over the past century. The introduction continues by providing an overview of what a Tabib is, how medicinal plants are used, and why such plants are important in the health context of the mountain peoples of Tajikistan and Afghanistan. In this section, the connections between the human and the ecological are clearly laid out (see Figure 1.5).

Figure 1.5. Video still of a medicinal plant and its uses.

(02:19–10:28): The body of the video follows Shozodaev as he meets with a patient to discuss his prognosis from a Western doctor regarding his kidney ailments. Shozodaev explains how Western doctors and Tabibs work together within the hospital system to help their patients. The video then follows Shozodaev into the field

to gather the plants needed to create a treatment for his patient. Shozodaev explains the importance of medicinal plants to his culture and to the health sovereignty of the Pamir people, and the importance of maintaining knowledge of the plants in order to protect the plants themselves. He returns from the field to create the medicine and provides it to his patient upon his return (see Figure 1.6).

(10:29–12:00): The video ends with a discussion of plants as both food and medicine. Specifically, it focuses on how the plants of the Pamir region and the knowledge of their use continue to thrive because people like Shozodaev have tended to their care. Knowledge of plant use is given primary importance in local conservation; by proxy, the role of Tabibs in acquiring and passing down this knowledge is positioned as a critical link for biodiversity protection. Finally, the video states that loss of knowledge about plants imperils not only the plants but also the health sovereignty of the Pamir people; thus, the interconnections between human and ecological systems are reinforced (see Figure 1.7).

Figure 1.6. Video still of Shozodaev in the field (bottom right).

Figure 1.7. Video still of Shozodaev sharing medicine with a patient.

Video Case Study 3: Protecting the Sacred: Conservation of Three Sacred Sites in the Pamir Mountains

Description of Final Video: The final video portrays three different Mazars and introduces the Khalifas, the stewards that protect the sacred sites. Through interviews with the Khalifas and documentation of various rituals associated with the Mazars, the video shows how the rules surrounding the maintenance of the Mazars serve to protect important natural resources while building a sense of community and stability for local people.

The video can be viewed here: https://vimeo.com/45028053. The following provides a written description of each of the major sections in the video as noted by the time stamp in minutes:seconds.

Video at 00–02:19: The introduction to this video begins with a discussion of the concepts of ‘sacred’ and ‘profane’ as discussed in the sociological literature. The argument is made that what human cultures decide to protect are the rituals, objects, and places they consider to be sacred, whereas the rituals, objects, and places that are considered to be profane are less likely to be protected in times of struggle and conflict. The video then introduces the Mazars in the Pamir Mountains of Tajikistan. Mazars are sacred sites that are used, revered, and protected by the Pamir people due to an ancient belief that they hold spiritual value. Next, the video provides a historical overview of the constant socio-cultural and ecological upheaval that the people of the Pamir Mountains have faced. It further describes how the sacred sites and their associated landscapes have been protected through the work of local Khalifas, whose role it is to pass down knowledge of the sacred sites in order to preserve them. Thus, the human–ecological system is clearly laid out in the first two minutes of the video (see Figure 1.8).

Figure 1.8. Video still illustrating the ecological impacts of human conceptions of the sacred and profane.

(02:20–12:11): The body of the video features three different sacred sites and interviews with the Khalifas who are responsible for their protection. Each sacred site features a different environmental context that is protected by the rituals involving, and the protection of, the site.

(2:21–5:06): The first sacred site to be presented is in the mountainous region of the Roshtqala Valley, where the Khalifa inherited the honor of caring for the area

through a long lineage of religious men. According to the narrative of this site, Imam Muhammad al-Baqir, a significant religious figure in the area, emerged from a cave inside the Mazar's structure centuries ago, revealing miracles to the village and leaving behind angels that visit every nightfall. The video introduces the site and the daily ritual of lighting a fire to ensure that the angels know how to find the location. Interviews are done with Muborakqadam, who explains the site's sacredness, the importance of its protection, and the surrounding habitat and the rules that are in place to protect it (see Figure 1.9).

Figure 1.9. Video still of Muborakqadam lighting a fire in the Mazar.

(05:07–08:38): The second sacred site is located in the Gund Valley, where the Mazar is located alongside a sacred stream. According to oral tradition, the village of Gund was besieged by despair and disease a thousand years ago. One of the villagers sought guidance in front of a cave. Imam Muhammadi al-Baqir emerged from the cave and showed the villagers miracles that began to heal them. Imam Muhammadi al-Baqir then re-entered the cave and fresh water began to flow. The video follows Akbarsho Orifshoev as he prays with local elders and explains the importance of the

stream both for religious practice and for survival, as it is the only water source for the entire village. The video also shows the ecological context of the stream and the surrounding trees, which constitute the only forested area in the valley. The video then argues that the stewardship of this Mazar over centuries has ensured the protection of the stream and the forested area that surrounds it (see Figure 1.10).

Figure 1.10. Video still of the sacred stream in the Gund Valley.

(8:39–12:11): The third sacred site is in Langar, which is home to a Mazar under the care of Yodgor, another Khalifa. The Mazar is home to the tomb of ShohQambari Oftobi, a holy man that lived in the village over 10 centuries ago. The video follows Yodgor and the rituals he enacts as he enters the sacred site. He first lights a fire and prays. Local village women enter the site with bread and butter. Yodgor then enters the main tomb area and spreads butter over the horns of the Marco Polo sheep heads that guard the temple and mark it as a sacred space. The fat from the butter also provides food for birds that flock here daily during the ritual. After the ritual, an interview is conducted in which Yodgor and his apprentice show the old-growth trees in the Mazar, which are thousands of years old and are the only examples

of such trees in the region. The two men discuss the rules for the protection of the trees, which are considered to be a sacred part of the tomb, and the important role that the Mazar plays in bringing community stakeholders together and maintaining cultural tradition (see Figure 1.11).

Figure 1.11. Video still of Yodgor honoring the tomb of ShohQambari Oftobi.

Figure 1.12. Video still of Yodgor (bottom right) leaving the Mazar.

(12:12–13:41): The video ends with an overview of how sacred sites continue to exist as a result of communities' belief in their significance. In the Pamir Mountains, the sacred and ecological aspects of these sites are intertwined and the protection of the sacred sites also protects the environmental integrity of the areas surrounding them (see Figure 1.12).

Educational Outcomes

Once the videos were completed and shared with the communities to meet the agreed-upon obligations, the videos were presented in a course at Cornell University taught by Dr. Karim-Aly Kassam, the main educational partner in the production of the videos, in order to determine if the production method yielded the desired educational benefits. The videos were incorporated into an upper-year interdisciplinary course entitled "Ways of Knowing: Indigenous and Local Ecological Knowledge," which was cross-listed among the Departments of Natural Resources, American Studies, and American Indian Studies. The class was divided up into three groups. Each group was shown one of the three videos. An open-ended survey was provided to students (N=41) after viewing the video to determine how well key human–ecological concepts were learned. Additional questions were provided to determine how important this learning was to students by using student motivation, self-efficacy, and impact on future course choices and career development as proxies for the impact the videos had on students (see Table 1.2).

Table 1.2. Open-Ended Survey Questions

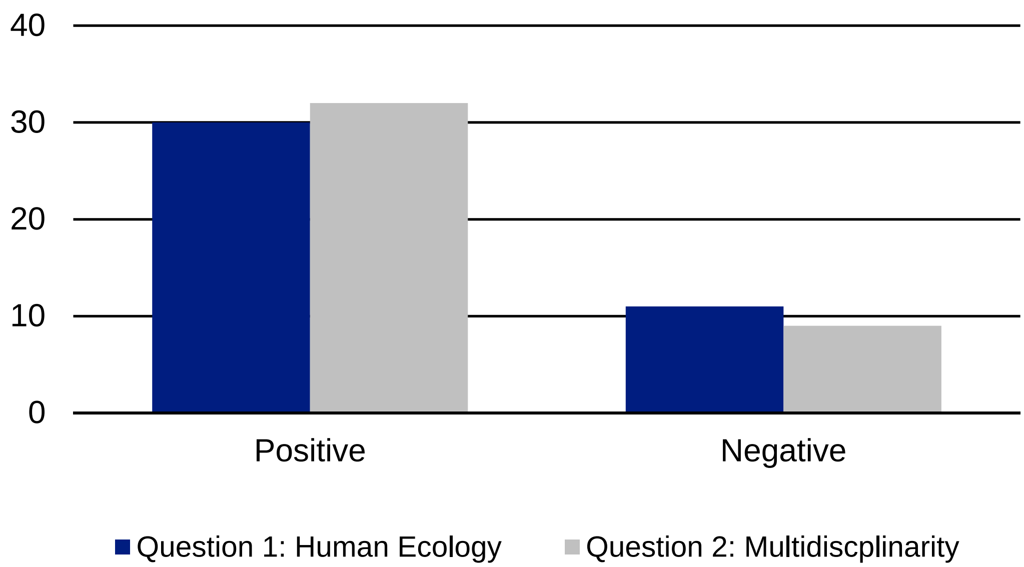
Framework	Open-ended questions
Understanding	1. In what ways did this film help you understand human ecological (i.e. socio-cultural and ecological) systems?
	2. Give an example of how this case study required a multidisciplinary approach?
Motivation/Self-efficacy	3. Were you more motivated to learn about human ecological issues from this case study than from reading similar information in textbooks and journal articles? Explain.
	4. Do you feel more confident in your ability to consider human ecological topics? Explain.
Career development	5. How will this case impact the courses you will select in the future?
	6. How has this case helped you prepare for your career?

The following presents the results broken down by their framework categories.

Understanding

For the two understanding questions, each of the 41 surveys was analyzed using thematic codes. For question 1, a content analysis (Neuendorf, 2002) documented whether students were able to identify the interconnection between human and ecological systems portrayed in the video. Where students were able to identify interconnections, responses were recorded as positive. Where students were unable to identify interconnections, responses were recorded as negative. For question 2, a content analysis documented whether or not students connected various disciplines to the context of the video. Responses in which students were able to identify various disciplines were recorded as positive. Responses in which students were unable to identify various disciplines were recorded as negative (see Figure 1.13).

Figure 1.13. Responses to understanding questions.



For question 1, 30 of the 41 students were able to identify interconnections between human and ecological systems in the videos. Example responses included:

> "The film illustrated the importance of medicinal plants as a mode of healthcare within the Pamir Mountains. It is obvious that the role of medicinal plants exceeds their cultural importance for it provides various societal benefits. Moreover, there is a clear ecological connection between the medicinal healers and the environment. The Pamir people must first obtain a profound knowledge of their environment in order to identify plants and their medicinal purposes. The role of medicinal plants is an important link between the people, as well as between the people and the land."

> "The imagery is integral to humanizing the content of the film. It can be written about, but ultimately this is one of the more powerful ways to shift people's framework from frontier to homeland. I like that the film followed one guy (and his family and friends) who was preparing the festival for his community. Through his story we are able to experience his human ecological relationships with more senses. Even almost taste and smell with all the imagery of food. Through the value and example of sharing we are able to better understand his human ecological relationships. Comments about climate change from elders powerfully illustrated how a locally adapted, complex, self-sustaining culture is threatened by climate change."

For question 2, 32 of the 41 respondents were able to convey how the content in the video required a multidisciplinary understanding. Example responses include:

> "This video was multidisciplinary because it incorporated the cultural aspects of the community in multiple ways such as their whale hunt, the festival, etc. along with scientific aspects of climate change."

> "The interaction between community members, and the dynamic that results from a whale hunt represents the socio-cultural aspect of the human ecological lens, and the dynamic between the whale and the community represents the ecological component of this lens."

> "The ecology of the area and plants is necessary for carrying out health services, but there is also a history that must be acknowledged because it shapes the way the health system operates."

Motivation/Self-Efficacy

For the motivation/self-efficacy questions, each of the 41 surveys was analyzed. A positive answer was scored as a yes and a negative answer was scored as a no. For question 3 (motivation), 38 of the 41 respondents claimed that the videos did provide more motivation to learn about human–ecological issues. For question 4 (self-efficacy), 32 of the 41 respondents claimed that the videos increased their confidence in terms of considering human–ecological topics. Five respondents claimed that the video did not increase their confidence and 4 respondents did not provide an answer to this question (see Figure 1.14).

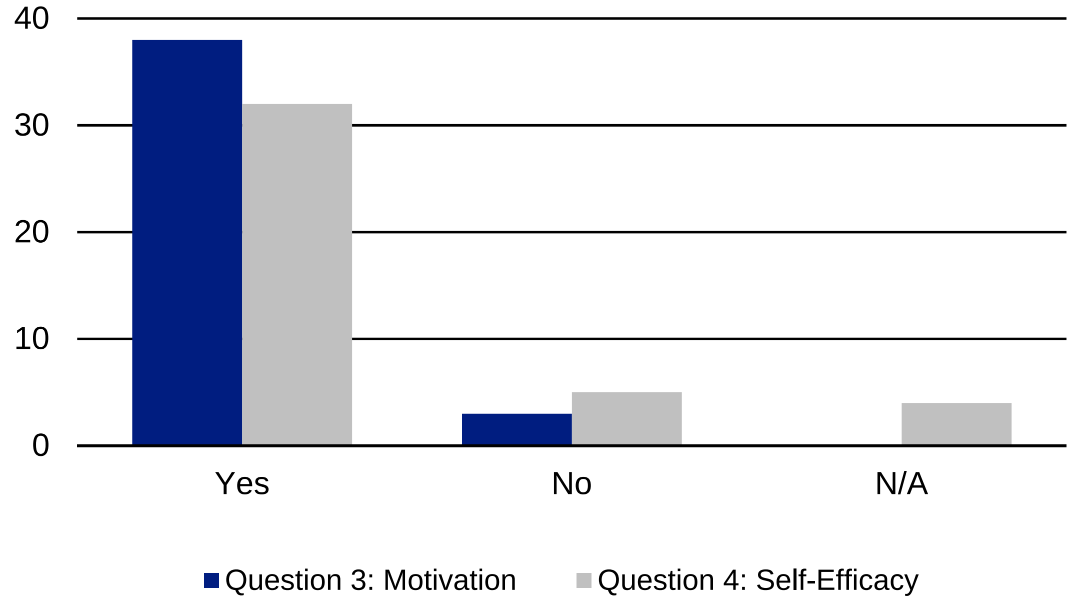


Figure 1.14. Responses to questions of motivation and self-efficacy.

Example responses included:

> "(It) humanized the subject matter by bringing the content down to earth instead of being abstracted by averages and numbers."

> "It was great to see the faces of the people whose lives are affected by traditional medicine, and who still practice traditional medicine. I think that it is easier for the audience to feel and understand the importance of these medicinal plants to the community. It also creates an understanding and a desire to help conserve these precious ecosystems and plants. Overall, I think that it is much easier to inspire understanding and devotion to a topic once you can connect the audience with the subject of interest."

> "What made the case more motivating?–It gave us a real-world example of the immediate relevance of indigenous ecological knowledge and showed the physical interactions that are engendered between humans and their environment as part of the process of practicing this knowledge."

For the self-efficacy question, sample responses included:

> "It increased my ability to further appreciate the relationship between nature and culture. Climate change is often viewed from the lens of a myriad of incomprehensible quantitative scientific statistics designed to use 'shock and

> awe' tactics to scare the public. Specific examples, like this, that recognize the science but focus on the cultural impacts of climate change help me relate to the issue on a human level and see it from the perspective of people who are seeing the context around them change in ways that threaten their lifestyle and livelihoods."

> "The film made some of the concepts very explicit and more compelling as it humanized some of the readings, but I think I have about the same amount of understanding as I did before I watched the film. It is always helpful to reinforce the concepts however, so I would say the film cemented the ideas I already had through the readings."

Career Development

For the two career development questions, each of the 41 surveys was analyzed and coded. For question 5, answers were coded as positive (will influence future course selection), neutral (may influence future course selection but unsure), negative (will not influence future course selection), or not available (no answer given). For question 6, answers were coded as positive (has helped career development), neutral (unsure if it helped career development), negative (has not helped in career development), or not available (no given answer).

For question 5, 19 respondents mentioned that the videos would affect future course selection, 13 respondents were unsure if the videos would affect future course selection and 5 said the videos would not affect course selection. For question 6, 19 respondents stated that the videos did make them feel more prepared in a career, 10 mentioned that they were unsure whether the videos would help, and 4 responded that the videos would not help them in their career (see Figure 1.15).

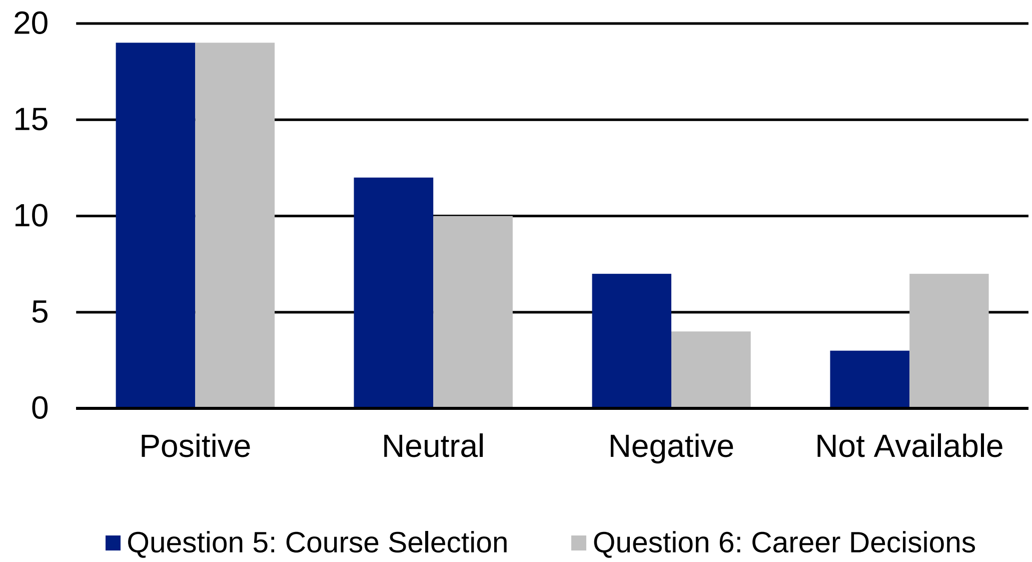


Figure 1.15. Responses to how case will impact future courses and career decisions.

Example responses for question 5 included:

> "I tend to focus on other environmental issues, but I will look for courses that offer other opportunities to learn about communities and their relationships with changes in the environment."

> "I would like to take more courses in the physical sciences specific to climate change in the Arctic and mountain environments. I would also like to take additional courses in sociology and perhaps even anthropology to better understand human culture. As a senior, I may be limited in my final semester. My coursework so far in Natural Resources has been interdisciplinary, and I plan to continue with this approach next semester."

> "It won't since I am a senior and my courses for next semester are already chosen!"

Example responses for question 6 included:

> "I want to help protect endangered species and by working with local communities I may learn there are other reasons to protect an area (like an area that holds important medicinal plants) that will make a conservation proposal stronger."

> “This case has helped me foray into the food systems and agriculture sector, which is an important component of the human dimensions of natural resources. This added understanding of the interconnections of human ecology will help me deal with more complex environmental issues as I embark on a career in environmental policy, planning, and management.”

> “Among the many potential careers that I am interested in, this film definitely pushed me back towards considering research and conservation in this area as an important and viable career. On a broader level, even if I choose to pursue a career in an entirely different direction, it reminded me of the importance of considering issues from multiple perspectives (including the career I ultimately choose)!”

Discussion

In terms of the educational outcomes of the hybrid approach to production, the videos were successful in attaining their set goals. Students were readily able to point to the multidisciplinary objective of the videos and were able to identify how human and ecological systems were connected. The analysis of motivation and self-efficacy shows that a large majority of students reported increases in both areas. Many students reported that the visuals helped achieve these goals by providing human reference points for the concepts and theories that were taught in class. The videos “humanized the subject matter” and provided “real-world example[s]” of the topics that students were studying. This connection to the characters in the films provided a point of empathy for students as it helped them to “relate to the issue[s] on a human level.”

However, students reported fewer positive responses regarding whether the videos helped them in their career development. Although 18 of the 41 respondents where either unsure of the impact or had impact on their future course selection, many students were in their final year of studies and had already chosen their courses, leaving them no room to choose new ones. In regard to how the videos were perceived as helping students to prepare for their careers, a similar response rate was found. Twenty-one of the 41 respondents stated that the videos had a neutral impact or no impact on their career preparedness. While this response was low compared to the other responses, the videos were not created with the objective of influencing career decisions. It is anticipated that if the videos were directly to present available careers related to their content, these benefits would be higher. This is an area for future research.

A notable issue with this study's approach was that most test subjects in the course were upper-year students and the course was an elective. Thus, the group was already self-selected to be interested in the topic and in the content of the videos. It was anticipated, therefore, that the results of showing the videos to the students would be generally positive since the students were already predisposed to be interested in the topic. An additional area of study would be to see whether similar positive results would emerge in mandatory or more broadly focused courses in which students might not have a direct interest in human–ecological systems.

In terms of the community benefits, this method provided tangible products to the participating community members. In the case of Wainwright, Alaska, 500 copies of the video were sent to Wainwright, one for each member of the community. The medicinal plants video in Tajikistan has been used in courses at the University of Central Asia to teach local students about the interconnections between plant knowledge and plant protection. The sacred sites video was shown at the Academy of Sciences in Tajikistan to promote the importance of Mazars in the stewardship of biodiversity.

This being said, issues of representation persist and may be a potential problem of the hybrid approach in general. Granting that communities are heterogeneous, the approach nonetheless pre-selects community partners who are leaders of their communities and focuses on specific characters as a means of understanding the communities, rather than focusing on the communities as wholes. This approach was chosen due to budgetary and time constraints that are inevitable in most video productions. Thus, the videos can only be seen as representations of the communities as seen through the lenses of the leadership within those communities. This limits the generalizability of the videos to the whole communities and may serve to limit dissention or opposing views that may emanate from elsewhere in the communities. In the case of the three videos above, representation of the communities was firmly in the hands of the leaders who participated. As such, the videos cannot be seen as successful representations of the communities as wholes. This was most problematic in Wainwright, Alaska, where the community is divided about whether or not climate change is real—a conflict that the community's leadership did not want to highlight in a public forum such as a video.

Finally, questions remain about the transferability of the results to other classroom settings. While it is important to tightly weave key concepts into the content of the videos, the videos were created to connect directly to Dr. Kassam's course material. This ensured that the videos were easily integrated into the overall course structure, as both the videos and the courses were based on Dr. Kassam's previous work and publications. While this connection created a strong final product, it might limit the use of the videos for courses that are not so tightly linked to the videos from their inception. Future research should be done to determine how effective the videos would be as a teaching tool in courses that are not built around the themes and content of the videos themselves.

Conclusion

The efficacy of video as an educational tool is well documented. With the surge in online video content, the expectations of students regarding the use of video in courses has grown. Video has been shown to improve student learning outcomes, the acquisition of key concepts, and preparedness for in-class discussion and engagement

(Bennett and Glover, 2008; Fernandez et al., 2009; Foertsch et al., 2002; Kay, 2012; Wang et al., 2010). The use of video in courses is, therefore, certainly an educational opportunity ripe for development. The challenge for environmental educators is no longer how to provide students with the means to access video content but rather to gain access to relevant content. In many cases, videos set in specific community contexts that are also tied to key concepts and theories can be difficult to find. This necessitates that educators begin to produce these videos themselves.

The process outlined in this article is a first step toward developing an appropriate production process that can also fit within educational budgets. While far from perfect in terms of community representation, this approach does provide mechanisms for community partners to have a central voice in production. The transferability of the products of this approach merits more research. The videos benefited greatly from close collaboration between the video production crew, the educational partner, and community members. Whether the positive results that were garnered from this one test course can be reproduced in other courses remains unknown. That being said, the approach reveals a promising path toward the production of budget-conscious, real-world problem-based environmental education videos that have tangible results for both educational and community partners.

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CHAPTER 3. BRIDGING LEARNERS WITH PRACTITIONERS THROUGH WEB-MEDIATED AUTHENTIC AND SERVICE LEARNING: THE CASE OF *CONSERVATIONBRIDGE*

Introduction

Conservation biology has been defined as a ‘crisis discipline’ (Pullin 2002; Wilson 2002) in which success is “measured not only by the quality or quantity of scientific work produced but also by the degree to which it helps conserve biodiversity” (Niesenbaum & Lewis, 2003). It is easy to see why. Although biodiversity conservation is difficult to quantify, the Convention on Biological Diversity estimates that between 18,000 and 55,000 species become extinct each year, or 150 each day, or three every hour (Knight, 2012). Along with species diversity, ecosystem services such as fresh water, pollination, and carbon sequestration, which underpin species diversity and human well-being alike, are themselves being degraded at an alarming rate (Díaz, 2005; Scherr & McNeely, 2007).

Due to the sheer scope of the problems facing the planet’s varied species and ecosystems, conservation biology as a discipline needs to be simultaneously locally and globally situated. Substantial research has been done at the local level in order to produce species inventories and understand the impacts of perturbations on ecosystems and their services. At the same time, though, this research needs to be considered within a global context, as threats to biodiversity such as climate change (Heller & Zavaleta, 2009), population growth (Mckee, 2004), invasive species (Dazak et al, 2000), resource extraction (Butt, 2013), and deforestation (Vieira et al., 2008) are themselves international in scope. Furthermore, the habitats of many species do not fall conveniently within political boundaries. Thus, solutions to the world’s biodiversity crisis require a simultaneous understanding of both local and global contexts.

In the face of the immensely ambitious goals of stemming the tide of species loss and revitalizing ecosystems and their services, education in the field of conservation biology needs to produce an array of professionals capable of addressing these complex problems. This presents a number of major challenges for academic institutions.

First, academic learning has historically focused on concepts and theories. According to Negroponte, Resnick, and Cassel (1997), the traditional hallmark of university learning has been the separation of knowing and doing. Studies show that the abstract knowledge on which universities typically focus their educational curricula is not highly useful in real-life problem-solving contexts (Bransford et al., 1990; Brown et al., 1997; Herrington & Oliver, 2000; Laurillard, 2002). The lack of applied context separates learners from the results of their learning, forcing students to focus on facts rather than processes. Alone, however, acquiring the skills to apply one's academic knowledge of conservation in process-focused practical settings in order to develop solutions is still insufficient for balancing the needs and interests of multiple stakeholders. Conservation practitioners also require a strong interpersonal skill set, including the ability to think critically, to communicate effectively both orally and in writing, to participate in group decision making, to persuade others with integrity, to resolve conflicts, to translate science for the lay public, to act with cultural sensitivity, and to work effectively with others in varied socio-political contexts. The academic system continues to lack sufficient emphasis on developing such an interpersonal skill set, though it is necessary in a conservation career trajectory (Blickley et al., 2012; Fisher et al., 2009; Muir & Schwartz, 2009).

Second, academic institutions have historically been criticized for being ivory towers disassociated from the world outside their boundaries. Over the past two decades, much work has been done through various technology transfer programs, internships, and work exchanges to bridge the divide between academics and professionals working in the field. Bridging this divide and enabling students to develop a more practical understanding of conservation are critically important for species preservation. Conservation action requires an understanding of how the concepts and theories taught in the classroom can be applied in the real world.

Third, academic institutions have a long history of strict mono-disciplinary focus and of the resultant creation of departmental silos. However, multiple disciplines must be integrated into conservation science in order to guide the actions required to preserve biodiversity. This is the essence of the growing discussions of ‘coupled’ natural and human systems (Alberti et al., 2011; Easterling & Polsky, 2004; Force & Machlis, 1997; Lambin, 2005; Liu et al., 2007; Machlis et al., 1997; Pfirman, 2003; Turner et al., 2003; Young et al., 2006). As the main causes of biodiversity loss and ecosystem degradation are anthropogenic, human behavior must be understood on social, economic, and political grounds in order to develop appropriate solutions (Stedman-Edwards, 2000). In order to achieve this understanding, students must have an interdisciplinary education that transcends departmental boundaries and allows them to make connections among a range of disciplines.

Fourth, understanding the global context of conservation problems is paramount in addressing biodiversity loss. While the overarching causes of biodiversity loss can be generalized into a handful of categories including climate change, deforestation, resource extraction, habitat loss, and invasive species, the complex political and economic factors that enable such resource degradation must also be understood. A global understanding of biodiversity loss must be informed not only by the direct drivers (e.g., climate change) but also by the indirect drivers (i.e., economics, politics, and policies) that underpin it (OECD, 2005).

Fifth, conservation education must be able to link the overarching causes of species loss at the global level to locally specific examples from around the world. This is an exceedingly difficult challenge within the confines of the classroom. A further challenge to traditional academic pedagogy is the integration of local forms of knowledge such as traditional environmental knowledge into a framework based on Western scientific principles. Local knowledge can provide valuable insights into changes in ecological systems, such as sea-ice change due to global warming (Kassam, 2008), landscape-level ecological changes (Scherr & McNelly, 2007), and shifting species composition (Berkes & Folke, 2002). Furthermore, research practitioners and scholars of human ecology have increasingly documented that subsistence practices not only are compatible with the conservation of biological diversity, but also in many cases actually increase diversity (Harmon, 2001, 2007; Kassam, 2008; Maffi, 2005). Thus, local forms of knowledge are valuable contributors to the advancement of a curriculum that has traditionally been informed by Western scientific knowledge (Bisong & Andrew-Essien, 2009).

For these reasons among others, Niesenbaum and Lewis (2003) argue that these educational challenges are not being met with adequate responses at the undergraduate level: “We need new case studies, readings, assignments, and course structures, coupled with rigorous assessment of the extent to which they promote the skills and knowledge needed by future conservation biologists.” Other scholars support this position, arguing that innovative models to integrate various disciplines into the field of conservation need to be continuously developed and assessed in order to overcome complex obstacles (Focht & Abramson, 2009; Newing, 2010; Spelt et al., 2009).

Taking students around the world on a global field trip to see how the concepts and theories they have learned in class apply to real-world contexts is an obvious but unfeasibly expensive solution to this educational challenge. Thus, *ConservationBridge* was conceived as a way to leverage the web to virtually take students to field locations around the world through multimedia case studies, giving students opportunities to witness local consequences of biodiversity loss as well as local, site-specific conservation challenges. Since 2008, *ConservationBridge* (www.conservationbridge.org) has been tested in classrooms and with field practitioners around the world. This chapter explores the pedagogical framework within which *ConservationBridge* is situated and the surveyed results of its use with students, educators, and conservation practitioners.

Creating Value for All *ConservationBridge* Participants

From the outset of the project, it was understood that three main constituent groups needed to benefit from *ConservationBridge:* students, educators, and conservation practitioners. Students needed an improved learning experience that would allow them to develop applied knowledge of conservation and would provide them with opportunities to develop the interpersonal skills that would aid them in their future career trajectories. Educators required additional teaching tools that would allow them to teach interdisciplinary concepts. Practitioners needed continually improved results from their conservation efforts.

Students: In regard to students, the educational strategy that underlay the development of *ConservationBridge* was supported by recent research on how to motivate students to learn and retain knowledge and to apply and transfer it into other settings (Eison, 2010). Thus, authentic- and service-learning strategies were infused into a web-mediated student experience through multimedia case studies.

Authentic learning is defined as an educational strategy that focuses on embedding students within a real-world framework that exposes them to complex problems (Herrington, 2009; Lombardi, 2007). These learning environments are inherently multidisciplinary, as “they must bring into play multiple perspectives, habits of mind, and ways of working within a community” (Lombardi, 2007). Learned skills include being able to synthesize information, using judgment to distinguish reliable from unreliable sources of information, and having the flexibility to work across disciplinary boundaries to generate innovative solutions (Herrington & Kervin, 2007; Herrington, Reeves & Oliver, 2002). When students are embedded in an authentic learning environment, they are provided with more intrinsic motivation to learn and retain knowledge because they see the direct applicability of their experience to future endeavors.

Service learning calls for a similarly experiential approach to education, but with a tighter connection to the ‘real world’ through the production by students of useful outcomes for communities outside of academia (Butin, 2005; Eyler, 2002; Furco & Billig, 2002). “Service-learning programs are distinguished from other approaches to experiential education by their intention to equally benefit the provider and the recipient of the service as well as to ensure equal focus on both the service being provided and the learning that is occurring” (Furco, 1996). To accomplish these dual goals, service-learning programs must have some academic context and be designed in a way that “ensures that both the service enhances the learning and the learning enhances the service” (Bradford, 2005). These experiences provide a social context in which students can contribute to the practices of a social community.

Herreid (2005) and McDade (1995) have demonstrated that using case studies to educate students fosters critical thinking by employing information analysis to solve complex problems. Problem solving is enhanced through the provision of a rich contextual framework that encourages collaboration and interdisciplinary thinking (Lombardi, 2007). The Internet now offers new opportunities to place students within these real-world contexts in order to provide authentic learning experiences

(Antonova, 2011; Dede, 2009). The way Internet technology is designed for this purpose will, however, determine its effectiveness. Tying online case studies to people working on real projects can generate a deeper level of reality, providing an even greater authentic-learning experience.

Educators: In regard to educators, the main goal of *ConservationBridge* was to provide a series of multimedia case studies that could be used in a variety of classes. Rather than dictating how the case studies should be used, we chose an open-ended approach, leading to the case studies' integration into courses in various ways. This included using case studies as central course materials for full semester courses and using them as supplementary reading materials. The contents of the case studies were interdisciplinary by nature and, thus, intended to be used across different courses and departments.

Practitioners: In regard to practitioners, the goal was to provide useful outcomes of their interactions with students that could provide meaningful contributions to their work. This was a central objective, as significant outcomes for practitioners were viewed as mandatory to ensuring their long-term participation. The advantage that students hold over practitioners is ready access to scientific literature from university resources such as journals and periodicals. Students may also have direct access to faculty members and academic experts in the field. Thus, the vision for *ConservationBridge* was that students could work on scientifically relevant questions posed by practitioners in 'consultancy' roles through which the students would produce and deliver reports. Through this relationship, we hypothesized, practitioners would benefit from scientifically based research that could help them understand or resolve particular issues that they were facing in the field. Thus, they would receive value from the time and effort that they spent communicating with students and educators.

ConservationBridge.org and the Multimedia Case Study Approach

To accomplish these goals, a website and multimedia case studies were created. The website has undergone three separate iterations based on user feedback, while the case study approach has undergone two separate iterations. The current iteration of each component is described here.

ConservationBridge.org

ConservationBridge.org was built upon a WordPress backend content management system (CMS). WordPress was chosen as the main CMS as it is an open-source blogging engine. Rather than having a basic site where case studies are simply posted online, we felt that it was important to be able to update the cases on a regular basis and to allow students and practitioners to post materials themselves. The WordPress engine allowed us to attain both of these goals.

While prior iterations of the site favored students in terms of its design and user interface, the current site is tailored to teachers, as they are the main gateway to the case studies for students. Thus, the home screen on the current site allows teachers to filter cases based on the geographic locations of the case studies, suggested courses in which the cases might be used, and general topic tags (see Figure 2.1).

Once the user is on the case study page, several main features are available. Each case study contains a 7-to-12-minute documentary video intended as a general introduction to the case study location and to the issues that practitioners are facing in the field. On the right-hand side, additional information is provided in the form of a written case study that provides more details of the case. Additional readings are also provided, as well as any relevant charts, graphs, or other resources (see Figure 2.2).

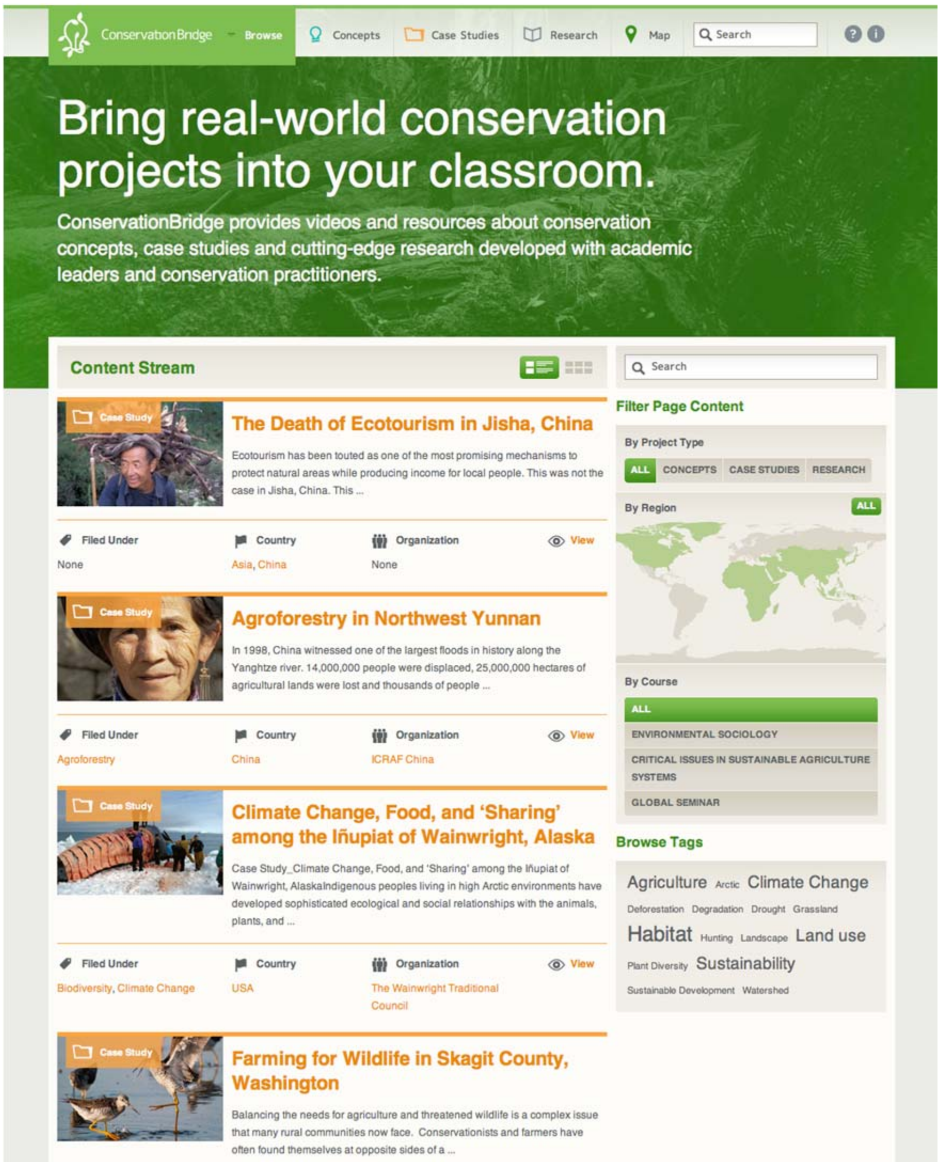

Figure 2.1. ***ConservationBridge.org*** **home screen.**

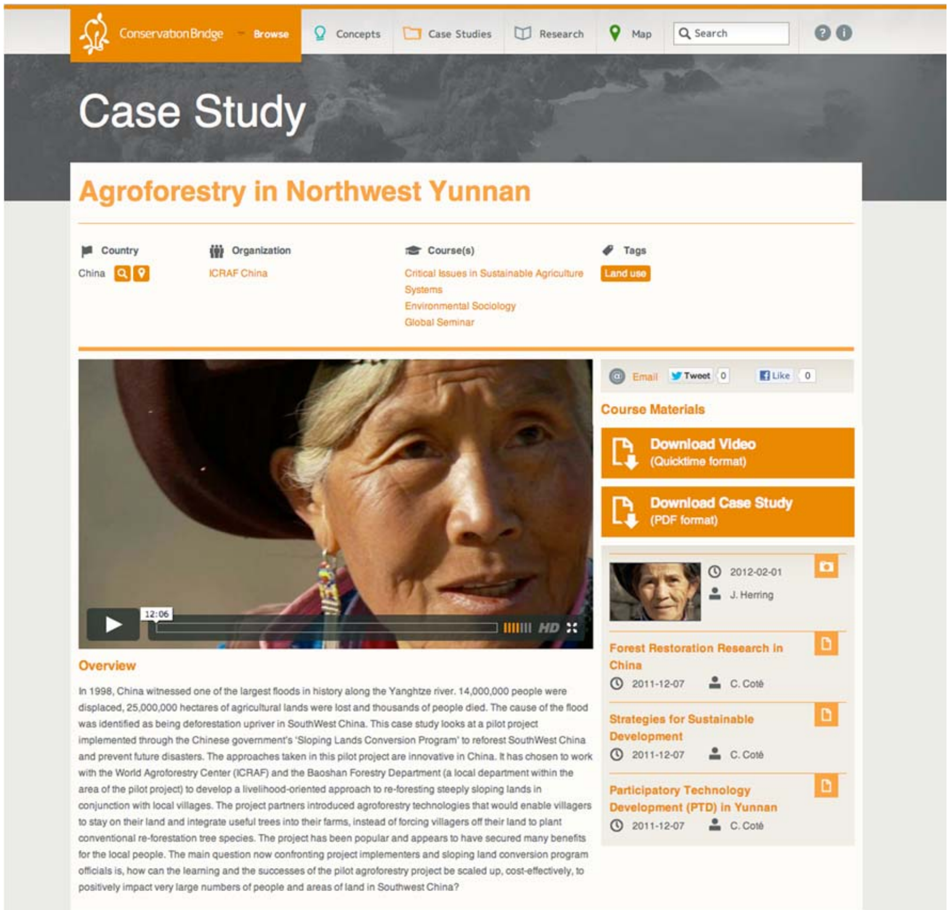

Figure 2.2. *ConservationBridge.org* case study page.

The main innovation on the case study page is the opportunity it provides for practitioners to ask questions to students. These questions have been developed in collaboration with educators for the particular classes that students have been enrolled in. This has ensured that the questions are reasonable enough for students to answer, while still providing research benefits to the practitioners. As a result of using the WordPress CMS, questions can be easily updated or changed. Students have the ability to share their reports, which provides opportunities for feedback from the practitioners or other students (see Figure 2.3).

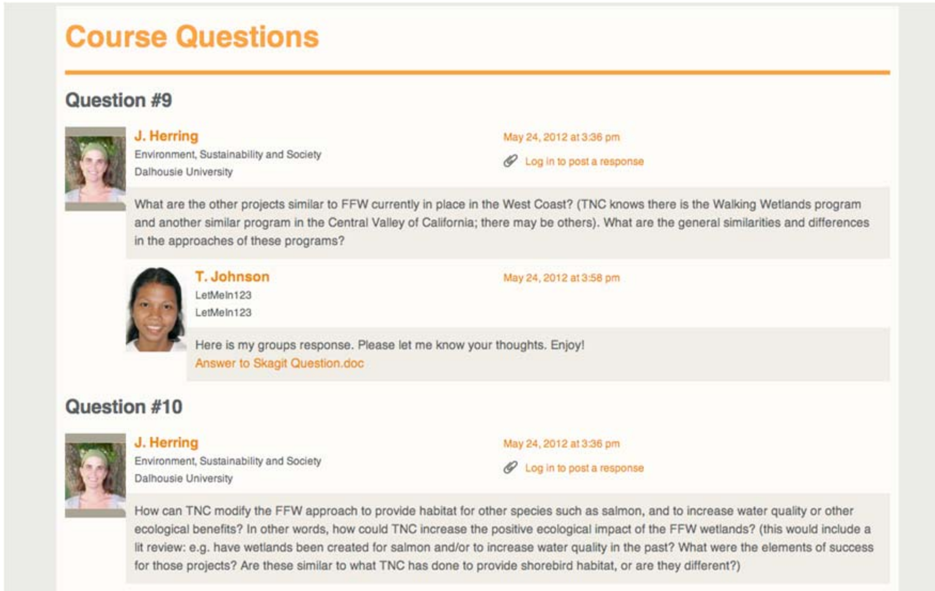

Figure 2.3. Practitioner-driven research question section.

ConservationBridge Case Studies

The production of the case studies is also unique. Case studies have been created in close collaboration with practitioners (see chapter 2). A team of professional videographers has worked closely with educators and practitioners to develop the video components of the case studies. The videos introduce students to the practitioners, their projects, and the specific issues they face. To accompany the videos, written case studies have been produced and additional resources have been provided in the form of research papers, white papers, PowerPoint presentations, graphs, and tables. These additional resources have been provided in order to give students a deeper sense of the projects and a better understanding of their scopes and goals.

Over the course of the project thus far, 18 case studies have been completed, and others are in production. A sample of projects has been chosen from around the world based on accessibility, the willingness of practitioners to be involved, and the potential for interdisciplinary engagement among a broad range of educators (see Table 2.1).

Table 2.1. Brief Description of Case Studies Produced

Case study	Location	Problem description/Questions
Climate Change, Food and Sharing among the Iñupiat of Wainwright, Alaska	USA	Although indigenous peoples of the Arctic have contributed little to the causes of climate change, they are among the first to feel its effects. What threats does climate change pose to the livelihood aspirations and cultural survival of indigenous people in Arctic environments?
Agroforestry in Northwest Yunnan	China	The devastating 1998 floods along the Yangtze river in China were attributed primarily to deforestation. This case study looks at a pilot project implemented through the Chinese government's "Sloping Lands Conversion Program" to reforest Southwest China and prevent future disasters. How can this project be scaled up cost-effectively to positively impact greater numbers of people and land areas in Southwest China?
Farming for Wildlife in Skagit County, Washington	USA	Balancing the needs of agriculture and threatened wildlife is a complex issue that many rural communities now face. It is increasingly apparent that common ground does exist among agricultural and conservation interests, but how can those intersections between the need for biodiversity and the needs of local farmers be used to advance these mutual interests?
Water and Climate Change in the Andes	Bolivia	The Bolivian Andes, where warming temperatures and unpredictable climate patterns have affected local livelihoods, are at the frontlines of climate change. Bolivia's Andean glaciers, which provide water for drinking and for irrigation, are small to begin with, making them particularly sensitive to steadily increasing temperatures. Over the last 35 years, Bolivia's glaciers have lost about half of their mass due to climate change. How will the Altiplano people survive in a future that will likely bring further changes in climate patterns?

Table 2.1 (Continued)

Case study	Location	Problem description/Questions
The Death of Ecotourism in Jisha, China	China	Ecotourism has been touted as one of the most promising mechanisms for protecting natural areas while producing income for local people. This was not the case in Jisha, China. This case study documents the enthusiasm with which an ecotourism project was undertaken in Jisha and the problems that arose, which eventually led to its demise.
Saving the Giant Ibis in Cambodia	Cambodia	The 2001 rediscovery of the Giant Ibis presented an opportunity to link conservation efforts to poverty alleviation in Cambodia, a country still affected by decades of war and genocide. A three-tiered conservation approach was developed in order to incentivize local people to engage in conservation efforts to safeguard the Giant Ibis and other threatened wildlife. However, in order for the approach to be successful, it must continue to make economic sense for locals to engage in conservation actions over the long-term. Will this three-tiered approach be economically self-sustaining over the long term?
Building Local Food Systems and Assessing Landscape Outcomes in Ithaca, NY	USA	Proponents of the local foods movement argue that major environmental benefits can be generated by sourcing foods locally. But what exactly are the environmental benefits and how can they be measured?
Capturing New Market Opportunities for Farmers in the Kijabe Landscape of Kenya	Kenya	This case study examines the overlap between human culture and the survival of biodiversity in the agricultural landscapes of central Kenya's Kikuyu Forest Escarpment.
Payments for Ecosystem Services in the Kanyabaha-Rushebeya Landscape	Uganda	Kanyabaha-Rushebeya in Uganda is one of the most densely populated regions in Africa. Of the hundreds of wetlands that once existed here, only one remains. The wetland is an important resource that provides immeasurable livelihood benefits to local people as well as habitat for numerous species of birds and wildlife. Under intense pressures, the wetland has become degraded by people and wildlife alike. How can a local Ugandan NGO generate financial incentives to preserve the local wetland?

Table 2.1 (Continued)

Case study	Location	Problem description/Questions
Farmscape Ecology at Hawthorne Valley Farm	USA	Agriculture and biodiversity are often pitted against each other as working toward opposite ends. Farmscape Ecology has been presented as a way to bring these two normally opposing forces together to increase biodiversity on agricultural lands while improving agricultural yields.
Human-Wildlife Conflicts in Bhutan	Bhutan	Bhutan is home to a variety of charismatic megafauna including tigers, leopards, snow leopards, elephants, and other mammals. A highly agrarian culture, 60% of the country has its species protection enshrined in the constitution. With very strong legislation in place to protect Bhutan's biodiversity values, the main threat to wildlife stems from human-wildlife conflict, as most of the villages border prime wildlife habitat and wildlife frequently enter farm land. How can wildlife be preserved without encroaching on local livelihoods?
Payment for Ecosystem Services in Lijiang, China	China	Growing tourism in Lijiang has put stress on local water resources that have been impacted negatively by agricultural uses of pesticides. *The Natural Capital Project* has chosen Lijiang to implement a payment-for-ecological-services (PES) project in conjunction with *The Nature Conservancy* and *Conservation International.* Can PES serve as an example for similar projects across China and the rest of the world?
Marketing Local Food of the Capay Valley	USA	This case study looks at how local farmers, ranchers and community organizers in the Capay Valley have sought to maintain the rural landscape and local agriculture by developing farmers' markets and educating consumers about the environmental and health benefits of local foods.
Biodiversity Conservation in Nairobi National Park	Kenya	Nairobi National Park is home to over 80 species of mammals and 400 species of birds. When vegetation and water become seasonally scare throughout the park, some wildlife migrate southbound into Maasailand. How do wildlife and the Maasai people co-exist in these areas when competing for scarce natural resources for their survival?

Table 2.1 (Continued)

Case study	Location	Problem description/Questions
The Landscape Measures Approach: Río Copán, Honduras	Honduras	The Río Copán watershed in western Honduras is comprised of small and mid-sized farms producing cattle, coffee, and subsistence crops. Recent population growth has created many environmental and social challenges such as increased deforestation and water pollution, low agricultural productivity and high poverty levels, especially among the indigenous Mayan population. How can local municipalities join together to develop solutions for development and environmental problems?
Payments for Agrobiodiversity Conservation Services: PES and Quinoa in the Andes	Peru, Bolivia, Chile	Quinoa is an ancient grain of the Andes, and is important not only for the livelihoods of local farmers but also to the export economies of Peru, Bolivia and Chile. Can quinoa continue to improve the livelihoods of the poor farmers who grow it without leading to genetic erosion?
Controlling Invasive Species in Hell's Canyon, Idaho	USA	Biodiversity thrives in the high altitudes and diverse terrain of Idaho. However, invasive species are taking over the area and threatening local species. How can invasive species be controlled in such a massive and rugged landscape?
Rural Conservation Strategies in Susquehanna County, Pennsylvania	USA	What are the largest threats to the rural landscape of Susquehanna County? What local strategies can protect the rural landscapes?
Conserving the Miyun Watershed, China	China	Beijing has faced a water crisis for over a decade. Roughly 70% of Beijing's drinking water comes from the Miyun Reservoir, China's largest reservoir, which collects its water from the Miyun Watershed. The health of the soil and forests throughout this watershed plays a vital role in the supply and availability of good quality drinking water downstream. The villages located upstream within the watershed, therefore, have a significant impact on the downstream water supply for the Miyun Reservoir. How can forest restoration and sustainable livelihoods be promoted in villages throughout the Miyun Watershed?

Methods

ConservationBridge was tested in 12 classes at Cornell University between 2008 and 2013. Evaluations were done in two different types of courses: freshman-level courses and senior-level courses. Students in the freshman-level courses were exposed to the case studies but not directly connected to practitioners. Students in the senior-level courses were exposed to both the case studies and practitioners. This difference in approach was chosen in order to evaluate whether there were differences in understanding, motivation, and perceived value between students exposed only to the case studies and those both exposed to the case studies and connected directly to practitioners. Although the case studies here could be used to emphasize different aspects of conservation, their main focus was on ecoagriculture, a theoretical framework that emphasizes conservation outcomes in tandem with enhancing rural livelihoods and more sustainable and productive agricultural systems (Scherr & McNeely, 2007).

The evaluation used mixed methods to measure and document three areas: (1) student perception of the value of online case studies, student understanding of key course concepts, student motivation, and changes in self-efficacy; (2) faculty experiences teaching with multimedia case studies; and (3) the degree to which student work was useful for practitioners. All three constituent groups were also asked how the *ConservationBridge* approach could be improved.

Students

The student study used a quasi-experimental design and descriptive data. Evaluation triangulated quantitative indicators from (1) student course surveys and open-ended text questions administered to both the freshman-level group (N=54, 100% response rate) and the senior-level group (N=104, 100% response rate) (Total N=159, 100% response rate), (2) pre-tests administered to a subsection of the senior group before using *ConservationBridge* compared to post-tests administered to the same subsection of students after using *ConservationBridge* (N=45, 100% response rate), and (3) coded qualitative data from in-depth student interviews with both freshmen and seniors (N=8).

(1) The post-course surveys included three types of questions that explored students' perceptions of their understanding and their motivation to learn as well as the perceived value of the cases in terms of time investment. Open-ended questions were also provided and results were analyzed for common themes among their responses.

(2) Pre-test/Post-test questions were conducted and coded to see if there was a shift in students' understanding of key concepts in regard to human and natural systems. The pre-tests and post-tests were graded on a scale from 1 to 5 (1 being negative and 5 being correct) and the pre-test results were compared to those of the post-tests. Five questions were asked and scored using the following key (Table 2.2):

Table 2.2. Pre-Test/Post-Test Questions and Answer Key

Question	**Correct answer (5)**	**Partially correct answer (3)**	**Negative answer (1)**
What is an ecoagriculture landscape?	Includes the following: (1) An integrated landscape management approach (2) Agriculture, conservation and rural livelihoods	Includes either of the following: (1) An integrated landscape management approach (2) Agriculture, conservation and rural livelihoods	Does not include either of the following: (1) An integrated landscape management approach (2) Agriculture, conservation and rural livelihoods
Provide an example of an ecoagriculture landscape?	Includes an example of a landscape that uses an integrated management approach for agriculture, conservation and rural livelihoods	Includes an example of a landscape that has agriculture, conservation and rural livelihoods	Does not include an example of a landscape with agriculture, conservation and rural livelihoods

Table 2.2 (Continued)

Question	Correct answer (5)	Partially correct answer (3)	Negative answer (1)
What is the relationship between ecoagricultural synergy and ecosystems?	Includes the following: (1) ecoagricultural synergy includes sustainable agriculture, conservation, and rural livelihoods (2) Improved integrated management improves the long-term sustainability of ecosystems	Includes one of the following: (1) ecoagricultural synergy includes sustainable agriculture, conservation, and rural livelihoods (2) Improved integrated management improves the long-term sustainability of ecosystems	Does not include either of the following: (1) ecoagricultural synergy includes sustainable agriculture, conservation, and rural livelihoods (2) Improved integrated management improves the long-term sustainability of ecosystems
What is the relationship between markets, ecosystem stewardship, and livelihood?	Includes the following: (1) markets sustain livelihoods (2) ecosystems stewardship sustains critical natural resources (3) Markets, ecosystem stewardship and livelihood all need to be managed for long-term sustainability	Includes one of the following: (1) markets sustain livelihoods (2) ecosystems stewardship sustains critical natural resources	Does not include: (1) markets sustain livelihoods (2) ecosystems stewardship sustains critical natural resources

Table 2.2 (Continued)

Question	Correct answer (5)	Partially correct answer (3)	Negative answer (1)
What is the relationship between collaborative landscape management and ecoagriculture?	Includes the following: (1) Collaborative landscape management involves managing resources across various sectors (2) Ecoagricultural synergies can only come from collaborative landscape management	Includes one of the following: (1) Collaborative landscape management involves managing resources across various sectors (2) Ecoagricultural synergies can only come from collaborative landscape management	Does not include: (1) Collaborative landscape management involves managing resources across various sectors (2) Ecoagricultural synergies can only come from collaborative landscape management

(3) External evaluators conducted in-depth interviews with eight students. Interviews lasted 15 to 30 minutes. Evaluators looked for evidence of the value of case studies, increased understanding of key course concepts, greater student motivation, and increased confidence. Three students were randomly selected from the freshman course to be interviewed (one from each of the three majors in the class). Five students were interviewed from the senior course, each representing a different case study. The eight interviews were audio-recorded, transcribed, and thematically coded.

Faculty

Twenty-minute in-depth interviews were conducted with faculty members on the efficacy of teaching with *ConservationBridge* case studies (N=7). These interviews explored how the use of *ConservationBridge* impacted courses and student learning outcomes. Faculty perceptions of the growth of student confidence, student motivation, and student understanding of key concepts were tracked through frequency analysis of the in-depth interviews. Faculty were also asked how *ConservationBridge* might be improved in the future.

Practitioners

During the spring semester of 2012, *ConservationBridge* linked students and field practitioners through five online case studies in a course entitled *Special Topics in International Agriculture and Rural Development* (IARD 4940). This was a final-semester capstone course at Cornell University. Five small teams of Cornell seniors each selected one case study. Each team completed a research project based on real-world problems posed by a field practitioner featured in one of *ConservationBridge*'s case studies.

A 12-question survey was then administered to participating practitioners (N=5). The survey explored how practitioners used research-based information from, and engaged in collaborative problem solving with, Cornell students. The survey also documented practitioners' perceptions of the benefits, usefulness, and value of the project.

Limitations of the Design

By the nature of the study's design, the collected data are not sufficient to draw causal inferences. The data were restricted by funding limitations that allowed us to produce in-depth interviews by external evaluators with students in only two of the classes engaged in *ConservationBridge.* Also, findings from interviews with faculty members and practitioners were limited by the number of interview participants, in this case seven faculty members and five practitioners. Findings, therefore, should be viewed as exploratory. This study was further limited by a lack of a control group to test differences between students exposed to *ConservationBridge* and those not exposed within the same course. In addition, freshmen-level students were not exposed to practitioners while upper-division students were. Thus, the age and education level of the students may have also impacted the educational outcome scoring. Furthermore, as this study tested students within a classroom environment, it cannot make any comparisons to differences in learning outcomes potentially achieved by students physically visiting a case study site and engaging with practitioners at a local level.

Results

Results of data collection regarding *ConservationBridge*'s use indicate positive outcomes for each of the three main stakeholder groups. The results are broken down according to these three groups.

Students

Students demonstrated increased understanding of key course concepts and said that they were more motivated to learn when using the *ConservationBridge* case studies than through the use of textbooks and journal articles. Students reported and demonstrated increased confidence in their ability to consider and discuss complex issues related to sustainability.

(1) Student Post-Course Survey

Students agreed that the case studies were valuable and reported an improved understanding of key course concepts as well as increased motivation. Ninety-four percent (150 of 159) agreed or completely agreed that they felt more confident analyzing complex environmental issues after engaging with *ConservationBridge* (see Table 2.3).

Open-ended text responses yielded a number of common themes. The following are exemplars of repeated and frequent themes (see Table 2.4).

Table 2.3. Learning Outcomes Relative to Each Course

Dimension	Students 1101 (n=54)	Students 4940 (n=104)
Case studies were a good use of time (value)	3.5	4.3
Case studies increased understanding	4.1	4.2
Students were more motivated by case studies	3.1	4.4

*Based on 5 point scale (5 = Completely Agree; 1 = Completely Disagree);

Table 2.4. Themes from Open-Ended Text Responses

Dimension	Themes	Example comments
Increased understanding	Real-world problems, thinking, knowledge, information, multidisciplinary	"They [case studies] provide real-world situations, and allowed us to analyze them" "[I had] a feeling of pride being able to apply my own thinking to real-world problems" "They showed topics not just from an environmental viewpoint, but also from social and economic perspectives" "I like that they [case studies] were divided into economic, cultural, and environmental consequences"
Good use of time	Small groups, discussion vs. lecture, student-centered, valuable	"The small groups promoted discussions and creative thinking" "I got to participate and explore my ideas and other people's in discussions" "Hearing other student's opinions forced you to consider multiple perspectives" "I prefer discussion rather than being lectured to" "Discussion groups facilitated more in-depth reflections"

Table 2.4 (Continued)

Dimension	Themes	Example comments
More motivated	Video, more interesting, active, engaged, choose topics of personal interest	"Videos were more interesting than textbook readings" "[Videos showed] specific things going on around the world instead of textbook examples"
More confident	Critical thinking, problem solving, analyze complex issues, demonstrate advanced understanding, part of a team, confident	"The case studies allowed me to explore specific topics of research that I find interesting" "Helped us create arguments and form opinions about environmental topics" "Helped me see how to develop questions to aid in exploring a new topic"

(2) Pre-Test/Post-Test

The pre-test/post-test results saw a major improvement in student understanding of key human–ecological concepts related to ecoagriculture (N=45). Across all questions, students saw an improvement in understanding of over 37% (see Table 2.5).

Table 2.5. Results of Pre-Test/Post-Test

Question	Average pre-test result	Average post-test result	Percent improved
What is an ecoagriculture landscape?	2.4	3.9	30%
Provide an example of an ecoagriculture landscape?	1.8	4.2	48%
What is the relationship between ecoagriculture synergy and ecosystems?	1.7	3.6	38%
What is the relationship between markets, ecosystem stewardship and livelihood?	2.3	4.0	34%
What is the relationship between collaborative landscape management and ecoagriculture?	1.9	3.8	38%

(3) Student Interviews

Several main themes emerged from the coding of student comments from the student interviews. Key themes included “real-world,” “hands-on,” “multidisciplinary,” “more engaging,” “team,” “discussions,” “new information,” “improved communication,” and “more confident.”

In terms of understanding key concepts, evidence showed that *ConservationBridge* increased students’ ability to understand sustainability as a multidisciplinary issue with environmental, economic, and social components. Comments included:

> “The videos . . . are a phenomenal way of introducing us to the key issues.”
>
> “We discovered the link between environmental and social issues.”
>
> “The case was presented very pleasantly and it was fine, but looking more into it, I realized there’s a political issue here and I became morally opposed.”
>
> “[Our team had] biology people, sociologists and economists working together.”

In reference to generating increased motivation to learn, *ConservationBridge* yielded an increase in motivation to learn about environmental issues when compared to textbooks and journal articles. Comments included:

> “The video makes it feel a little more real, a little more engaging.”
>
> “You can see the people. You can see the landscapes. Sometimes that’s hard to extract from a journal article.”
>
> “The videos did a good job of bringing interesting issues in an accessible way.”
>
> “We are talking with real people who are facing these problems.”
>
> “Meeting the practitioner builds a greater sense of accountability.”

Regarding self-efficacy, students said that they felt more confident in their ability to consider environmental topics because of the online case studies, and that engagement with *ConservationBridge* had influenced their future courses and career choices. Comments included:

> "I feel more confident expressing my opinion."

> "[I acquired] much more awareness of how important good communication is."

> "It was kind of like eye opening. [Our team realized] students can actually make a difference."

> "It's been great. [This class] made me realize what I wanted to do."

> "Strengthened that feeling that I wanted to take more courses [in Marine Systems]."

> "I recognize the importance of interdisciplinary studies."

> "I was forced to learn more about the social sides of things."

Although the comments were generally positive, students did describe several areas in which *ConservationBridge* could be improved. Such statements are easily organized around the themes of communications and logistics. Statements included:

> "I think anything to facilitate communication would help."

> "Communication. It was very difficult to get in touch with our practitioner. For, I think, two weeks in a row, we set up a Skype meeting and our practitioner didn't show up or showed up a couple hours late. We couldn't wait around all day. Then we finally got in touch and we had a great conversation, but then we haven't been in touch since."

> "Increasing the feedback from the practitioner. We just Skyped once and our practitioner was like, 'Yeah, it looks good.' But you want feedback."

> "It's been difficult to stay in touch and to get the feedback that we need to help with our direction. We get a little bit of information at the beginning to sort of frame the assignment, but so many more questions are brought up."

> "It's difficult to get all the information back if we can't get in touch with them. It has been a challenge. At this point, we're sort of going ahead with what we have and we'd like to get some more information, but we can't necessarily."

> "The one in Bhutan, because of the infrastructure problem, it's kind of difficult. But we tried our best to connect to them."

> "It's not easy to make contact with the people that are working on those projects in real time, in the alpine province in China and the one in Bhutan. It was a little bit difficult to work with our practitioners because of all those issues."

> "What I've gotten out of it is much more awareness of how important good communication is when dealing with practitioners. If you're going to be a consultant, you have to communicate well with your client."

Faculty

In general, faculty reported an overall positive experience utilizing *ConservationBridge* in their courses and also perceived benefits for their students. Faculty's responses were rated based on their level of agreement with statements regarding *ConservationBridge.* All faculty members reported very strong agreement (see Table 2.6).

Table 2.6. Responses to Survey

Item	**Ranking**
Case studies were a good use of time	4.57
Case studies increased understanding	4.57
Students more motivated	4.33

*Based on 5 point scale (5 = Completely Agree; 1 = Completely Disagree)

In terms of the in-depth interviews, several major themes emerged from the coding of faculty comments. These themes were: “real-world,” “student-centered,” “students engaged,” “relevant,” “active learning,” “critical thinking,” “problem solving,” and “new ideas.” Interview questions revolved around faculty perceptions of student engagement, student motivation, and student self-efficacy. Responses to these questions are explored below.

Student Engagement

Faculty reported that students seemed more engaged in their courses while using *ConservationBridge.* All faculty mentioned student engagement as one of the main benefits of their use of the case studies. Comments included:

> “I was very impressed with how the students were engaged, what their knowledge level seemed to be.”
>
> “I was surprised at the quality of responses [from] a freshman class.”
>
> “I don’t know how to summarize this but [during a discussion] I saw a student and the light bulb appeared above their head.”
>
> “Conversations around the cases were very engaged, both within the larger classroom, but mostly in the small groups that were working on the cases.”
>
> “[The value is] confronting the students with the details of the issues in the real-world rather than something more vague and theoretical.”
>
> “They were very engaged. They had things to say.”

Student Motivation

Faculty unanimously reported that students were more motivated to learn about environmental issues by discussing online case studies than by reading the same information in textbooks and journal articles. All faculty interviewees cited examples of increased student understanding of the concept that sustainability is multidisciplinary and integrates environmental, economic, and social components. Comments included:

> "Students are more motivated to learn through video."
>
> "I think it was very, very valuable. The fact is that students were very engaged."
>
> "Evidence from the student course evaluations [showed] a large majority were very favorably impressed by *ConservationBridge*."
>
> "Not only was it current and relevant, it was in line with their [student] interests."
>
> "For the senior course the strength is real-world application."
>
> "The strength of the person in the field, you see it as a motivator for students."

Self-Efficacy

Faculty felt students were more confident in their ability to consider environmental topics because of the online case studies. Comments included:

> "They [students] gained confidence throughout the semester."
>
> "Students assumed the role of problem solver."
>
> "Over time, you could definitely see people [students] gaining more confidence."
>
> "We found very positive improvements in their ability to analyze complex issues."
>
> "For the freshman, I think it did increase confidence. For most it was their first time to discuss a real environmental problem."

Although *ConservationBridge* provided positive benefits for reporting faculty, issues of scalability seemed to be the most common suggested improvement. Comments included:

> "It would be better if we have some follow up materials like what happened after one year or two years later."

> "There is [a scalability issue], there definitely is. You can't use the same practitioner in five different schools using it over and over."

> "We can't keep up with the cases evolution and what the practitioner's needs are."

Practitioners

Four of five (80%) practitioners reported increased opportunities to use research-based information generated by students compared to their normal exposure to scientific literature. Four of five (80%) said research-based information provided either 'Many Insights' or 'Some Insights' useful for their work. All practitioners said that they gained value from participating in the case study (60% said "Big Value"). Four of five (80%) practitioners said that participating in the case study was useful (60% said "Very Useful"). All are interested in participating in a future case study. In terms of the benefits to their organizations, practitioners noted a high level of benefit. Statements included:

> "The case study video has been of tremendous value in communicating our work. The student's research raised our awareness of a few projects we weren't aware of."

> "It gives a different perception of how I see the way I do things. We are now serving a wider community and target groups than we used to in the past."

> "Gave us a focal point for catalyzing continued discussion."

Furthermore, many practitioners noted that they were able to access scientific information sources previously unavailable to them and that the research that was provided was useful for their work and organizations. Statements included:

> "The osotua camp established by KENVO is using some of the information provided to market the ecosystem and collaborate with other stakeholders. This was not the case in the past."
>
> "In sustainable alpine grazing case, we worked with students collaboratively to solve the problems in adaptive management from social, ecological and economic perspectives."
>
> "The sample list of grants made for agricultural projects was very insightful we would never have the time to do that kind of thing ourselves. The same for the sample list of USDA programs we really don't have time to put together these kind of synthesis products so they are very useful for us."
>
> "The research-based information generated by students has been cited in my research proposal and scientific papers."
>
> "I am able to use other reference material provided by the research. We are also implementing some of the recommendations made by the study."
>
> "The final report itself, with its references to research on US and international food justice issues, was useful."

While there were benefits, practitioners noted that there were some problems, including logistical issues in connecting to students and problems with defining the scope of research questions. Answers to the question "What challenges did you face in working with students?" included:

> "Time constraints and Internet failures."
>
> "Knowing what level of work was reasonable to expect, and I don't think I provided them enough guidance for them to go beyond what we already know. I think the questions we outlined at the beginning might have been too broad for the students to really be effective."

> "I was unsure if students had a strong enough background to hear my concerns and offer unbiased suggestions. They seemed surprised by some things I said."

> "It was easy for me, but I know the students had a hard time connecting with some of our participants—so that was surely hard for them. So the overall number of interviews was disappointing."

> "The students should have asked us what we wanted to learn/gain."

> "Transforming their research-based information into problem-solving practices."

Discussion

This initial test of *ConservationBridge* showed some promising results for students, faculty, and practitioners.

For students, *ConservationBridge* did indeed increase their motivation to learn and to apply concepts. Although students were unable to physically go to these sites and thus there was no control group to test whether on-site visits yielded different educational outcomes, evidence shows that they still received the benefits of an authentic-learning and service-learning style of education. Their motivation to learn increased, as did their understanding of the importance of cross-disciplinary work and their sense of self-efficacy in the face of complex environmental problems. As such, *ConservationBridge* showed promise in terms of delivering improved educational outcomes through exposure to real-world experience via a web-mediated platform. This was particularly true for students who were both exposed to the case studies and connected directly to practitioners who could answer their research questions. While the freshman group, who did not connect directly to practitioners, still saw benefits, the benefits were amplified for the senior groups, who were directly connected to practitioners. In the three dimensions measured in post-course surveys and open-ended text questions, students who were connected to practitioners responded with higher evaluations than those who were not (4.3 vs. 3.5 for ‘case studies are a good use of time’; 4.2 vs. 4.1 for ‘case studies increased understanding,’ and 4.4 vs. 3.1 for ‘students motivated by case studies’). Thus, on all scales (understanding, motivation, and value), students who were connected to practitioners gave higher scores.

For faculty, *ConservationBridge* also provided benefits in terms of improving the quality of courses and the learning outcomes of students. All faculty members noticed an improvement in students’ self-efficacy, motivation, and engagement. The integration of case studies was also an improvement in terms of providing both ‘global’ and ‘local’ contexts for applying the concepts and theories that were taught. This improvement presents the most promising indication that *ConservationBridge* can serve to break down the traditional separation between academic institutions and real-world problems. The interdisciplinary nature of the case studies and the practitioner questions also served to bridge the divide that exists between academics and practitioners.

Most surprisingly, practitioners reported many benefits arising from their involvement in *ConservationBridge.* In the development of this project, these benefits were the greatest uncertainty, as practitioners are not typically integrated into the institutional framework of higher education. As such, we were concerned that student work would not provide adequate value to make it worthwhile for practitioners to participate. However, four of the five practitioners reported that the time investment was ‘acceptable’ while the value they derived from the student research was high.

In general, these responses bode well for the main driving idea behind *ConservationBridge,* which is that a web-based, collaborative system can act as a useful mechanism for connecting students, faculty, and practitioners in the field in such a way as to produce meaningful results for each of the three sets of stakeholders.

While these benefits were shown to exist, challenges were also identified by all three groups. This identification of challenges points to the need for improvements, specifically in three main areas: scalability, communications and logistics, and ensuring that cases are continuously updated. All three of these main areas speak to the problems of connecting ongoing conservation projects with faculty and students.

In terms of scalability, managing the relationships between students and practitioners required an expenditure of time and effort beyond what faculty are normally accustomed to. Faculty and practitioners needed to work closely together to construct questions that helped serve the goals of the practitioners and the learning objectives of the students. This required faculty to determine what students could potentially accomplish given their available time and skill level, and to match this estimate with the research needs of the practitioners. While this was possible to do for one course at a time, scaling this kind of interaction over several classes at the same time would be difficult. As one faculty member stated, “[Managing the practitioner is the] hardest part of the whole thing because of time.” If three or thirty other universities began using *Conservation Bridge,* the project would not be able to establish relationships with the current practitioners for all the schools, and would need to expand to include new ones.

In addition to the issue of scalability, communications and logistics also posed a major problem. The problem of coordinating the schedules of students, faculty members, and practitioners was compounded by international time zone differences and poor telecommunications infrastructure in developing countries.

Finally, keeping the case studies up to date also proved to be challenging. One of the main issues with location-specific conservation problems and projects is their dynamic and changing nature. Projects can change scope based on a number of different variables including staff turnaround, community support, funding streams, political upheaval, and project success. While such changes in scope are an important factor to learn for students interested in conservation careers, documenting this change is difficult if the video component is one of the central features of the case study. As one student stated, “You see the online video case study and it answers questions like: ‘Who is the practitioner?’ ‘What’s on their mind?’ ‘What’s the general problem?’ Then, as you know, the practitioner says, ‘Well, that’s all nice and fine, but here’s what I’m dealing with now.’” Text is easy to change and update. Updating videos requires that a video crew be on call to document the changes on an ongoing basis. This is a large hurdle to overcome when budgets are already constrained.

Conclusion

The importance of making conservation education increasingly interdisciplinary cannot be overstated. In order to address the complex conservation challenges that students will face in their future career trajectories, students must develop knowledge that combines a theoretical and practical understanding of conservation, an understanding of both western and traditional ways of knowing, an understanding of the scale of conservation problems on both global and local levels, and an understanding of how physical ecology interacts with social, political and economic factors. Of additional importance is the development of an interpersonal skill set that enables future practitioners to work with diverse stakeholders. The need for conservation solutions to address a range of factors necessitates that future conservation practitioners be educated in an interdisciplinary manner (Brewer, 2001). In order to achieve these lofty education goals, students need direct exposure to the complex nature of conservation problems.

The eighteen case studies created for *ConservationBridge* at the time of this study provided students with an engaging and motivating platform for developing their practical understanding of conservation challenges. By employing an authentic-learning and service-learning strategy in multimedia case study education, *ConservationBridge* provided students with the opportunity to apply their theoretical knowledge of conservation to real-world situations to gain practical exposure (authentic learning) as well as the opportunity to provide their own research and expertise for local conservation solutions (service learning). Furthermore, regular interaction with practitioners allowed students to develop their interpersonal skill sets in relevant professional contexts.

ConservationBridge did not only yield benefits to students. Teachers acquired new tools to enhance their lesson plans and engage students in coursework. Practitioners, who are frequently disconnected from other locally situated conservation problems or global environmental affairs, benefited from the research provided by students. While there were some communication challenges experienced by teachers, students and practitioners alike, overall the three groups derived meaningful benefits from their participation.

This chapter has explored the pedagogical framework within which *ConservationBridge* is situated and has analyzed surveys completed by students, educators, and conservation practitioners on the results of its use. The innovation in teaching and learning provided by *ConservationBridge* gives theoretical knowledge real-world applicability and trains future practitioners with the skills required to work in the field.

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CHAPTER 4. COMMUNICATING LOCAL CLIMATE RISKS THROUGH DOWNSCALED CLIMATE PROJECTIONS

Introduction

The vast majority of climate scientists agree that global warming is occurring, that it is disproportionately anthropogenic, and, if left unaddressed, will have serious consequences for the natural world and humans (Stoker et al., 2013). However, general public perceptions of both its existence and its causes are less robust, particularly in the United States. The Yale Project on Climate Change Communications (2009), which surveyed over a thousand Americans, concludes that only 66% of Americans believe that global warming is happening and that just under half (46%) believe it is mostly caused by human activities (also see: Leiserowitz et al., 2014).

Changing beliefs and attitudes about climate change is key to mitigating and adapting to climate change, as it will require significant public engagement and changes on micro levels, such as individual lifestyle changes, and macro levels, such as policy changes and technological innovation (O'Neill & Nicholson-Cole, 2009). How the risks associated with climate change are communicated, therefore, is seen by many as critical, as human perceptions of climate change reflect the level of public concern and motivation to act (Swim et al., 2009) and play a central role in mobilizing public engagement (Moser & Dilling, 2011).

Climate change, however, is a notoriously hard topic to communicate. Many climate communication researchers argue that the causes and potential impacts of climate change lack temporal and spatial proximity. This line of argument is based on research in behavioral psychology that shows that direct experience and immediate personal demands are more important to accessing risk, and therefore action, than longer-term and conceptually abstract risks (Freidman et al., 1999; Morgan et al., 2001; Slovic, 2000; Weber, 2006). As the causes of climate change are not immediately visible and their impacts are felt across large geographical areas and across long time periods, they argue, climate change does not have the proximal impacts in time and space needed to make it an immediate risk in most people's minds. Thus, they call for improved science communication using more precise, personal, repetitive, and locally specific data and messaging in the media (Koger et al., 2011; Leiserowitz et al., 2011; Moser, 2010).

To communicate future risk, climate communication relies on climate projections. A climate projection is a scientifically informed "statement about the likelihood that something will happen in the future if certain influential conditions develop" (WMO, 2015). However, there are two main challenges to communicating proximate risks of climate change using climate projections. The first involves the science itself, and the second involves the distribution of climate data sets in forms that are meaningful for a lay audience.

In terms of climate science, Moser (2010) argues that "many of the changes observed to date required systematic monitoring over decades to emerge as signals of long-term change from the 'noise' of more immediately felt and conspicuous day-to-day, seasonal, and interannual variability in the state of the weather, climate, and the environment" (p. 33). In the scientific literature, climate is differentiated from weather, as weather represents short-term variability while climate refers to trends over time (Barry & Chorley, 2009). The attribution of a locally specific weather event, even an extreme weather event that would make climate change risks more personally relevant, is difficult to scientifically attribute to changes in the broader climate trends (Hulme, 2009). Thus, communication must rely on climate projections within which extreme weather is embedded as trends in order to communicate both future change and risk. However, scientific uncertainty is built into how the projections themselves are produced. Important physical processes in the Earth's climatic systems are not fully understood (Maslin, 2012). Climate projections rely on Earth system models. As there are uncertainties in terms of how the climactic system functions, these uncertainties are extended into the projections themselves. Furthermore, future climate change is directly tied to the amount of greenhouse gases (GHGs) that are emitted into the atmosphere (Melillo et al., 2014; Stoker et al., 2013); As the amount of future GHGs is based on a number of unpredictable factors (reliance on fossil fuels, technological development, climate action, deforestation, policy, population growth, among others), climate projections themselves must account for various future scenarios that are uncertain (Dessai & Hulme, 2004). Finally, producing projections at localized scales requires that coarse-level data (100 km to 150 km grids) be statistically downscaled to local levels (1 km grids). Statistically downscaling coarse-level data must be done by using observed historical data and based on the assumption that local variations in temperature and precipitation will not change in the future. This presents a level of uncertainty because it is not fully known whether historical patterns will persist within the context of global changes in temperature and precipitation (Wilby et al., 2004). The combination of not being able to attribute any one specific weather event to climate change with the uncertainty inherent in the methods of producing climate projections presents a challenge to producing communications that present climate change as a clear, immediate, and proximate risk.

The second challenge is the distribution of the projections themselves. Uncertainty notwithstanding, downscaling methods are capable of increasingly high resolution to display proximate risk. However, downscaling methods require supercomputing resources and produce massive data sets. For example, the continental United States at a spatial resolution of 800 meters produces a 17 TB data set with trillions of lines of code. This presents a technological challenge to produce and distribute localized visualizations that the layperson can understand within the constraints of current information technologies.

Given these challenges, Weber (2006) and Sterman (2011) point to the use of interactive simulations whereby people can see for themselves what will happen in the future in locally specific areas of value to them framed within the context of risk. It is hoped that through such simulations the issue of proximity can be resolved and the risks of climate change can be made more personal and, therefore, more urgent to address.

This chapter tests this premise. Since May 2014, a team of information architects, software producers, user-interface experts, and climate data scientists have collaborated to produce ClimateData.US. This partnership leveraged supercomputing capacity at the NASA Ames Research Center that produced statistically downscaled climate projections for the continental United States. A custom-created big-data mapping technology to serve tile-based visualizations of projected local climate change impacts on temperature was produced. The resulting web-based interactive visualization allows users to navigate to locally specific areas and see the effects of differences in temperature change on their communities.

This chapter tests whether a tool that was specifically designed to address the issues of proximity can change beliefs and attitudes about climate change.

Literature Review

Despite 66% of Americans believing that climate change is real, action on climate change continues to rank close to the bottom of priorities compared with other major voting issues. Of 19 major voting issues, climate change ranks 17th in importance (Leiserowitz et al., 2014). The lack of urgency in terms of the political support for action belies the fact that references to climate change as a topic in the media have grown threefold since 2010 (Media Matters, 2014). Despite this proliferation of climate change information in the media, action on climate change remains a low priority for the public.

According to behavioral psychology, the reason for the disconnect between belief and action lies in the way we process risk. Weber (2006) argues that human beings have a processing bias toward concrete and immediate threats and away from those that are conceptual, distant, and abstract. Worry, Weber argues, drives risk management and the compulsion to act:

> When people fail to be alarmed about a risk or a hazard, they do not take precautions. Recent personal experience strongly influences the evaluation of a risky option. Low-probability events generate less concern than their probability warrants on average, but more concern than they deserve in those rare instances when they do occur. (p. 106)

Risk perception is therefore driven more by association- and affect-driven processes than by analytical processes (Lowenstein et al., 2001). Hertwig et al. (2006) show that decisions based on descriptions of risk versus those based on experience lead to different results in choices of behavior. Decisions based on the description of risk, such as drug-package inserts or financial investment brochures, overweight the probability of rare events. Decisions based on experience, on the other hand, underweight the probability of rare events because a person is unlikely to have experienced the rare event itself. People tend to discount the risk from experience despite potentially statistically risky behavior (Hertwig et al., 2006; Weber et al., 2004). For example, findings from research assessing risk perception based on proximity to a chemical plant found that the closer a resident lived to the chemical plant, the less they expressed uncertainty about the risks of living nearby and the more they expressed support for the chemical industry. Residents living farther away, on the other hand, expressed more concern for risks and lower support for the chemical industry. People who lived close by were able to discount the risks by pointing to their own experience, whereas people living farther away relied on descriptions of risk (Heath et al., 1998).

Given this context of how humans process risk, it is not surprising that climate change remains a relatively low priority in terms of action. In general, most of the U.S. population does not directly experience climate change (Swim et al., 2011). The causes of climate change are invisible in the sense that GHG emissions cannot be detected by the human eye. The impacts of increased GHG emissions are also not directly locally tied to the location around which they are produced. This combination of invisible causes and distant impacts (both spatially and temporally) means that the connections between actions (emitting GHGs) and risks of climate impacts are not immediately correlated (Moser, 2010). Furthermore, climate change is not one risk hazard but a driver of many potential risks such as extreme weather, drought, changes in disease vectors, sea-level rise, and changes in agriculture, among many others (Melillo et al., 2014). As such, climate change is experienced not as a singular event but rather as a series of events that are seemingly disconnected from the cause. Although climate change is accelerating (Melillo et al., 2014; Stoker et al., 2011), it does not follow a linear trend, so that even past experience is not a reliable guide for future risks (Swim et al., 2014).

Within the context of behavioral psychology, it makes sense that action does not necessarily follow understanding of global-level change, because the local, personal impacts and associated risks are not directly felt. The time-delayed and spatially distant nature of climate change means that traditionally the represented risks associated with climate change do not evoke strong, immediate visceral reactions (Weber, 2006). The risks are easy to personally discount based on personal experience because most people experience changes in weather, not climatic trends over time. Furthermore, climate change is often presented as melting glaciers, dying polar bears, and loss of arctic sea ice, experiences that are not immediately relevant to most of the American population (Moser, 2010). Climate change therefore remains abstract and distant compared with more pressing concerns that require immediate action. Leiserowitz's (2005, 2006) research on climate change and willingness to act supports this argument. Survey respondents perceived climate change to be a risk. However, this risk was seen as distant, both temporally and geographically. As such, this risk offset respondents' willingness to pay for increases in their own energy costs to offset the impacts of climate change (Leiserowitz, 2006).

As a result of this framing, Weber (2006) calls for climate communications that are direct and locally proximate to evoke more personal reactions to climate change risks through simulating impacts on local regions and areas that people value. It is through this type of communication, he argues, that belief in climate change can change attitudes toward action by providing better insights into the proximate, personal risks associated with inaction (Weber, 2006).

Producing communications that are more direct and local to solve the issue of proximity, unfortunately, is not a trivial task. Communicating future climate risks within a local context requires the use of climate projections. However, the reliance on locally specific climate projections introduces both scientific and distribution challenges for communications.

In terms of science, climate projections and the methods used to derive local impacts themselves inherently contain a range of uncertainty. There are three main reasons for this.

The first uncertainty is built into how the models derive projections. Climate models are used to analyze past changes in the long-term averages and variations in temperature and precipitation in order to project how these trends may change in the future based on various radiative forces (Maslin, 2012). Climate models are based on mathematical and physical equations representing the many processes that affect the Earth's climate system. However, some important physical processes within the Earth's system are not fully understood, such as the impact of clouds, convection, natural variability, pollution particulate, and turbulent mixing of the atmosphere. Since the science of how these variables interact with GHG emissions is not known, these gaps in Earth system knowledge lead to uncertainty in the models themselves (Randall et al., 2007).

The second uncertainty has to do with GHG emissions. The amount of GHG that will be emitted depends on how humankind responds to climate change through new technology, economies, lifestyle, social organization, and policy (Moss et al., 2010). As the response to climate change is unknown and dependent on human behavior, action, and policy, emission scenarios have been produced to mimic a range of future scenarios. "Emissions scenarios are descriptions of potential future discharges to the atmosphere of substances that affect the Earth's radiation balance" (Moss et al., 2010). The most recent set of scenarios agreed upon by the climate science community through the Intergovernmental Panel on Climate Change (IPCC) are called Representative Concentration Pathways (RCPs). The RCPs describe four possible climate futures depending on the amount of GHGs emitted and are used within the model simulations to project a range of possible future outcomes. Thus, projections are uncertain, as the RCPs are approximations of potential futures, not statements of fact.

To achieve a localized scale in these projections, a third uncertainty presents itself. To produce local projections that are within a scale that people can understand (1 km grids), climate scientists use coarse-level projections from the IPCC's Coupled Model Intercomparison Project (CMIP) project. CMIP is a framework within which climate modelling groups from around the world work to produce global climate projection models. The latest iteration, called CMIP5, produces coarse-level projections at a grid resolution of 100 km to 150 km (Knutti & Sedláček, 2013). To improve the spatial resolution for more localized impacts, one can downscale these coarse-level data sets using statistical techniques that compute the difference between projected changes at this coarse scale with local variations in temperature and precipitation based on observed historical patterns (Maurer & Hidalgo, 2007). However, statistically downscaling the models to local levels assumes that historical spatial patterns in temperature and precipitation will be consistent in the future. Thus, another level of uncertainty is presented.

While work is ongoing within the science community to reduce uncertainty, these uncertainties must inform climate communications. Climate projections must be communicated within the context of risks, not certain outcomes. According to Painter (2013), framing climate change as risk is a promising direction. Although uncertainty can be an obstacle to decision making, Painter argues, risk framing can "shift debate away from the idea that decisions should be delayed until conclusive proof or absolute certainty is obtained (a criterion that may never be satisfied), towards timely action informed by the comparative costs and risks of different choices and options (including doing nothing)" (p. vii). Given information about what the projected risks are based on current behaviors, people can better understand the impacts of the choices they make. Thus, communication strategies that rely on localized climate projections can benefit by contextualizing climate change within uncertainty and risk as opposed to debates about the accuracy of the science.

Assuming that scientific uncertainty within downscaled climate projections can be addressed by framing them within the context of risk scenarios, a second major challenge presents itself: distribution. In order to produce the projections, the algorithmic processes that match historically observed variations at a local level must be computed against changes in the coarse-level projections. For a spatial resolution of 1 km grids for the continental United States, this algorithm must be computed for each 1 km grid point, monthly, for 90 years into the future for each of the four RCPs and using 33 model simulations contained within CMIP5 (Taylor, 2012). Although supercomputing capacity now exists that did not exist even five years ago, this computing yields files of between 15 and 17 TB of raw data. Sharing this raw data with the public is not a feasible solution, as the data itself is presented in databases containing trillions of tables. Thus, an approach to producing tangible assets that can be consumed and understood by the general public must be created.

A potentially promising approach to solving this distribution challenge is through the use of interactive web-based visualizations.

Visualization is "the process of generating images by filtering, mapping and rendering of data" (Nocke et al., 2008). Visualization has long been known to have various cognitive benefits when compared with written or verbal information, especially in conditions that cannot be seen directly (Shepard, 2005). Visual information can also provide affective triggers that can induce feelings that are persistent over time and that influence people's decision making (Gilovich et al., 2002; Sheppard, 2005). As climate change is a trend over time rather than a specific event in time and space, visualizations have been widely used by climate scientists and communicators to depict climate change futures and to "bridge the gap between what may seem an abstract concept and everyday experience, making clearer its local and individual relevance" (Nicholson-Cole, 2005). Appearing in major research articles, climate reports, assessments such as the IPCC's, and news media outlets, climate visualizations such as the one below depicting two future scenarios (Figure 3.1) are a common tool for distributing climate science findings (see Neset et al., 2009).

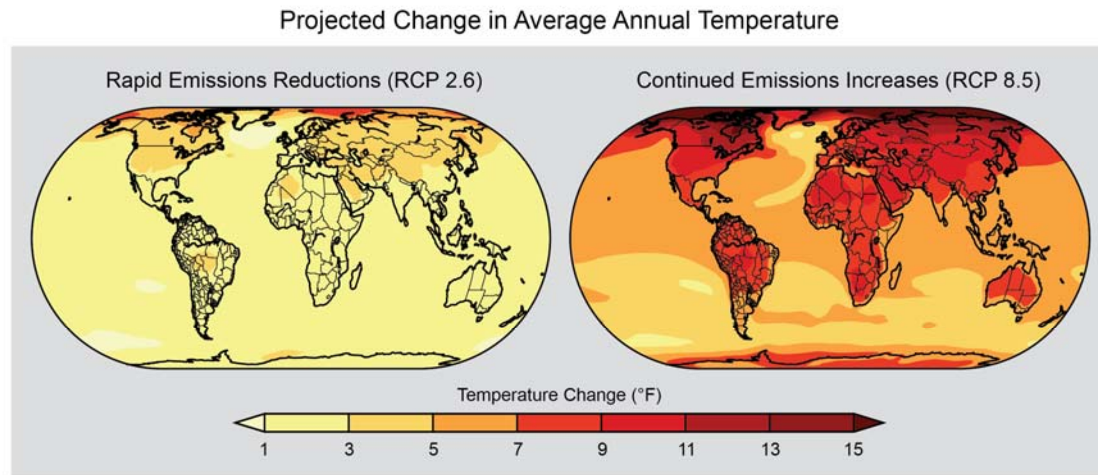

Figure 3.1. Projected change in average annual temperature (Melillo et al., 2014).

While static graphics can portray important information, the medium is limited in terms of both the temporal and spatial scales required for proximate relevance (Neset et al., 2009). “Scientific visualizations of climate model data (e.g., the now iconic image of the globe turning red) can become banal, almost everyday images” (O’Neill & Smith, 2014). Thus, many scholars have argued for the use of interactive visualizations (Neset et al., 2009; Nocke et al., 2008; Sterman, 2011; Weber, 2006).

However, interactive visualizations are much less commonplace. In a survey of ongoing climate visualization initiatives, Nocke et al. (2008) conclude that “recent developments in interactive visualization using alternative visual metaphors are not wide-spread in the climate community. Thus, a major task for future developments is to further bridge the gap between climate and visualization expertise” (p. 5). This is not surprising given the various skill sets required to produce interactive visualizations, including scientific knowledge, database management, interactive design, geospatial software engineering, and web services. However, the massive growth of information and communication technologies (ICTs) has increased to the point where innovations for translating and disseminating climate change information now provides room for innovation and novel approaches (Hammill et al., 2013).

In sum, the literature in behavioral psychology points to the need to develop climate communication tools that focus on the impacts of climate change at local scales in order to increase proximity and communicate the risks on a more personal, visceral scale. The limits of climate science require that such tools address uncertainty by framing the issue in terms of future risk and choice based on our actions today. The reliance up climate projections and the massive data output of new climate downscaling methods necessitate the need for innovative technological approaches to its distribution. It is hoped that combining these various factors into an interactive visualization tool that increases proximity and frames the climate issue within the context of risks associated with various emissions scenarios will render the issue of climate change more salient and personally relevant. In addition, it is hoped that exposure to this type of communication tool can make climate change more temporally proximate for users and lead to increased concern for climate change, stronger attitudes toward and beliefs in climate change, and certainty in one's attitudes about climate change (H1). In addition, employing this tool to browse geographically proximal locales should make the issue of climate change more salient. Thus, these predicted changes in beliefs and attitudes should be greater when browsing geographically proximal locales relative to more distal locations (H2). Last, the duration of user interaction with this tool should be greater when it permits browsing of proximal versus distal locales based on the increased salience or personal relevance of proximal locales (H3).

Methods

The issues described above were recently explored by a collaboration that included user-interface designers and software engineers from HabitatSeven, climate data scientists from the NASA Ames Research Center, and end-user testing experts from Texas Tech University. The goal of this collaboration was to create an interactive map-based climate visualization that public web users could use to search for their local areas of interest and see the differences between emission scenarios. The resulting website product used for testing was entitled ClimateData.US (www.climatedata.us).

To demonstrate the effectiveness of this site in terms of eliciting change in attitudes and beliefs, a controlled experiment was conducted whereby a sample of young adults were instructed to browse the site and examine either nearby (i.e., geographically proximal) or distant (i.e., geographically distal) locations or the site. The study employed pre- and post-test measures of beliefs and attitudes to examine changes as a function of site exposure and locales browsed. This section describes the website and testing methodology.

ClimateData.US

Over the course of six months in 2014, ClimateData.US was produced and launched as part of the President's Climate Action Plan within the Climate Resilience Toolkit. The goals of the site were to (1) visualize NASA's DCP-30 downscaled data set for the continental United States through an intuitive map-based web interface; (2) allow users to search for and view local areas of interest; (3) easily view the potential impacts of two main emissions scenarios (RCP 2.6 and RCP 8.5) on temperature and precipitation across 4 seasons; (4) contextualize the data within the framing of risk and choices; and (5) explain issues of uncertainty with climate data.

The NASA NEX-DCP-30 data set is a statistically derived downscale of the continental United States derived from the General Circulation Model (GCM) runs conducted under CMIP5 (Taylor et al., 2012). It contains projections from 33 models, as well as ensemble statistics calculated for each RCP from all model runs available.

As the output of this data set is a 17 TB file, an innovative information architecture and process was developed to bring the raw data set into a geospatial platform with temperature and precipitation visualizations as base layer maps overlaid with state boundaries, city names, and roads. This geospatial platform was then wrapped with a web interface to guide users through the visualizations and contextualize what they are seeing. In order to deal with the issue of uncertainty within the models, an ensemble average of all models was used to create the base layer maps. The resulting site was hosted at www.climatedata.us.

Participants

Forty-six undergraduate students enrolled in media and communication courses at Texas Tech University were recruited for participation in this study. A majority of the sample was female ($n = 27$, 58.7%; male $n = 19$, 41.3%). Average age was 21.20 ($SD = 2.46$). Participants received nominal course credit in exchange for participation. Eligible participants were able to view a brief study abstract informing them that they would interact with an online data portal. No reference was made to the specific nature of the site content. Participants self-selected individual study appointment times.

Procedure

Approximately 48 hours before a participant's study appointment, he or she was emailed a pre-test questionnaire and a reminder of the scheduled participation date. The pre-test questionnaire was programmed and distributed through an online survey platform. Pre-test measures included participants' reported concern for climate change, attitude toward the reality of climate change, and attitude certainty (see *Dependent Measures*). In order to disguise the nature of the study, the questionnaire also included additional questions related to perceptions of new technologies and the political landscape, and three “matching” questions used to connect individual participants’ responses to the pre- and post-test data.

Research participation took place in an eye-tracking lab located in the college’s Center for Communication Research. The lab contains an eye-tracking apparatus and two desktop computers—one for the experimenter to operate the eye-tracking hardware and one used to run the Gazetracker software, which is capable of collecting and storing participants’ gaze data and synchronously recording web-browsing behavior.

Participants were given an information sheet to review in the lobby before the study began. After the information sheet was reviewed and any participant questions were addressed, the participant was escorted to the eye-tracking lab. The participant was seated approximately 24″ from a 19″ computer monitor with resolution set to 1280 × 1024.

Prior to browsing, participants were shown the www.climatedata.us site and its different functions in order to familiarize them with its features (e.g., emissions scenarios, future climate projections). The site begins by introducing users to the data and frames the issue of climate change within the context of choices between a high-emissions and low-emissions future. The site then invites users to explore their local areas to see what the potential impacts will be based on these emissions scenarios (see Figure 3.2).

Once the user clicks ‘get started,’ they are brought into a mapping interface. They are presented with a view of the continental United States with a slider bar that splits the screen into a low-emissions scenario and a high-emissions scenario. Along the bottom, they are provided a scroll bar that allows them to split the data visualization into decadal averages. At the top, they are provided with a search field that uses predictive search functions to allow users to find local areas of interest (see Figure 3.3).

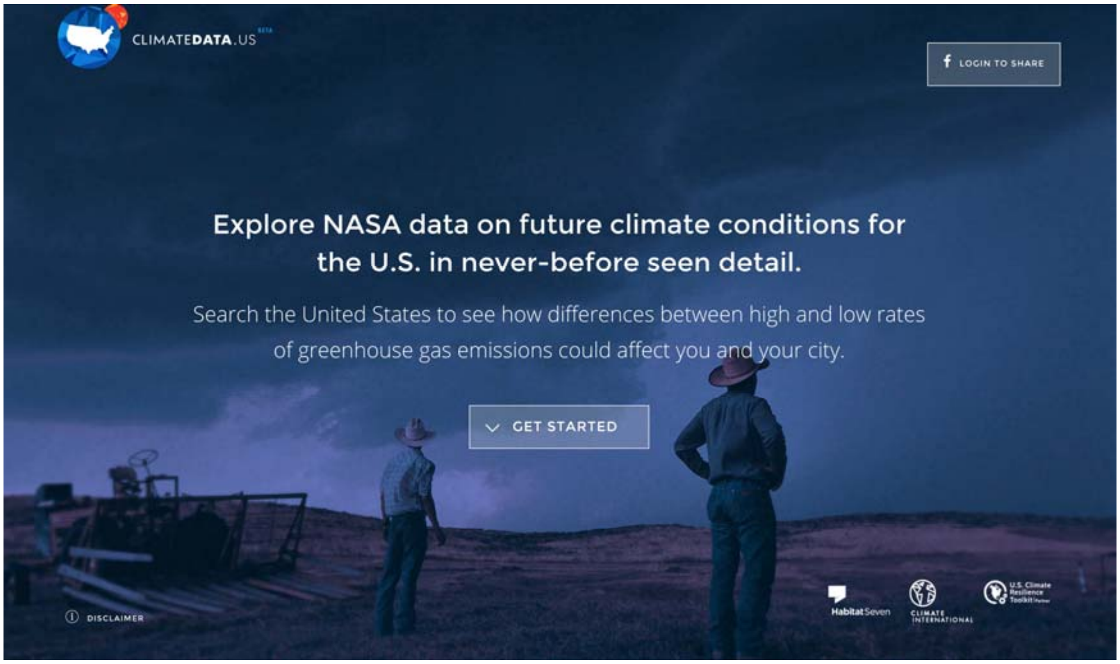

Figure 3.2. Introduction page for ClimateData.us.

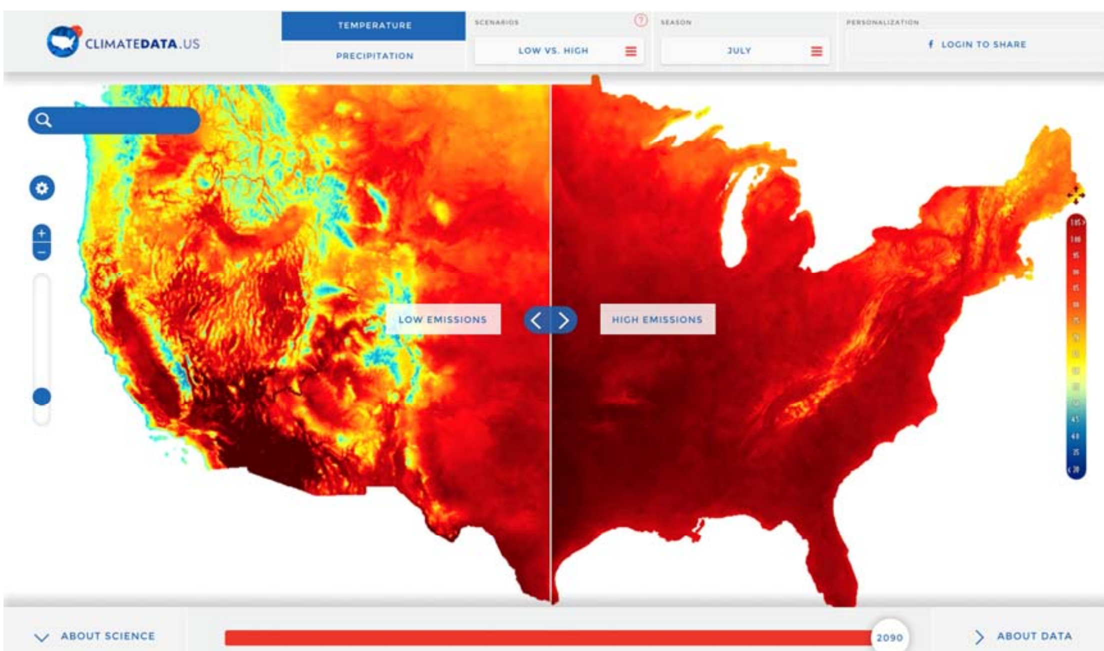

Figure 3.3. Mapping interface for ClimateData.us.

By either zooming in to a local area or using the search field, users can focus on a local area of interest and see the differences between what a low-emissions and a high-emissions future looks like in their area of interest (see Figure 3.4).

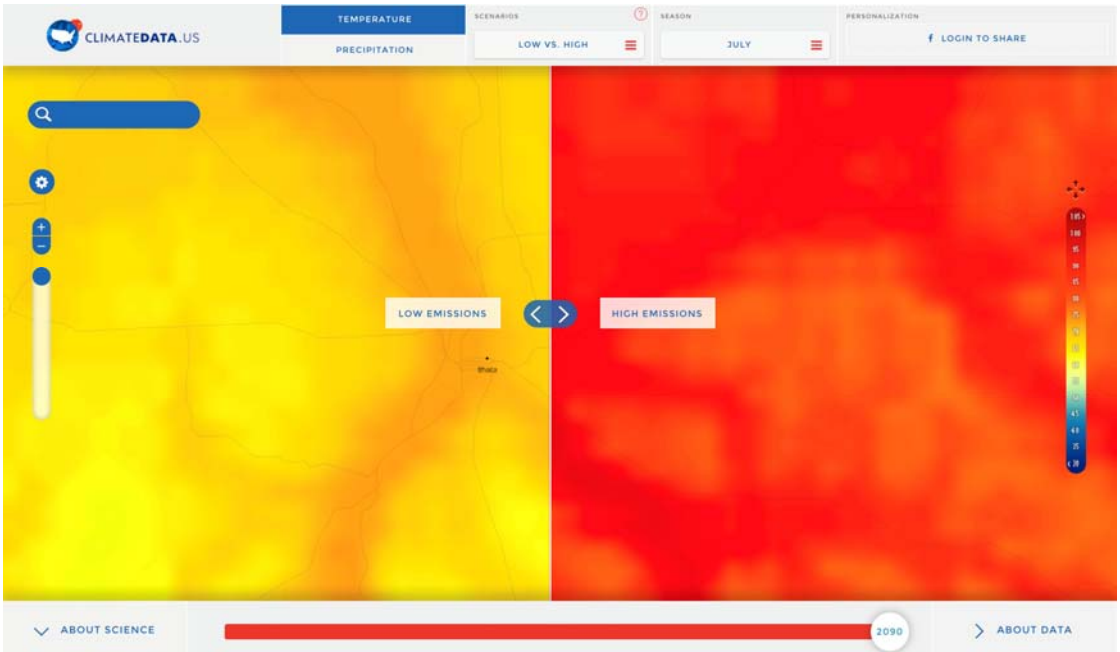

Figure 3.4. Zoomed-in view of local-level area under low-emissions and high-emissions scenarios.

Users interested in understanding the science behind how the data were generated can view a section underneath the map to explore what the climate science community means by uncertainty and descriptions of how computer modelling is done, and to place the local data they viewed on the map within the larger context of climate data (see Figure 3.5).

Participants were randomly assigned to one of two experimental conditions: proximal (e.g., Lubbock, Dallas, and Hobbs, New Mexico) or distal (e.g., New York City, Chicago, and Los Angeles). To achieve the manipulation, researchers explained to participants that they could interact with the season, high- versus low-emissions scenario slider bar, and the decadal average bar to examine how greenhouse gas emissions may affect temperatures in the cities of Lubbock, Dallas, and Hobbs (or in New York City, Chicago, and Los Angeles) over time. Participants were instructed to use the search field to reposition the map to cities of interest and to browse only the immediate vicinity around those cities. Beyond interacting with the three specified cities, participants were told to explore the website as they normally would and to inform the researcher when they had finished. Participants were given up to 15 minutes to browse, but the time limit was not mentioned prior to the browsing task.

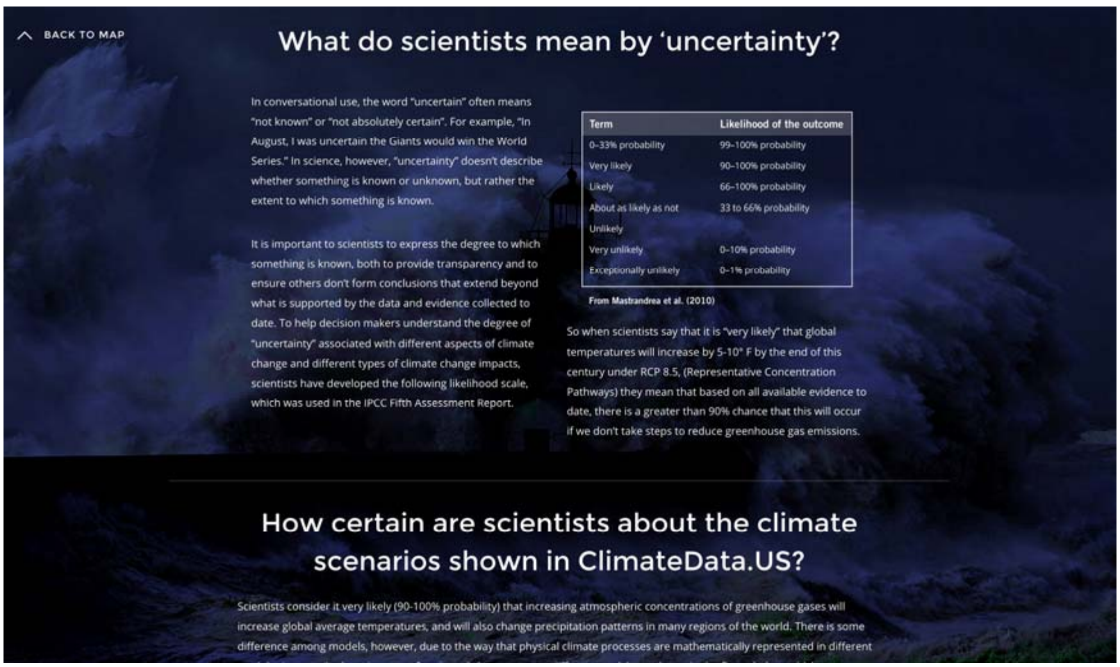

Figure 3.5. Climate science section of ClimateData.us.

As participants interacted with the mapping interface, their web-browsing behavior was recorded via the eye-tracking software. After participants finished browsing the online data portal, they completed post-test measures via an online questionnaire assessing concern for climate change, attitude toward the reality of climate change, and attitude certainty. Upon completing the self-report measures, participants were thanked for their participation and dismissed.

Dependent Measures

Concern for climate change was assessed at the interval level using two items modified from Leiserowitz (2004). Responses ranged from 0 (*Not at All*) to 10 (*Very Much*) in regard to two items: “How concerned are you about climate change?” and “How much do you worry about climate change?” Participants’ concern for climate change was operationalized as the composite of the two items.

Attitude toward the reality of climate change was assessed at the interval level using seven 11-point semantic differential items, some of which were modified from Lim and Golan (2011). A prompt asked participants to evaluate “the fact that our climate is changing” as unlikely/likely, dishonest/honest, wrong/right, ridiculous/reasonable, unintelligent/intelligent, unbelievable/believable, and foolish/wise. Participants’ attitude toward the reality of climate change was operationalized as a mean composite of the seven items.

Climate change attitude certainty was assessed at the interval level using three items modified from Petrocelli, Tormala, and Rucker (2007). Responses for two items ranged from 0 (*Not at All Certain*) to 10 (*Very Certain*). These items assessed the following: “How *certain* are you of your opinions toward climate change?” and “How certain are you that your opinion toward climate change is the *correct attitude to have*?” Responses for the third item ranged from 0 (*Not at All Clear*) to 10 (*Very Clear*) in regard to the item “To what extent is your opinion toward climate change *clear in your mind*?” Participants’ climate change attitude certainty was operationalized as the composite of the three items (see Appendix A for measurement instrument).

Web-browsing behavior was continuously recorded as participants interacted with the website to yield an overall measure of *time spent browsing the site*. To yield a more granular measure of engagement with various pieces of site content, a trained graduate student subsequently coded videos after data collection to determine time spent interacting with the map versus time spent browsing static content. *Time spent interacting with the map* was operationalized as the total number of seconds participants spent interacting with features on the mapping interface. *Time spent browsing static content* was operationalized as the number of seconds participants spent reading text below the mapping interface or other ancillary site content such as graphs or figures.

Results

In order to test the hypotheses involving self-report measures of attitude toward climate change, attitude certainty, and concern for climate change, a series of three mixed-measures analysis of variance (ANOVA) tests were conducted in which time of assessment (pre-test versus post-test) served as a within-subjects repeated measure and assignment to the proximal versus distal geographic conditions served as a between-subjects factor.

The first hypothesis predicted an increase in three key self-report metrics as a function of exposure/interaction with the site. With respect to concern for climate change, the test statistic for time of assessment was significant, $F(1, 44) = 4.39$, $p = .04$, $\eta^2_p = .09$. Study participants expressed a significant increase in concern for climate change after browsing the site ($M = 6.43$, $SD = 2.32$) compared with before ($M = 5.77$, $SD = 2.14$).

Interaction with the site yielded a significant increase in participants' attitude toward the certainty of climate change, $F(1, 44) = 45.67$, $p < .001$, $\eta^2_p = .51$, and the associated effect size reveals the magnitude of the change. Compared with pre-exposure ($M = 7.54$, $SD = 1.77$), participants reported greater certainty in the reality of climate change after browsing the site ($M = 8.77$, $SD = 1.70$).

Finally, examination test where attitude certainty served as the dependent measure yielded a similar effect of site exposure, $F(1, 44) = 7.87$, $p = .008$, $\eta^2_p = .16$. Participants were more certain of their attitudes toward climate change after browsing the site ($M = 7.31$, $SD = 1.92$) than before ($M = 6.70$, $SD = 1.91$). Thus, results support H1, that interaction with the site would yield significant changes in attitudes and concern for climate change.

The second hypothesis predicted that the effects stipulated in H1 would be greater for those browsing geographically proximal locations than those browsing distal locations (i.e., a significant interaction between time of assessment and the manipulation). However, no such interaction was observed for any of the three self-report measures (concern for climate change, $F(1, 44) = .34$, p = n.s.; attitude toward reality of climate change, $F(1, 44) = 001$, p = n.s.; attitude certainty, $F(1, 44) = .16$, p = n.s.). As seen in Figure 3. 6, the aforementioned effect of site exposure was consistent regardless of the geographic locations browsed.

The final hypothesis predicted that participants instructed to browse cities near the testing location (i.e., the proximal condition) would spend more time browsing the site in general than those browsing more distant locations (i.e., the distal location). On average, participants spent 9 minutes and 15 seconds browsing the site ($SD = 244.66$) and browsed a minimum of 3:35 and a maximum of 15 minutes (the limit imposed by the study parameters). To test this, an independent-samples *t* test compared mean browsing time between the two conditions. That test failed to find a difference, $t\ (44) = .22$, p = n.s. Likewise, tests examining more granular measures of time spent interacting ($t\ (44) = .06$, p = n.s.) and time spent browsing site content ($t\ (44) = .32$, p = n.s.) were not significant. Thus, participants spent equal time browsing the site and interacting with the visualization, regardless of the locale they were asked to browse.

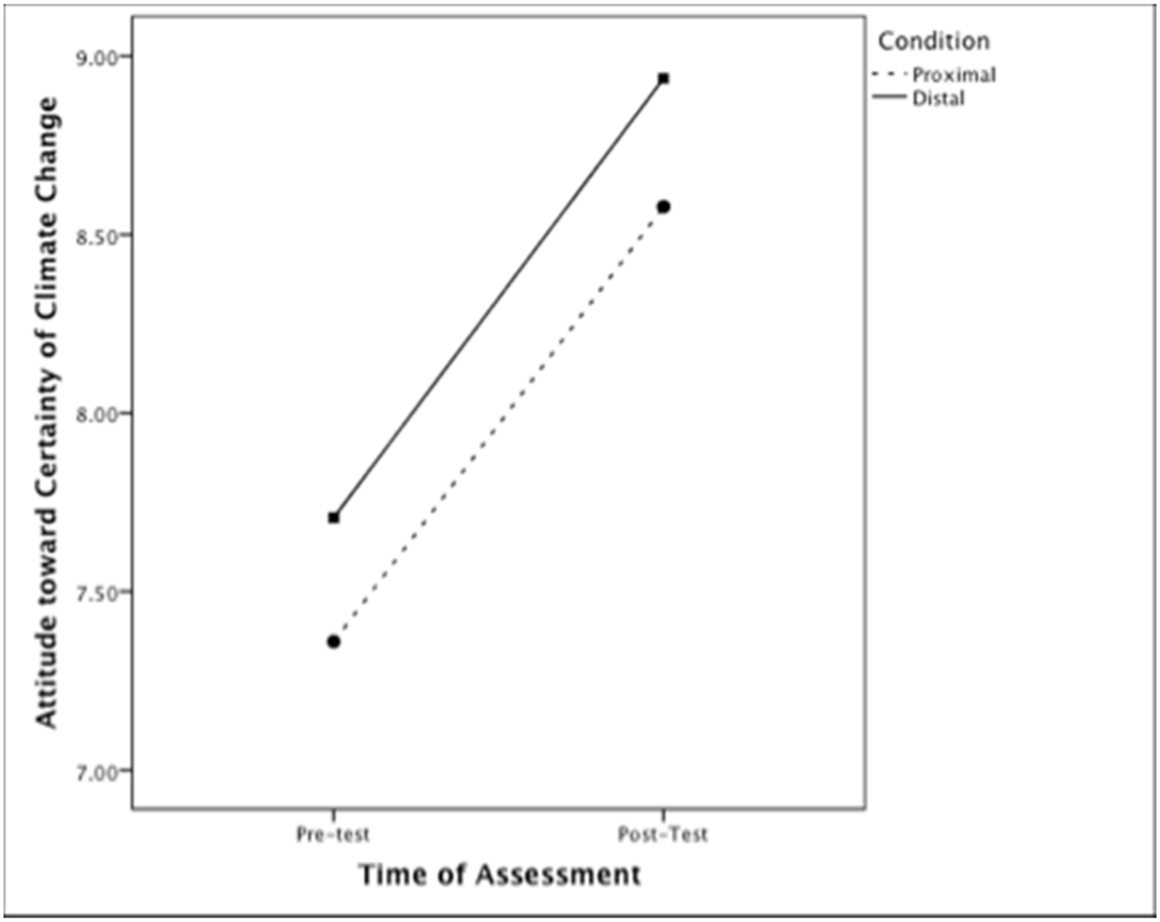

Figure 3.6. Pre-Test/Post-Test assessment scores.

Discussion

The results of this experiment yielded surprising findings. The site was successful in reducing the temporal proximity of climate change for users, which led to stronger attitudes toward and beliefs in climate change (H1). In all three key self-report metrics, interaction with the site uniformly led to significant changes in beliefs and attitudes. In terms of beliefs, participants expressed more certainty that climate change is real. This increase in certainty was correlated to a strong effect size in attitudinal change. Surprisingly, however, spatial distance did not have a significant impact in terms of changes in beliefs and attitudes (H2 and H3). The differences in terms of changes in beliefs and attitudes after exposure to the site between the proximal and distal groups were statistically insignificant. This was surprising, as the literature points to the focus on spatial distance in public climate communications (i.e., melting ice caps and loss of polar bears) as one of the main reasons for climate change not being seen as a key risk requiring immediate action (Moser, 2010; Weber, 2006). There are several ways to view the lack of effect in terms of spatial proximity.

One way is to conclude that reducing temporal proximity is more important than reducing geographic proximity. The observed change in beliefs and attitude occurred even when browsing distant locations. Viewed in this light, reductions in temporal proximity may have a greater impact on beliefs and attitudes about climate change than geographic proximity. This conclusion, however, may not be true, for several reasons.

First, an unexpected and noteworthy finding in the study involved the amount of time spent on the site. The final hypothesis predicted that participants instructed to browse cities near the testing location would spend more time browsing the site than those instructed to browse distant locations. There was no statistically significant difference found between the groups. However, this may have been due to allowing participants to have 'free time' in terms of their exploring the site as they wished. Ten of the 46 participants (21%) ignored the researcher's instructions to browse only the instructed cities and immediate surroundings. For example, a number of participants browsed their designated cities before turning to other locations such as Austin, TX, Houston, TX, Denver, CO, and the Texas and Louisiana Gulf Coast regions. Therefore, despite being assigned to either the proximate or distal groups, many participants chose to look at other locations that may have been spatially significant to them. This may have muddied the findings, as those assigned to the distal group may have explored areas that are locally significant to them.

Second, the study did not account for scale in terms of what was considered proximal by the participants. All participants for the study were American citizens, and all originated from the continental United States. Regardless of whether they were assigned to the proximal or distal groups, all participants were still looking at locations within the continental United States. Thus, viewing the continental United States may have had enough geographically proximate relevance to all participants if the participants considered the continental United States to be meaningfully 'local.' Thus, the experiment may not have yielded differences because regardless of where the participants were looking, it was still perceived as 'local.'

Third, in a related point, this study did not take into account potential variations in how proximal was defined by each particular participant. In other words, the meaning that a location has for participants may have varied depending on their particular histories, family backgrounds, and experiences. While all participants were physically located in Lubbock, TX, for the study, participants assigned to the proximal group may not have had any meaningful attachments to the location. They may have considered other locations to be more personally meaningful to them such as where their families are from, where they may have traveled to, or where they would like to live in the future. Conversely, participants assigned to the distal groups may have had meaningful attachments to the cities they were assigned to view through having family there, having visited there, or by assigning other meanings to these places. Thus, the distal groups may still have been viewing areas with high personal meaning and therefore still experienced proximal impacts to areas they care about. This study did not account for the potentially subjective nature of assigning proximate meaning.

Fourth, this study did not take into account interactivity as a potentially defining factor accounting for changes in beliefs and attitudes. Both the proximal and distal groups were each exposed to the same level of interactivity in the site. The empirical evidence of study participants engaging in personally relevant browsing behavior despite instructions to the contrary suggests the utility of the interactive interface in terms of finding locally meaningful content. Findings within the advertising literature on the relationships between interactivity and meaning creation show that providing interactive pathways on a website can lead users to attribute personally relevant meaning to content they find. The act of searching and finding content itself can become a personally meaningful action that leads to the attribution of personal meaning to the content (Pavlou & Stewart, 2000). Thus, the user agency made possible through the climatedata.us interface may itself elicit meaningful attachments to places that are searched. This potential attachment of meaning to the local exploration of the map was not accounted for in this study.

Fifth, the level of personal proximity in terms of what climate impacts mean to people might be improved with the addition of new data sets that show impacts other than temperature and precipitation. If the perception of risk is mediated by the viewer's proximity to these risks, adding data sets that are less abstract than temperature and precipitation, such as climate impacts on food, drought, water, economies, transportation, housing, and others, may increase the magnitude of perceived personal risk. This is worthy of future research.

Conclusion

Despite not revealing any statistically meaningful relationship between geographic proximity and changes in beliefs and attitudes regarding climate change, the empirical evidence for this general approach to presenting climate change information is strong. Regardless of the experimental groups they were assigned to, all participants scored strong changes in beliefs and attitudes as a result of interacting with the site. While the study did not show any significant difference in browsing time between the proximal and distal groups, providing local-level content through the mapping interface still compelled people to look at the projected impacts of climate change under two different risk scenarios.

This effect points to the need for future research that defines “proximal” in order to determine whether geographical proximity meaningfully influences belief in and attitudes toward climate change. To do so, several studies should be undertaken. First, a study on scale should be undertaken to determine whether exposure to various scales of geographic proximity renders different results. For example, continental-level scale views could be tested against city-level scale views to determine whether these produce different impacts on beliefs and attitudes. Similarly, another study should take into account the meanings assigned to various locations by the participants themselves to determine whether exposure to geographically meaningful areas renders different changes in beliefs and attitudes versus exposure to geographical areas that are not viewed as meaningful to participants. A third study should also be undertaken to determine how interactivity itself as a variable influences beliefs and attitudes by comparing participants who have the capacity to self-direct their searches with participants who do not.

The results of this study are therefore varied. The findings support Weber’s (2006) and Sterman’s (2011) call for the use of interactive simulations to explore climate risks as a mechanism that can change beliefs and attitudes about climate change. All participants, regardless of their assignment to distal or proximate groups, showed strong changes in beliefs and attitudes simply through exposure to the site. This points to the efficacy of using interactive approaches to at least reduce the temporally distant nature of climate risks by showing its impacts on a time scale relevant to participants. However, the results are inconclusive in terms of whether or not geographic proximity is an important variable to consider. This surprising result requires future research that further defines what geographic proximity means to participants and at what level geographic scale becomes meaningful. Furthermore, adding data sets that are more personally relevant than temperature and precipitation is worth exploring in terms of increasing the perception of livelihood risks associated with climate change.

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CHAPTER 5. CONCLUSION

From biodiversity loss to ecosystem degradation, pollution, and climate change, we face many global environmental issues today. The scope, scale, and risks associated with these myriad issues make environmental education critical. Considering that resolving many of these world's environmental challenges will require economic, social, and political change at both the micro and the macro levels (Scherr & McNeely, 2007), it is easy to understand why environmental education is difficult. The field of environmental education must cut across disciplines, turn complex data and concepts into understandable information, and connect to disparate communities (Wals et al., 2014).

While the production and use of digital media tools within the context of education is growing rapidly, many within the environmental education community view digital media with some skepticism (Jickling, 2008). Digital gadgets and screens are seen by many as tools that take us away from nature and, therefore, distance us from the environmental impacts of our choices. Given that recent global polls show that the average time spent in front of a screen is between 5 and 9 hours a day in the developed world (Meeker, 2014), this argument carries weight.

However, how we act toward nature is largely influenced by how we understand it (see Temper & Martinez-Alier, 2013). Seeing the Earth enveloped in black from the moon "focused our energies on the home planet in unprecedented ways, dramatically affecting our relationship to the natural world and our appreciation of the greater community of mankind, and prompting a revolution in our understanding of the Earth as a living system" (Benjamin, 2003). Seeing hurricanes through the lens of climate change affects behaviors toward reconstruction after natural disasters. As Painter (2013) points out, reconstruction efforts differed drastically between New Jersey and New York after Hurricane Sandy. New Jersey's reconstruction plans framed Sandy as a one-time event. New York's framed it within the context of a changing climate with the likelihood that it will happen again. This led to drastically different reconstruction and environmental plans (Cutter et al., 2014; Painter, 2013). Native to China, the Kudzu is a beautiful tree with sweet-smelling blooms, sturdy vines, and large leaves that make it a desirable plant for landscaping. But understood through the lens of invasive species, the Kudzu is a destructive killer, capable of growing at a rate of one foot per day and overtaking local species and landscapes in the United States (Waldner, 2008). The decision to plant or destroy Kudzu is largely determined by how it is viewed. Our experience of nature and our actions around it, therefore, are mediated largely by what we think we know about it. Digital media, I believe, can therefore play an important role in environmental education by allowing for novel ways of framing issues and distributing information.

The three chapters presented in this dissertation were attempts to leverage digital media tools in new and innovative ways to see whether they improve environmental education outcomes. The first chapter, "Producing Real-World Problem-Based Environmental Education Videos," explored novel production methods for communicating human-ecological systems and challenges. The second chapter, "Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge*," used the web as a mechanism to exchange knowledge between students and practitioners working to protect critical environmental resources. The third chapter, "Communicating Local Climate Risks Through Downscaled Climate Projections," describes experiments with new web-based mapping technology to communicate proximate climate risks. At the core of each chapter is an overarching effort to leverage digital media to help frame issues, impact beliefs, and, hopefully, change actions. All three showed promising results.

"Producing Real-World Problem-Based Environmental Education Videos" explored a video production process that combines traditional filmmaking methods with participatory methods. The challenge this methodology was designed to address is that of producing real-world environmental videos for an educational audience. In traditional documentary making, directors with film crews shoot a video with a story in mind prior to filming. The characters are interviewed prior to shooting and the story is laid out in pre-production. Once shot, the video is edited to produce a final product driven by considerations such as budget, audience, market, and the creative vision of the director (Lunch & Lunch, 2013). Participatory methods, on the other hand, place the entire power of the narrative and its production in the hands of communities. Thus the representations of the communities are created by the community members themselves (Mistry & Berard, 2012; Nelmes et al., 2007). Creating environmental videos of real-world problems, however, requires that the representations of communities be in the hands of participating members while still linking back to the theoretical and conceptual frameworks being taught in classes. Thus, a hybrid model of video production was proposed and tested.

The methodology put trained video professionals in the field with a process that included various stages of approval by the community members being represented in the videos. Professional filmmakers were responsible for the product and the inclusion of environmental concepts and theories, and the community participants were responsible for how they were depicted. The result, it was hoped, would be educational videos that provided students with better learning outcomes while giving the narrative power and control to participating community members.

The productions showed promising results in the classroom. Students reported that the visuals provided a human reference to the concepts and theories taught in class and that the videos 'humanized the subject matter' by providing a 'real-world example' of the topics they were studying. This connection to the characters in the videos provided a point of empathy for students, as it helped them to 'relate to the issue on a human level.' As such, students were readily able to point to the multidisciplinary objective of the videos and identify how human and ecological systems connected. The analysis of motivation and self-efficacy showed a large majority of students reporting increases in both areas.

However, there is room for improvement. The main challenge for any educational video production will be budget and access to professionals who understand both the educational content and how to work appropriately in communities. Thus, for this approach to scale, more needs to be done to train filmmakers to produce these kinds of works. This approach also relies heavily upon community engagement by requiring major time investments from community members. This constraint could be addressed by focusing production on shorter videos with very specific learning outcomes rather than on longer pieces that try to include many concepts and characters. Finally, this approach only tested the learning outcomes in the classroom. A future area of research that tests learning outcomes in the communities themselves if shown there is worthy of exploration.

"Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge*" examines the student learning impact of multimedia-based experiences of communities facing environmental challenges. This project sought to improve educational outcomes for students in the field of conservation through authentic learning experiences. The web was used as a tool to virtually bring students into the field and present them with real-world problem statements from practitioners that represented challenges they were facing. It was believed that for the project to be successful, all three major groups involved in using *ConservationBridge* would need to see benefits. This included the students using it as a learning tool, educators using it in their courses, and practitioners engaged in the production of the problem statements.

As with the first chapter, the results of this project were promising. Students demonstrated increased understanding of key course concepts, and said that they were more motivated to learn using the *ConservationBridge* case studies than through traditional textbook learning. They reported and demonstrated increased confidence in their ability to consider and discuss complex issues related to sustainability, saw improvements in their understanding of key human–ecological concepts, and reported increased motivation. Faculty reported an overall positive experience using *ConservationBridge* in their courses and perceived benefits for their students. They reported very strong agreement that the case studies were a good use of time, saw an increase in student understanding of core concepts, and saw a marked increase in student motivation. Practitioners found benefits as well. As the problem statements were produced by the practitioners themselves around questions they wanted answers to, they found that the research produced by the students was valuable and provided insights useful for their work.

There are several places for improvement and future research with *ConservationBridge.* Improved communication between students and practitioners was identified as one of the major issues with the project. Communication could be improved by adding facilitators to the teaching teams or by requiring that a student take on this role. Another improvement would be to add more context to the case studies themselves. This could include adding maps showing social, environmental, and economic data both within the site and surrounding it. Another approach that may improve student-learning outcomes is adding web-based citizen science components that could allow for the crowdsourcing of data gathering, analysis, or processing. If produced within the context of the case study sites, this work may also be greatly beneficial for practitioners.

"Communicating Local Climate Risks Through Downscaled Climate Projections" is another web-based experiment that explored whether a localized web-based visualization of climate impacts can influence changes in beliefs about and attitudes toward climate change. Such change is key to mitigating and adapting to climate change, as doing so will require significant public engagement (O'Neill & Nicholson-Cole, 2009). Climate change, however, is a notoriously hard topic to communicate, because of the lack of proximity between the causes of climate change (GHG emissions) and their myriad impacts (Moser, 2010). One approach called for in the climate change communication literature is the creation of interactive simulations that allow people to see for themselves what the locally specific projected impacts of climate change could be (Sterman, 2011; Weber, 2006). To test the efficacy of this approach, researchers built a website featuring an interactive map of future climate scenarios that project changes in temperature and precipitation. Housed at ClimateData.us, the site was tested at Texas Tech University. Participants in the study (N=46) were tested to see whether or not exposure to the site changed their beliefs about and attitudes toward climate change.

Results of pre-test/post-test on climate change belief and attitudinal measures yielded interesting results. Participants were grouped into two conditions (proximal and distal). The proximal group was assigned to view three local areas around Lubbock, TX. The distal group was assigned to view three distal locations spread across the continental United States. All participants exposed to the map were given 15 minutes of free exploration time. Interestingly, both groups exposed to the maps showed significant pre-test/post-test changes in belief and attitude toward climate change. In contradiction to the climate communications literature that suggests information provided at a local level will increase a person’s risk perceptions in terms of beliefs and attitudes toward climate change, this study did not find any significant difference between the proximal and distal groups. Regardless of which group they were assigned to, participants scored a significant pre-test/post-test change in beliefs and attitudes, but the differences between the two groups were not statistically significant.

While this study pointed to geographic proximity as not being as relevant to communicating climate risks as temporal proximity, the findings may have more to do with the design of the study itself. Geographic proximity was assumed at the outset of the research to mean geographical areas surrounding the study site itself. Thus, the proximal group was assigned to view areas surrounding Lubbock, TX. This assumption may be flawed. Twenty-one percent of all participants ignored the researcher’s instructions and explored other areas on the map regardless of which group they were assigned to. The site also allowed all participants to explore the same spatial scale of data. As all participants were American citizens, viewing the data at the scale of the continental United States may still have been seen as ‘local’ to them. Furthermore, the study did not take into account how the participants assigned personal meaning to the areas they viewed. Thus, the data gathered for the study could not be used to truly determine whether the distal group was truly seeing distal information, as the areas they explored may have had important personal meanings to them, thereby making their experience ‘proximal.’

The interactive site, however, did show promising results. Regardless of which group the participants were assigned to, the findings showed a strong statistical relationship between exposure to the site and changes in beliefs and attitudes. Future research, however, is required to better operationalize and define geographic proximity. This will require methods for identifying what specific geographical areas are meaningful to participants and how they attach meaning to these places. This will also require research into scale to understand at what geographic scale (i.e., continental vs. city block) data becomes more meaningful and personally relevant. Thus, this study should not be seen as conclusive evidence against the importance of displaying local-level data. Rather, it should be seen as a stepping-off point for future research that incorporates better defined operationalization of what geographic proximity means in order to adequately test its relevance for effective climate communications.

While the products that resulted from these three studies were distinct in their form (video, multi-media case studies, data map), all three make important contributions to the environmental education literature. All support research that suggests education can be improved through direct experience by reducing abstraction and making environmental issues more personally relevant. Furthermore, these studies also indicate that digital media can be successfully used as a tool to deliver such experiences.

Chapter 2, "Producing Real-World Problem-Based Environmental Education Videos," shows that production methods that are more inclusive of participants from a community facing environmental challenges are successful in providing a real-world experience of those challenges for students. While this chapter focused on production methods for the inclusion of community participants in the video-making process, classroom tests were conducted to see if the outcomes of this methodology yielded improved educational outcomes. Testing was limited in both the number of classes that participated and the lack of a control group against which to test. However, initial research proved promising. By focusing the videos on participating community partners, students were able to see how the environmental issues they were studying actually affect people in those regions. The videos served to humanize the environmental issue showcased, making it more relevant, less abstract, and more relatable. Thus, this chapter provides a meaningful contribution to the environmental education literature as it points to a methodology that can successfully capture participating community members' perceptions of environmental issues. It also adds to this literature by describing how exposing students to the final video product can increase desired educational outcomes.

Similarly, Chapter 3, "Bridging Learners with Practitioners Through Web-Mediated Authentic and Service Learning: The Case of *ConservationBridge*," shows that the web can be used to deliver multi-media case studies and connections to practitioners that serve to provide direct experience of an environmental problem. This tool deepened the students' direct experience of the topic by allowing them to directly engage with practitioners on the ground and produce work based on problem statements led by the practitioners themselves. Although the study had limitations in terms of a lack of a control group, preliminary results indicated that students who interacted with practitioners had higher learning outcomes. By allowing students to work on problems that they might face in their own professional careers, the case studies became more salient for students, and the work more personally relevant. This increased both motivation to learn and understanding of core theoretical concepts. The use of the web as a mediating force between students and practitioners, therefore, was successful in reducing abstraction, as the concepts and theories taught in class could be witnessed through the eyes of the practitioners. Students were also able to see how the concepts they were learning had practical applications in the real world. These findings not only support the literature on the benefits of experiential learning for students but show that experience can be mediated through the web by way of multi-media case studies.

Chapter 4, “Communicating Local Climate Risks Through Downscaled Climate Projections,” also shows evidence corroborating the benefits of direct experience for education and showed that the web can be used successfully as a mechanism to reduce abstraction. By using the web and big data mapping applications, abstract concepts related to climate change and its impacts were visualized at local-level scales. Test results indicated that allowing people to see climate data at spatial and temporal scales that are meaningful to them made climate change more personally tangible. This increased belief in climate change and changed attitudes about its associated risks. The study also showed that exposure to meaningful temporal and spatial scales also increased understanding of the severity of climate risks depending on carbon emissions. As such, this chapter contributes to the climate change communication literature in two important ways. First, it supports research suggesting that understanding of local-level impacts can increase people’s risk perception of climate change. Second, it shows that the web can be used to reduce abstraction and make the issue more personally relevant through the visualization of climate impacts at local scales.

While all three studies make important contributions to the literature, it is important to note that none of them are complete. The tools of digital production and dissemination are constantly evolving and changing. For context, this dissertation was started while Facebook was still only available to Ivy League schools and Mark Zuckerberg’s face was still the logo. The digital landscape has evolved drastically since this dissertation began and will continue to change quickly after it is complete. The studies here, therefore, are snapshots of the work produced and their efficacy in the periods in which they were produced. The approaches to producing, reducing abstraction, and disseminating stories described here will certainly change.

However, these changes are opportunities for improvement. New educational approaches that hold promise to both help frame environmental issues for students and connect them to the world are gaining momentum. Citizen science has become a major force in environmental data collection and education that supports both public participation and environmental stewardship (Dickinson et al., 2012; Booney et al., 2009). New tools for visualization are quickly transforming our capacities to make visual sense of massive data sets (Bughin et al., 2010). This, coupled with new open-data initiatives around the world in the public and private sectors, promises to provide visualizations of large environmental and ecosystem data in ways that can be understood beyond the science community. New social media and digital tools are constantly evolving and offering new ways to connect people and tell stories. In short, there are many opportunities to continue improving the projects described above. With effort, these projects will continue to adapt and evolve with the incorporation of new technologies, data, and techniques guided. It is hoped that these projects will continue to contribute to better environmental education.

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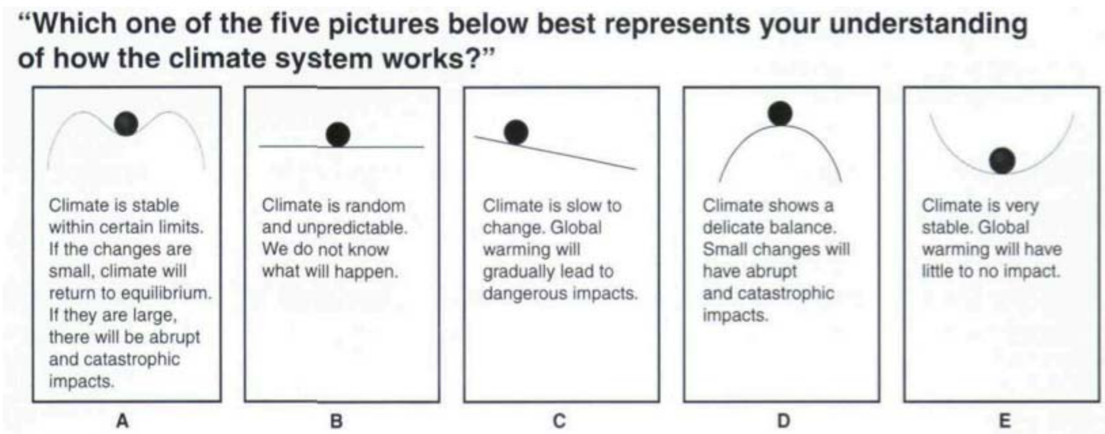
APPENDIX A: MEASURES FOR CLIMATEDATA.US STUDY

Conceptual Understanding of the Climate System (Leiserowitz, 2004)



Trust and Deference to Scientists (Brossard & Nisbet, in press, in Roser-Renouf & Nisbet, 2008)

1. Scientists know best what is good for the public.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. It is important for scientists to get research done even if they displease people by doing it.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. Scientists should do what they think is best, even if they have to persuade people that it is right.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. Scientists should make the decisions about the type of scientific research on climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Involvement (semantic differential items from Zaichkowsky, 1985, in Wojdynksi, 2014)

The information provided on this Web site:

Matters to me __ __ __ __ __ __ __ __ __ __ Doesn't matter to me

Is Relevant to me __ __ __ __ __ __ __ __ __ __ Is Irrelevant to me

Unimportant __ __ __ __ __ __ __ __ __ __ Important

Essential __ __ __ __ __ __ __ __ __ __ Non-essential

Wanted __ __ __ __ __ __ __ __ __ __ Unwanted

Mundane __ __ __ __ __ __ __ __ __ __ Fascinating

Beneficial __ __ __ __ __ __ __ __ __ __ Not Beneficial

Significant __ __ __ __ __ __ __ __ __ __ Insignificant

Of concern to me __ __ __ __ __ __ __ __ __ __ Of no concern to me

Perceived Interactivity (modified from Liu, 2003; excluded two-way communication items)

1. I felt that I had a lot of control over my visiting experiences at this Web site.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. While I was on the Web site, I could choose freely what I wanted to see.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. While surfing the Web site, I had absolutely no control over what I could do on the site. (RC)

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. While surfing the Web site, my actions decided the kind of experiences I got.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

5. The Web site processed my input very quickly.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

6. Getting information from the Web site is very fast.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

7. I was able to obtain the information I want without any delay.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Internet Self-Efficacy (modified from Eastin & LaRose, 2000)

1. I feel confident understanding terms/words relating to Internet hardware.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. I feel confident understanding terms/words relating to Internet software.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. I feel confident describing functions of Internet hardware.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. I feel confident trouble-shooting Internet problems.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

5. I feel confident explaining why a task will not run on the Internet.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

6. I feel confident using the Internet to gather data.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

7. I feel confident learning advanced skills within a specific Internet program.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

8. I feel confident turning to an online discussion group when help is needed.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Concern for Climate Change (modified from Leiserowitz, 2004)

1. How concerned are you about climate change?

Not at all Concerned	0	1	2	3	4	5	6	7	8	9	10	Very Concerned

2. How much do you worry about climate change?

Not at all	0	1	2	3	4	5	6	7	8	9	10	Very much

Attitude toward the Reality of Climate Change (some items modified from Lim & Golan, 2011 attitude toward Al Gore)

The fact that our climate is changing is:

Likely __ __ __ __ __ __ __ __ __ __ Unlikely

Honest __ __ __ __ __ __ __ __ __ __ Dishonest

Right __ __ __ __ __ __ __ __ __ __ Wrong

Reasonable __ __ __ __ __ __ __ __ __ __ Ridiculous

Intelligent __ __ __ __ __ __ __ __ __ __ Unintelligent

Believable __ __ __ __ __ __ __ __ __ __ Unbelievable

Wise __ __ __ __ __ __ __ __ __ __ Foolish

Attitude Certainty (modified from Petrocelli, Tormala, & Rucker, 2007)

1. How certain are you of your opinions toward climate change?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

2. How certain are you that you know what your true opinions toward climate change really are?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

3. How certain are you that the opinions you expressed toward climate change really reflect your true thoughts and feelings?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

4. To what extent is your true opinion toward climate change clear in your mind?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

5. How certain are you that the opinion you just expressed toward climate change is really the attitude you have?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

6. How certain are you that your opinion toward climate change is the correct attitude to have?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

7. To what extent do you think other people should hold the same opinions as you about climate change?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

8. How certain are you that of all the possible opinions one might have toward climate change, your opinion reflects the right way to think and feel about the issue?

Not At All Certain	0	1	2	3	4	5	6	7	8	9	10	Very Certain

Risk Perceptions (modified from Kellstedt et al., 2008; Leiserowitz, 2006; in Roser-Renouf & Nisbet, 2008)

1. Climate change will have a noticeably negative impact on my health in the next 25 years.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. Climate change will have a noticeably negative impact on my economic and financial situation in the next 25 years.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. Climate change will have a noticeably negative impact on the environment in which my family and I live.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. In your opinion, what is the risk of climate change exerting a significant impact on public health in your state?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

5. In your opinion, what is the risk of climate change exerting a significant impact on economic development in your state?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

6. In your opinion, what is the risk of climate change exerting a significant impact on the environment in your state?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

7. How likely do you think it is that worldwide, many people's standard of living will decrease during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

8. How likely do you think it is that worldwide water shortages will occur during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

9. How likely do you think it is that there will be increased rates of serious disease worldwide during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

10. How likely do you think it is that your standard of living will decrease during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

11. How likely do you think your chance of getting a serious disease will increase during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

12. How likely do you think it is that worldwide, many people's standard of living will decrease during the next 50 years due to climate change?

Very Likely	0	1	2	3	4	5	6	7	8	9	10	Very Unlikely

13. How serious of a threat do you believe climate change is to non-human nature?

Not Very Serious	0	1	2	3	4	5	6	7	8	9	10	Very Serious

14. How serious are the current impacts of climate change around the world?

Not Very Serious	0	1	2	3	4	5	6	7	8	9	10	Very Serious

15. Climate change is a threat to my future well-being and safety.

Not Very Serious	0	1	2	3	4	5	6	7	8	9	10	Very Serious

16. Climate change is a threat to future generations' well-being and safety.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

17. Climate change is a threat to all life on the planet.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Efficacy (various measures reported in Roser-Renouf & Nisbet, 2008)

1. I believe my actions have an influence on climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. My actions to reduce the effects of climate change in my community will encourage others to reduce the effects of climate change through their own actions.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. Human beings are responsible for climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. Ultimately, I am confident that the world community can find a solution to the problems posed by climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

5. The United States can take actions that will help mitigate climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

6. The actions of a single country like the United States won't make any difference in mitigating climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

7. I can take actions that will help reduce climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

8. The actions of a single person like me won't make any difference in reducing climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

9. There is nothing we can do to stop climate change.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

10. The actions we take can prevent climate change from becoming more severe.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Policy Support (Nisbet & Hart, 2012; some items modified from Six Americas segmentation (2009))

1. We should immediately increase government regulation on industries and businesses that produce a great deal of greenhouse gas emissions.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

2. We should immediately increases taxes on industries and businesses that produce a great deal of greenhouse gas emissions.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

3. Concern about global climate change is unwarranted and no action is needed.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

4. Climate change should be a priority for the next president and Congress.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

5. The government should regulate carbon dioxide (the primary greenhouse gas) as a pollutant.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

6. The government should provide tax rebates for people who purchase energy-efficient vehicles or solar panels.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

7. The government should create a new national market that allows companies to buy and sell the right to emit the greenhouse gases said to cause global warming. The federal government would set a national cap on emissions. Each company would then purchase the right to emit a portion of this total amount. If a company then emitted more than its portion, it would have to buy more emission rights from other companies or pay large fines.

Strongly Disagree	0	1	2	3	4	5	6	7	8	9	10	Strongly Agree

Demographics

Following are demographic questions. Please answer each question to the best of your ability by providing the response that most appropriately resembles your opinion.

1. What is your sex?

□ Female □ Male

2. What was your age on your last birthday?

______ years old

3. What is the zip code of your home address? _____________

4. When it comes to political parties in the United States, how would you best describe yourself?

A Strong Democrat	1	2	3	4	5	6	7	A Strong Republican

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