

Climate Change Communication in 3D Environments

*Agency and Place as Tools in Virtual Reality for Increasing Self-Efficacy
and Decreasing Psychological Distance to Climate Change*

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Abstract

People perceive climate change to be a distant phenomenon that is not relevant to them, this is referred to as psychological distance, the perception of how distant or proximal something is from an individual on four dimensions: spatial, temporal, social, and experiential. An individual's distance to an issue or event influences whether it is mentally represented and evaluated as abstract or concrete, in turn affecting behavioral responses and action. In order to decrease distance, we must make abstract concepts immediate and observable. Current climate change communication is disseminated mainly through traditional media channels, which are limited in their ability to successfully decrease distance to climate change and engage people in meaningful action. This research proposes that virtual reality is a promising channel for decreasing psychological distance due to the ability to transport users through time and space, and provide tools to exert their agency. This study investigates how the design of interactions within 3D environments can decrease an individual's psychological distance to climate change on each of the four dimensions. By working with graphic design students to design 3D interactive environments, the researcher developed a prototype for a system of tools intended for use within a virtual reality experience.

PART 1

Defining

the

Problem

Introduction

Q: “What are the boundaries of Design?”
A: “What are the boundaries of problems?”
-Interview with Charles & Ray Eames

Climate change is one of the most time-sensitive and life threatening issues we face as a global society. While the effects of climate change are becoming increasingly visible and tangible to particularly vulnerable communities and populations, many people and places across the globe still have yet to experience these effects. We attempt to relay the relationships between climate change’s impending effects on the environment and the people who make up our world, but this information is often fragmented, delivered as isolated events rather than as interconnected relationships within our ecological context.

Currently, we mainly receive climate change communication through traditional media channels such as television, books, and articles. These media channels place people within a passive role of consumer and receiver of information, with little means for active engagement, dialogue, and exploration. As Paulo Freire states in Pedagogy of the Oppressed (2000), “the more we accept the passive role imposed on us, the more we adapt to the world as it is”. When it comes to an issue as pressing as climate change, people can not just consume, reflect, and be aware, they must also engage, critique, and act. The public must understand their power and ability to have an active role in shaping and transforming their environments and futures. As Boehnert (2018) states, our future depends on not only a greater level of awareness, but perhaps even more so on a critical mass of individuals with the capacity for enacting personal and political change.

Our traditional means of climate change communication have only brought us so far in the fight against climate change. We need new approaches to how we conceptualize and facilitate discussion, engagement, and action on climate change issues. This is where designers have a critical role, as design is primed to function as a facilitator of social and technological change by creating new communication, tools, and techniques that influence audiences and users to change their ideas and behaviors (Boehnert, 2018). As communication technology develops and advances, and media channels possess increasingly immersive

and interactive features and content, we need to explore and envision the possibilities for communication and engagement within them. This project investigates the ways that we can design interactions with climate change communications that transform our perceptions and ways of seeing as a means to influence changes in associated behaviors.

At the time that I began ideating, researching, and writing for this project, I was driven by a desire to explore both the designers and citizens' role in climate change engagement and action. As I finish it, we have entered a seemingly new world, brought to its knees by a global pandemic. Now, more than ever, we must face the questions of what we are doing and what we are going to do moving forward to respond to global crises.

Problem Statement & Justification

Because action taken towards climate change is not immediately visible or rewarding, people perceive climate change to be a distant phenomenon that is not relevant to them. This is referred to as psychological distance, the perception that something (e.g., climate change) is uncertain, will occur at an unforeseeable point in the future, and is far away spatially, temporally, socially, or experientially (Evans, Milfont, & Lawrence, 2014).

In our increasingly visual culture, visual communication is many times the medium through which ecological learning is facilitated (Boehnert, 2018). Climate change issues have been communicated to the public for several decades through traditional media and various media channels such as the news broadcasts, social media, research studies, journal articles, podcasts, and political campaigns. While some of these channels aim to educate and bring awareness, others spur more tangible action from individuals, communities, cities, states, countries, and nations. As the issue of climate change becomes ever more present and threatening to our condition as a global society, it is imperative that these channels not only bring people to awareness, but to act on that awareness.

While media channels need to present information in a way that motivates engagement, this may be unsuccessful if people do not believe that they have the capability to make an impact and create change. Due to the scope of the issue of climate change, an individual's sense of personal efficacy — the feeling that individual actions can actually make an impact — is very low (Linden, Maibach, & Leiserowitz, 2015). The belief in one's own ability to produce desired effects by way of their actions is critical to producing action, without this belief, people have little incentive to act (Bandura, 2000).

Traditional media through which we receive most information usually negates education and knowledge as a process of inquiry, only allowing people a passive role. The more people accept the passive role imposed on them, the more they tend to adapt to the fragmented

view of reality deposited in them (Freire, 2000). To enhance people's self-efficacy and motivation to act, media channels need to make the unfamiliar and unprecedented tangible and relevant to the public in order to engage and empower them (Lejano, Casas, Montes, & Lengwa, 2018). This requires highlighting relevant experiences through scenarios and powerful narratives and metaphors as Marx et al. describes when talking about the need for experiential information, not just analytical information (Lejano, Casas, Montes, & Lengwa, 2018).

People represent risks in a spatially complex manner, inclusive of both proximity and distance. Describing climate change in spatially proximal terms is believed to counteract and decrease psychological distance in individuals receiving the messages, as it focuses on personally relevant people, places, and environments. But for people living in relatively privileged zones that do not see effects of climate change, a spatially distant perspective could bring them a stronger sense of urgency than a proximal perspective (Brügger & Pidgeon, 2018). Climate change should be seen, tackled, and communicated as an issue that is both local and global, proximal and distant (Gupta, Leeuw, & Moel, 2007)

There is a need in environmental education to bring innovative content and experiences to climate change education communication in order to bridge the gap between passively receiving information about climate change, and actively engaging with it (Adams & Gynnild, 2013). I propose that learning about climate change in virtual reality presents a special opportunity due to its affordances and ability to place people in various locations and allow interactions within various spatial representations. VR can be an immersive experience capable of transporting its user to alternative realities through the use of Head Mounted Displays, and can communicate information in ways that traditional forms of media cannot and are therefore limited by in regards to decreasing psychological distance and increasing self-efficacy.

Gigante (1993) described VR as “The illusion of participation in a synthetic environment rather than external observation of such an environment”. Immersive VR affords situated action, or the ability for people to move and act within a novel setting, which facilitates knowledge gain because learning occurs in the environment of interest. There is evidence that suggests people can develop strong social and psychological attachments to an environment by interacting and moving within it; this idea is rooted in embodied cognition research (Adams & Gynnild, 2013). VR experiences can be designed based on real-world scenarios or content, show abstract concepts in concrete ways, and bring distant places and experiences closer to the user.

Providing people with the tools and abilities to explore, interact, and learn allows them to engage with content and exert their agency over the interface, increasing self-efficacy. With an issue as complex as climate change, people cannot understand the current state of our world and all of its possible futures on their own. As the futurist Stuart Candy says, we must build the requisite tools to steer ourselves, and our communities, towards preferred futures. This project investigates the role of agency and interactions with place within VR experiences as a means to decrease psychological distance to climate change in users in order to motivate action.

Assumptions & Limitations

ASSUMPTIONS

VR is continuously changing, and this investigation does not examine the cost, ease, or accessibility of VR. I assume that VR technology is a media channel through which information will be disseminated at higher rates in the future, and therefore should be considered as an alternative to current traditional forms of media. With advances and mainstreaming of VR technology, I assume the costs of equipment will decrease and accessibility to VR equipment will increase. I assume that users will have access to VR equipment and be active and willing participants within VR experiences.

This research is not a definitive statement on how to decrease psychological distance to climate change, or increase participation with it's relevant issues, but rather a conceptual space within which to ground future VR experiences and explorations. I do not assume that the proposed use of a VR experience for climate change communication will “solve climate change”. Furthermore, I do not assume that users of such an experience are able to, or are responsible for, “solving” climate change. Climate change is a crisis that will require many solutions, from every level.

LIMITATIONS

While the assumption is that VR will be widely accessible and affordable in the future, at the time of this investigation I am limited by the current rate of adoption, accessibility, and precedents of VR technology and experiences. While research and resources focused on climate change communication in VR are currently available, they are limited.

I am limited by the time-frame of this investigation, in which the best use of time may not be in developing a fully working VR experience, but rather exploring the possibility space

for designing interactions that are intended to be implemented within VR experiences that focus on topics of decreasing psychological distance, climate change, or both.

Limiting the scope of the investigation permits deeper exploration into the concepts of agency and psychological distance as they relate to climate change and VR. These discoveries can then be useful for future research to determine how they can or cannot be incorporated, utilized, and implemented in representations of climate change issues within VR experiences.

Lastly, I am not limiting ideation and exploration to the possibilities of current VR technology and development, but allowing space for imagining future possibilities.

Annotated Bibliography

Communicating Climate Change

Traditional media channels are the main sources of disseminating information about climate change to the general public. It is these different voices, agendas, and media that influence our understanding and relationships with the environment. As they act upon us, they also invite us to act. This literature is critical in considering and understanding what the media’s roles and responsibilities are in disseminating this information and what the most effective communication methods are for bringing people towards awareness and action. This is imperative when attempting to communicate effectively through relatively new media channels such as VR.

Construal Level Theory & Psychological Distance

As important as it is to evaluate the current state of climate change communication in traditional media, in order to communicate to people effectively it is equally important to understand the way that individuals mentally construct and relate to climate change. Construal level theory and psychological distance are crucial to understanding the ways that individuals represent information as abstract (high level construal) or concrete (low level construal). This literature guides me in identifying what type of representation can be explored and utilized within a VR environment.

Framing & Role of Place

Psychological distance posits that there are cases for representing environments and concepts as both distal and proximate. The literature on the role of place in climate change communication is critical in understanding how the framing of climate change affects individuals. This literature is particularly important as I look at climate change

as a global issue that requires varied approaches depending on an individual’s location.

Virtual Reality for Climate Change

VR can provide us with direct access to digital media that seemingly has no limits (Jerald, 2016). But it is important to understand VR’s limitations and affordances in order to frame the experience in a way that matches the goal for the outcome of the experience. It is also imperative to know and critically evaluate what experiences are already out there, especially experiences that exist relating to climate change.

Self-Efficacy and Agency

According to Bandura, self-efficacy is the foundation of agency. Self-efficacy is the belief that one can accomplish a task, activity, or goal, and agency is the action one can take to achieve that goal. This literature guides this investigation in identifying experiences and actions that develop and improve self-efficacy in individuals and groups. A person with low self-efficacy is more likely to have “climate anxiety” and feel that there is nothing they can do about the issue. If we can help improve people’s ability to have high and positive self-efficacy beliefs, we can then move them towards exerting their agency in the world. In relation to climate change and the idea receptivity gradient (see page 31, Figure 5.1) this is crucial in understanding how to move people towards “ready to act”.

Communicating Climate Change	Design, Ecology, Politics: Towards the Ecocene	Boehnert, 2018
	Climate Change Risk Perception and Policy Preference: The Role of Affect, Imagery, and Values	Leiserowitz, 2006
	Weather, Climate, and Narrative: A Relational Model for Democratizing Risk Communication	Lejano, 2018
	Environmental Communication and the Public Sphere	Pezzullo, 2016
	Visual Climate Change Communication: From Iconography to Locally Framed 3D Visualization	Schroth, 2014
CLT and Psychological Distance	Mass Media Roles in Climate Change Mitigation	Swain, 2012
	Regulating Emotional Responses to Climate Change – A Construal Level Perspective	Ejelöv, et al. 2018
	Construal Level Theory and Spatial Distance: Implications for Mental Representation, Judgment, and Behavior	Henderson, et al. 2011
	Imagining Climate Change: The Role of Implicit Associations and Affective Psychological Distancing in Climate Change Responses	Leviston, 2014

	Construal-Level Theory of Psychological Distance	Lieberman, 2010
Framing and Role of Place	Environmental Messages in Online Media: The Role of Place	Adams, 2013
	Framing Climate Change and Spatial Planning: How Risk Communication Can Be Improved	Boer, 2007
	Spatial Framing, Existing Associations and Climate Change Beliefs	Brugger, 2018
	My Country or My Planet? Exploring the Influence of Multiple Place Attachments and Ideological Beliefs Upon Climate Change Attitudes and Opinions	Wright, 2014
	Considering Local Adaptation Increases Willingness to Mitigate	Evans, 2014
	Climate Change: a ‘Glocal’ Problem Requiring ‘Glocal’ Action	Gupta, 2007
Virtual Reality	Experience on Demand: What Virtual Reality is, How it Works, and What it Can Do	Bailenson, 2018
	The VR Book	Jerald, 2016
	Immersive Virtual Reality Field Trips Facilitate Learning About Climate Change	Markowitz, et al. 2018
	Virtual Field Trips and Climate Change Education for Tourism Students	Schott, 2017
Agency and Self-Efficacy	Perceived Self-Efficacy in the Exercise of Personal Agency	Bandura, 2000
	Exercise of Human Agency Through Collective Efficacy	Bandura, 2000
	Self-Efficacy: The Foundation of Agency	Bandura, 2000
	The Influence of Climate Change Efficacy Messages and Efficacy Beliefs on Intended Political Participation	Hart, et al. 2016
	Collective efficacy increases pro-environmental intentions through increasing self-efficacy	Philipp, et al. 2016

PART 2

Methodology

Conceptual Framework & Research Questions

CONCEPTUAL FRAMEWORKS

Idea Receptivity Gradient

David Rose's Receptivity Gradient is a framework for measuring behavior change on a scale over time. There are six positions ranging from not ready to know, to ready to advocate. This framework is important for considering that it is not possible to move a person through all positions from one intervention. You must seek to move them from one to the next, and therefore define and understand your target audience in order to identify the proper strategies.

My audience lives between the intersections of accepts ideas, acts on opinions, and becomes an advocate for the cause. Ideally, being moved to the latter end by interacting with the proposed VR experience.



FIGURE 5.1
Idea Receptivity
Gradient Adapted from
David Rose.

Theory of Psychological Distance

Psychologically distant objects or events are those that aren’t present in the direct experience of reality. Anything that is not present is distant, and can be thought of, constructed, or reconstructed but cannot be experienced directly. These alternatives to the direct experiences define four dimensions of psychological distances: temporal, spatial, social, and experiential (Liberman, Trope, & Stephan, 2007). This framework visualizes the four dimensions of psychological distance (Figure 5.2).

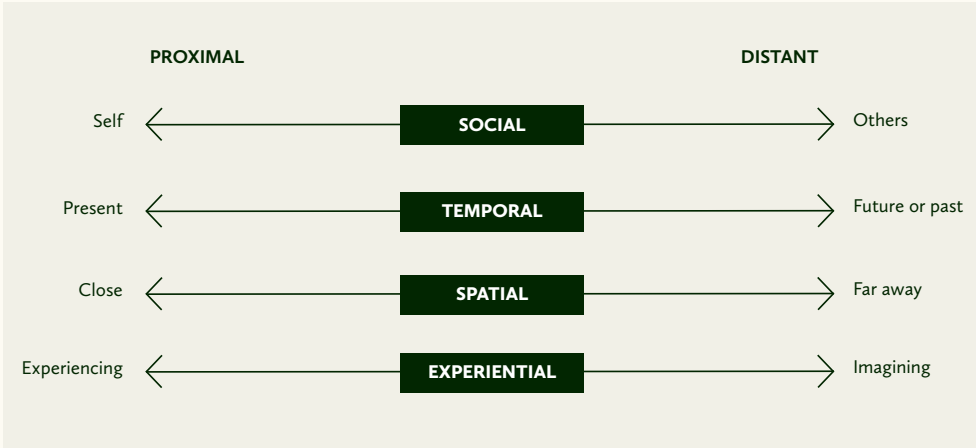
Spatial distance is the perceived space between a target and the self (Trope, & Liberman, 2010). Physical distance between an individual and the place where the event under consideration is taking place is the spatial distance (Prasad, 2015).

Temporal distance is the perceived time between a target and the self (Trope, & Liberman, 2010). Temporal distance refers to the events that are removed from the present time. For example, if one thinks of an event which is to take place four months later, there is greater temporal distance than thinking of an event that is to take place next week (Prasad, 2015).

Social distance is the perceived degree of social isolation of a target from the self (Trope, & Liberman, 2010). The degree to which two or more social groups or individuals are related to each other. It is the feeling of an individual as to how he or she interacts with other group members (Prasad, 2015).

Experiential distance is the perceived degree between imagining something and experiencing it (Trope, & Liberman, 2010).

FIGURE 5.2
Psychological Distance
Framework
Adapted from Rebecca
Hamilton.



Construal Level Theory

Construal level theory (CLT) proposes that the psychological distance of an object or event influences how it is represented and evaluated, in turn influencing the perceived set of behavioral response options available to respond to an event. CLT divides mental construals into two levels: high-level and low-level (Figure 5.3).

We view high-level construals as relatively abstract, coherent, and superordinate mental representations (Trope & Liberman, 2010). As we move away from direct experience of things, we know less information about those things, which requires representing them more abstractly than proximal entities. (Leviston, Price, & Bishop, 2014).

High-level construals are a way of thinking in the big-picture, thinking about the overall idea of the situation and extracting the main gist of the situation.

Low Level Construal are more detail-oriented or subordinate thought processes. Relatively unstructured, contextualized representations that include subordinate and incidental features of events (Trope & Liberman, 2010).

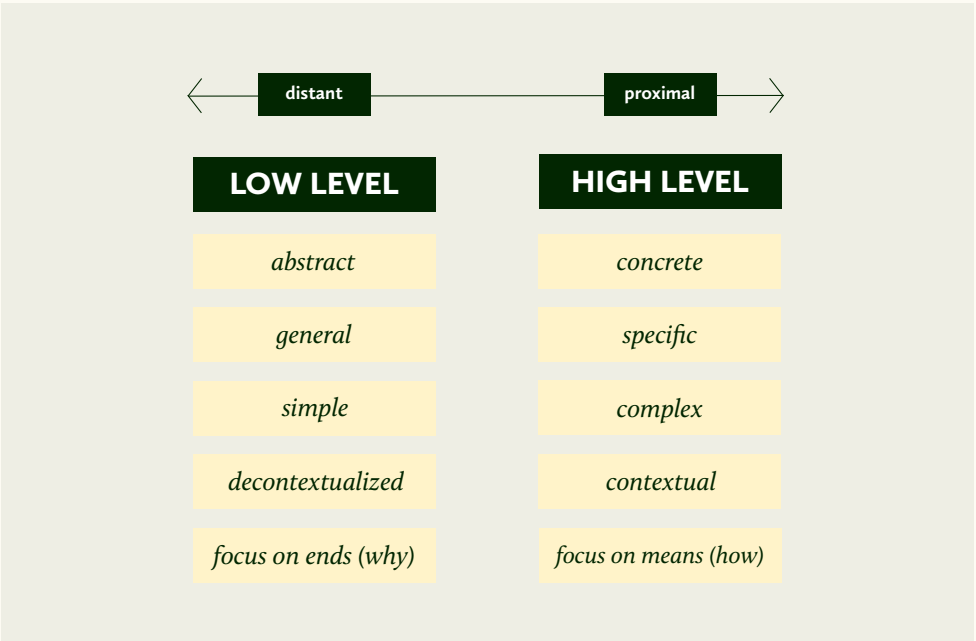


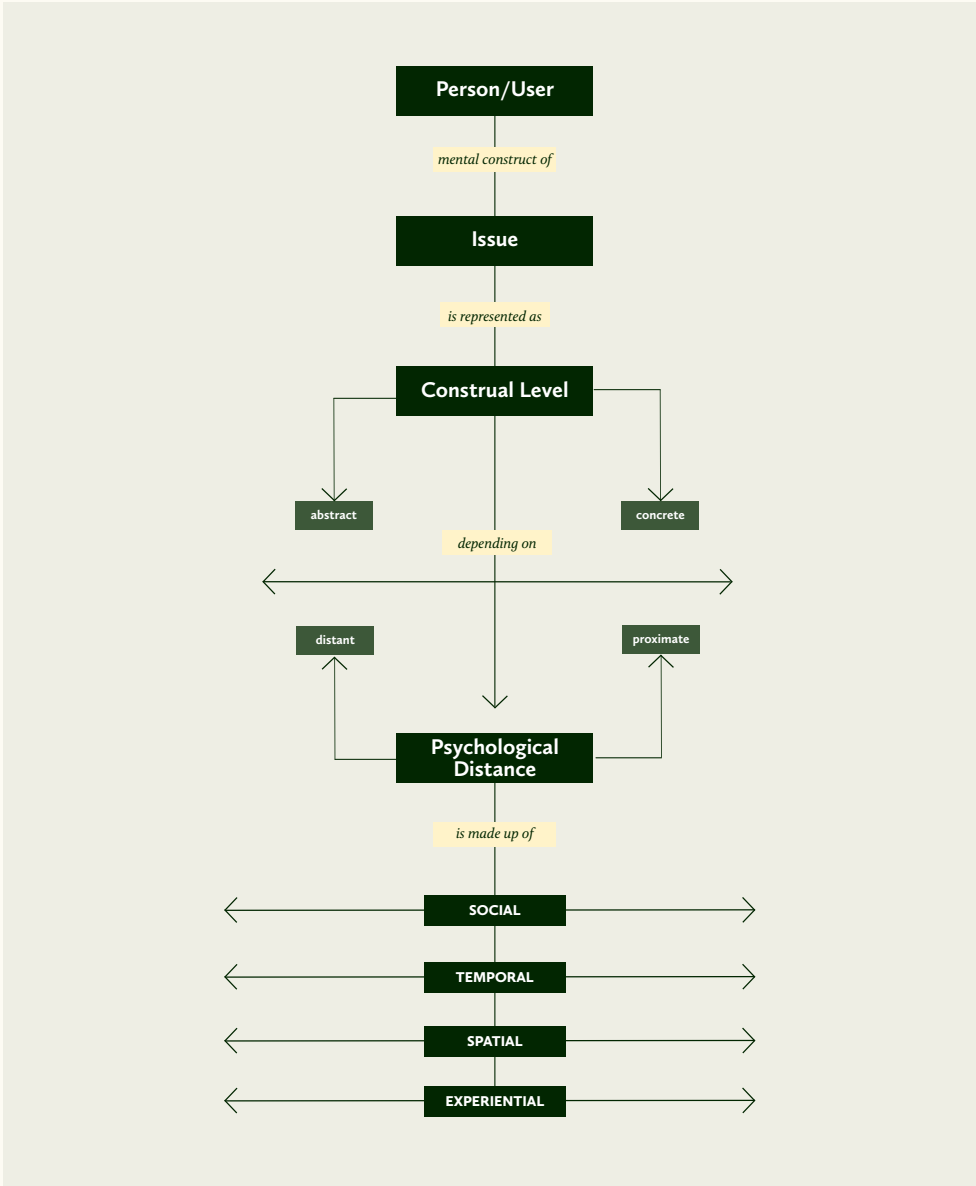
FIGURE 5.3
Construal Level Theory
Table
Adapted and synthesized
from Liberman & Trope.

Conceptual Framework

This conceptual framework synthesizes the relationship between psychological distance and construal level theory (Figure 5.4). The more psychologically distant people are from something, the more abstract they represent it, and vice versa. If they are psychologically distant from the information presented, the ability to construct meaningful mental images of the described situation is limited. They are likely to construct abstract and decontextualized mental representations and ideas of the described situations.

This investigation is grounded on the belief that if you can provide a person with various construal levels representations that can be engaged with in an interactive experience, this experience will add to their ability to mentally construct previously unfamiliar or abstract places or issues.

FIGURE 5.4
Conceptual Framework
This framework is a synthesis of construal level and psychological distance theories.



Investigation Framework

This agency vs. psychological distance matrix breaks down agency into two buckets, interactive and conceptual, and psychological distance into its four dimensions (Figure 5.5). I define interactive agency as the tools provided to the user that allows them to manipulate provided information, and conceptual agency as the information provided and presented to the user. These are further broken down into high and low agency. Low conceptual agency means there is a small amount or number of pre-determined and selected information available to the user. As compared to high conceptual agency which would provide a large amount of information to the user. Low interactive agency refers to the tools that allow for a small number of interactions and control over the information, as compared to high interactive agency that allows for complete control and customization over how the information is interacted with and experienced.

In this investigation, I analyze precedent projects and design the studies through the lens of agency and the dimensions of psychological distance. I propose that climate change communication in VR and 3D spaces should provide users with the highest amount of agency possible.

		DIMENSION OF PSYCHOLOGICAL DISTANCE				
		SPATIAL	TEMPORAL	SOCIAL	EXPERIENTIAL	
AGENCY	HIGH	CONCEPTUAL				
		INTERACTIVE				
	LOW	CONCEPTUAL				
		INTERACTIVE				

FIGURE 5.5
Investigation Framework
This framework combines the dimensions of psychological distance and varying levels of agency.

PRIMARY RESEARCH QUESTIONS

How can the design of *virtual reality experiences decrease psychological distance* to climate change in order to *increase citizens’ individual and collective efficacy*?

SUBQUESTIONS

- 1
- In what ways are information and narratives from traditional media transformed and enhanced when brought into 3D spaces?
- 2
- How can a 3D environment be designed to facilitate interactions that decrease psychological distance to a climate change issue?
- 3
- How can tools represent each dimension of psychological distance and interact as a system within a VR experience?

DEFINITION OF TERMS

Agency
Agency is the power people have to act in ways that shape their experiences and life trajectories. Agency can take individual and collective forms.

High agency
A large amount of information provided to the user, or tools that allow a high level of control over interactions.

Low agency
A low amount or number of pre-determined and selected information available to the user, or tools that allow for only a small number of interactions and control over the interface or the information provided.

Conceptual agency
Information provided and presented to the user.

Interactive agency
Tools provided to the user that allow them to manipulate that information.

Climate Change
A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels (Lexico, n.d).

Head-Mounted Display
A head-mounted display (HMD) is a visual display that is more or less rigidly attached to the head. Position and orientation tracking of HMDs is essential for VR because the display and earphones move with the head. Well-implemented HMDs typically provide the greatest amount of immersion (Jerald, 2016).

Immersion
Immersion is the objective degree to which a VR system and application projects stimuli onto the sensory receptors of users in a way that is extensive, matching, surrounding, vivid, interactive, and plot informing. Immersion is a description of a technology, and describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant (Slater & Wilbur, 1997).

Media Channels
A media channel refers to the specific medium by which a message is conveyed to its intended audience. Traditional channels include newspapers, magazines, billboards, direct mail, radio stations, and television stations. Online media channels include such communication vehicles as websites, social media, email, and search engines (Govoni, 2004).

Self-Efficacy
Determining the beliefs a person holds regarding their power to affect situations. Among the mechanisms of human agency, none is more focal or pervading than the belief of personal efficacy. This core belief is the foundation of human agency (Bandura, 2000).

Situated Action

The ability for people to move and act within a novel setting, which facilitates knowledge gain because learning occurs in the environment of interest (Jerald, 2016).

Virtual Reality (VR)

An artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer and in which one’s actions partially determine what happens in the environment (Merriam-Webster 2015). A computer-generated digital environment that can be experienced and interacted with as if that environment were real (Bailenson, 2018).

Methods

Literature Review

A literature review distills information from published sources to capture the essence of previous research or projects as they might inform the current project and converge information in a synthetic way. I performed a review of literature in relevant areas to understand the problem space and gain further insight on the research question.

Design Precedents

I performed a case study analysis of existing design projects and solutions using VR technology or other visualization methods that facilitate ecological systems learning. These existing solutions were evaluated or critiqued to identify features that may benefit this research.

Research Through Design

Research through design recognizes the design process as a legitimate research activity, integrating theoretical and conceptual frameworks with the design process to ground explorations and studies. Combining the findings from the frameworks, precedents, literature, and studies, I conducted a wide range of digital and functional explorations to generate designs for the VR experience prototype I propose.

Semi Structured Focus Group

A qualitative method used to gauge the opinions, feelings, and attitudes of a group in order to gain more insight regarding a design-related inquiry. In a peer setting, students share experiences, stories, memories, perceptions, wants, needs, and fantasies.

Design Workshop

Design workshops are a form of participatory design that utilize creative co-design methods into organized sessions for several students to work together.

Inductive Content Analysis

Content analysis is the systematic description of form and content of written, spoken, or visual materials in counted occurrences of words, phrases, images, or concepts (Hanington, 2012). I use inductive content analysis, in which the categories of description derive from a systematic reading of the data to be analyzed, establishing the categories that will be used for subsequent analysis.

In this case, I used inductive content analysis during study 1 (see media analysis section), I identified four pieces of media related to sea level rise, each in a different medium, and created the categories through which students would analyze the media. This provided the opportunity to identify common themes and patterns that emerged from the analyses.

Prototyping

Prototyping is the tangible creation of artifacts at various levels of resolution in order to test ideas. They serve as early testing of ideas so that the product is seen as a concept proposed for review and feedback for iterative changes.

All definitions cited from Hanington, 2012.

PART 3

Results

Results

PRECEDENTS

Virtual Planet: Sea Level Rise Explorer, 2019

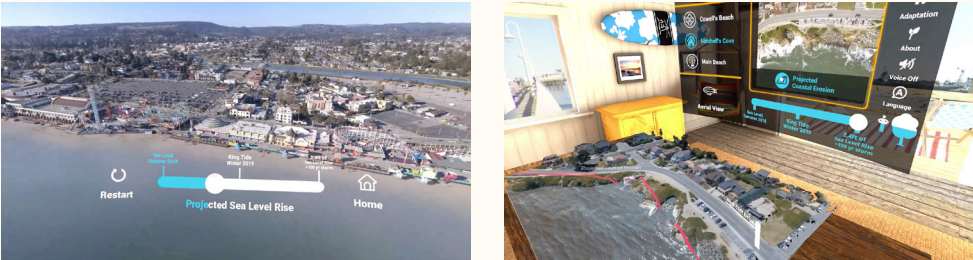


FIGURE 7.1
Sea level Rise Explorer
VR application that
allows user to see sea
level rise projections in
Santa Cruz, CA.

What it does:

The Virtual Planet Sea Level Rise Explorer depicts three locations in Santa Cruz, California: the main Beach Boardwalk and surrounding neighborhoods, Mitchell’s Cove off West Cliff Drive, and Cowells Beach, a globally popular surfing destination (Figure 7.1). For each location, the user can see projections of the beaches at 2018 levels, during a King Tide, and during a 100-year storm with 2.4 feet of sea level rise.

Relevance:

+
This experience was developed specifically for community members in the City of Santa Cruz, it is very effective in catering to a specific audience in order to communicate the immediacy of the issue in their own backyards. There is a certain degree of interactivity that allows the user to select between the three locations and move the slider between three

sea level conditions, providing choice and a small amount of agency over their experience.

While the experience is currently limited by the number of locations available, the development team on this project have indicated that their second phase of development will include a second coastal location, proposed solutions in the form of adaptation actions, an interactive survey, and a version in Spanish.

Greenland Melting, 2019

FIGURE 7.2
Greenland Melting
360 video experience
that follows NASA
scientists through
Greenland glaciers and
research stations.



The Greenland Melting experience uses a mix of 360 video, CG models, data visualizations, photogrammetry, and holograms. It is set in Greenland, as the user follows two NASA scientists through a linear narrative of the process of studying why the glaciers there are melting. The user is moved through several locations such as a NASA research boat as a timeline overlays how the ice has retreated over the years, a NASA research plane used for traveling across Greenland and taking various measurements, a helicopter, and below the water’s surface (Figure 7.2).

Relevance:

+ Particularly strong in this experience is the use of various locations to provide the user with multiple views of the glaciers and environments where research and data collection are carried out. The use of timeline and animation overlays are effective in providing further visual media that support the oral narration.

– The main limitation of this experience is the lack of interaction beyond looking around the 360 space. There is a lot of potential for providing interaction that allows the user to choose the order in which they would like to enter certain locations, and how long they spend within each location. As well as potential for introducing interaction within existing elements. For example, moving through a sliding timeline of years, rather than between.

Coral Compass: Fighting Climate Change in Palau, 2018



FIGURE 7.3
Coral Compass
360 video experience
showing causes and
effects of coral reef
damage in Palau.

What it does:

The Coral Compass experience shows users how the island of Palau is adapting to climate change to combat its effects on their reefs and economy. The experience begins with a view of where Palau’s is located on the globe, then zooms in to show the effects on coral reefs by causes such as tourism in the form of scuba diving, and poor land use that causes sediment buildup in the reefs (Figure 7.3). On a more positive note, the user is then shown a meeting of Palaun senators and marine scientists as they create initiatives to limit the number of people at any given reef, and solutions for good farming practices that reduce sediment in coral reefs.

Relevance:

+ Coral Compass is a great example of showing a location and how it’s impacted by climate change, in this case sea level rise, from multiple perspectives. Not only does it show the negative impacts, but also offers a view of real solutions that are being put into place, and ends by both visually showing and orally reminding the user of the beauty of earth’s coral reefs.

– While Coral Compass does a great job of balancing negative effects with positive solutions, it could tie these together by offering further resources for the user to engage in positive solutions as well. Additionally, there is no interaction beyond looking around the 360 space

This is Climate Change, 2018

FIGURE 7.4
This is Climate Change
360 video documentary
on forest fires,
deforestation, drought,
famines, and melting
glaciers around the
world.



What it does:

This is Climate Change is a four part 360 video documentary series that explores four key topics — fire, feast, famine, and melting ice — each in a different location (Figure 7.4). Glaciers in Greenland, fires in California, deforestation for cattle land in Brazil, famine caused by drought in Somalia.

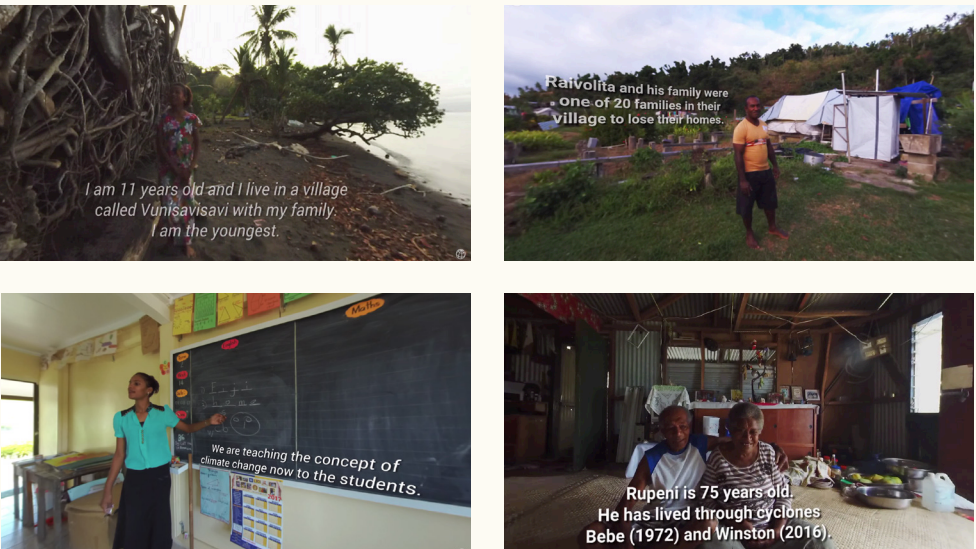
Relevance:

+ This series is a strong example of covering a variety of climate change topics or issues with consistency in visual style. In the melting ice video, the user is shown how a glacier collapsing in Greenland, causes a flood on the other side of the world in Florida. In Brazil the user follows the life of loggers as they cut down trees, views of the emptied forests, and then how those clearings are utilized for cattle. In California, the user follows firefighters actively putting out fires. Making the connections between cause and effect, showing people in action who are on the front lines of either contributing to the crisis, or fighting the crisis are all strong precedents for ways to decrease experiential distance.

– The main limitation of this experience is the lack of interaction beyond looking around the 360 space. As many of the scenes within each video show multiple locations, there is potential to organize the scenes on a map, so the user could understand detailed connections between the geographic locations of the scenes. This could also allow users to choose the order in which they watch the scenes.

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Our Home, Our People, 2017



What it does:

Our Home, Our People is a 360 video experience that takes the user on a journey to Fiji to tell the story of how Fijian people are affected by climate change today by following the lives of four people: Catalina, Rai, Asmita and Rupeni (Figure 7.5). Through narrative storytelling and findings from the Climate Vulnerability Assessment 2017, the user learns about the memories, hopes, and fears of Asmita, Rai, Rupeni and Catalina as they talk about how rising sea levels and extreme weather has already impacted them, and what support is needed for the future.

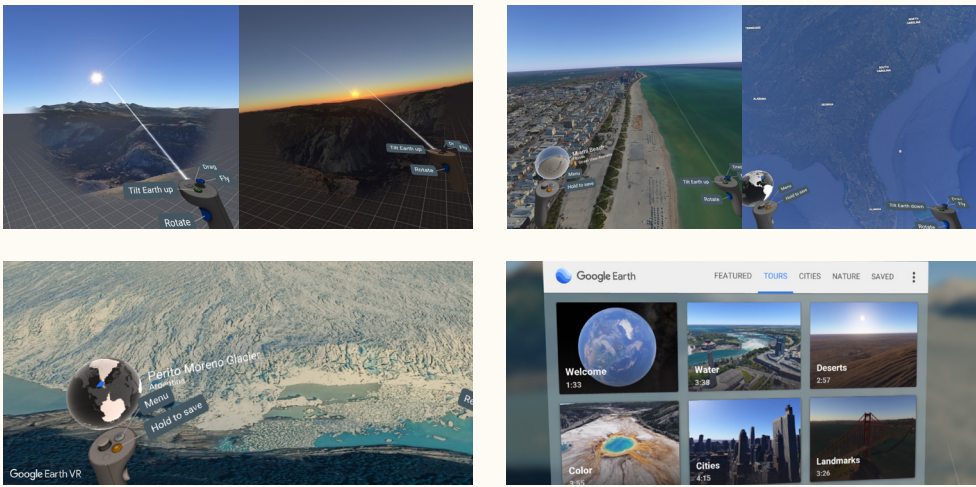
Relevance:

+ This experience is particularly valuable in its ability to connect the user with the real life stories and feelings of everyday people affected by climate change. This is particularly useful in decreasing social distance.

– The experience utilizes subtitles to translate people’s stories. The captions stay anchored in two places, if the user is looking in the other two directions, they are unable to read or understand the content. If the goal is to encourage a user to look around the in all directions, this is an inconvenience or possible frustration for the user. Additionally, there is no interaction beyond looking around the 360 space.

Google Earth VR, 2017

FIGURE 7.6
Google Earth VR
VR application that
allows users to fly all
over the world freely or
through curated tours.



What it does:

Google Earth VR allows the user to go to any location around the globe, the website highlights flying, walking, and browsing as the main features. The user flies through locations with the ability to zoom all the way into street view and walk around city streets, and all the way out to a state, country, or whole earth view (Figure 7.6). There is also a tours feature that brings the user through predetermined destinations, rather than free exploration, grouped by themes such as water, deserts, color, and landmarks.

Relevance:

- + The ability for a user to have access to geographic locations at various levels—global, national, state, city, neighborhood, and street view—is the ultimate platform that currently exists with this high level of potential to decrease spatial distance. Additionally, if we want to provide the highest degree of conceptual and technical agency possible, the user should be able to move through space as they please, which is the case in Google Earth VR. Compared to many of the 360 video experiences, this allows for a much higher level of interaction.
- The tours feature is a valuable addition for the user who does not want to freely explore at any given moment, providing them with a curated tour of locations. That being said, it does not provide any further information about the location or the option to decide when you move to the next scene. There is potential here to teach about specific events or stories through these tours, as well as through the free explore option. A detail within the experience is the ability to drag the sun across the sky to see the time of day change in real time. This feature points to potential for decreasing temporal distance through providing time scales that go beyond that of one twenty-four hour period.

Ocean Acidification Project, 2016



FIGURE 7.7
Stanford Ocean
Acidification Project
VR application that
visualizes CO₂ molecules
in the air and entering
the ocean and takes
users underwater to
coral reefs.

What it does:

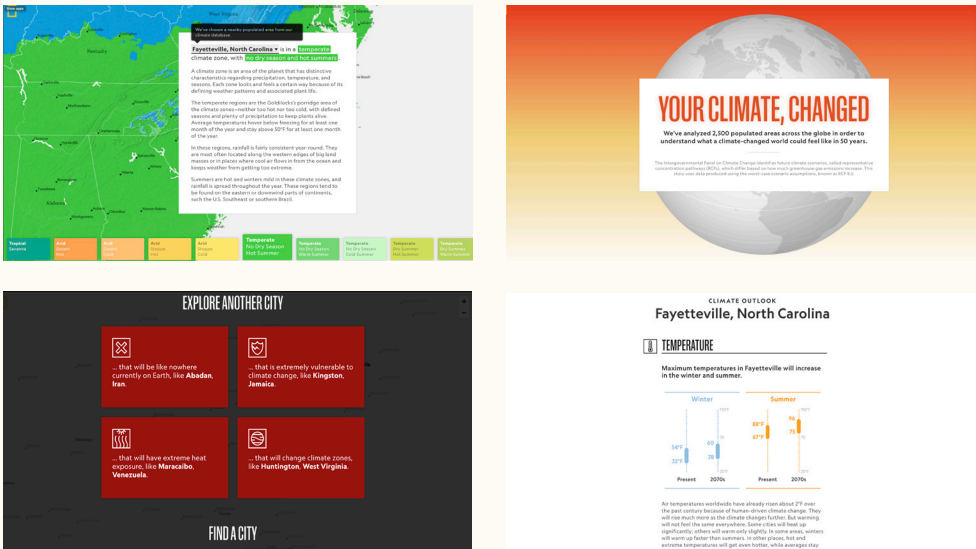
The Ocean Acidification experience makes usually invisible CO₂ molecules visible by representing them as physical objects and having the user watch the molecules be emitted from cars and absorbed into the ocean. The user is placed underwater at the bottom of a coral reef, first seeing what a healthy coral reef environment looks like and are tasked with tracking sea snails with flags (Figure 7.7). The user is also shown what an unhealthy reef looks like. To close out the experience, the user is asked to think about themselves in relation to the earth and states that it isn't too late to take steps to reduce your carbon emissions.

Relevance:

- + This experience allows a higher level of interaction than many of the other precedents in this section, actively engaging the user in an activity to see cause and effect relationships. The representation of invisible molecules as physical objects allows a usually abstract concept to become a concrete visualization. Placing the user underwater in the context of a coral reef brings the user closer to a usually spatially distant location.
- While the user is prompted at the end of the experience to consider that it's not too late to reduce their carbon emissions, there is no offer of information or resources on what steps can be taken or are already in place to reduce carbon emissions. In regards to the dimensions of psychological distance, this experience could be strengthened by showing coral reefs in various locations, the state of coral reefs in the past and impacts of CO₂ on coral reefs over time, and the implication that unhealthy reefs have on humans as well as animals.

National Geographic Climate Patterns, 2020

FIGURE 7.8
National Geographic
Climate Patterns
Interactive website
published by National
Geographic for Earth
Day 2020.



What it does:

This website was made for National Geographic's Earth Day issue, it shows comparisons between the weather conditions experienced in a location today vs. the city that location will feel more like in 50 years if carbon emissions continue to rise (Figure 7.8).

Relevance:

+ The user can choose locations that may be personally relevant to them, helping them understand the implications of climate change on their personal and everyday lives in the future. This could be useful for decreasing experiential distance. The website also provides a variety of visualizations to understand the data.

– The data point here is limited to weather and temperate zones, but has potential for applying many other datasets relevant to the climate change effects. It is powerful to see the projection for fifty years from now, but could provide the user with variability in time-frame.

Google Earth Voyager Tool, 2017

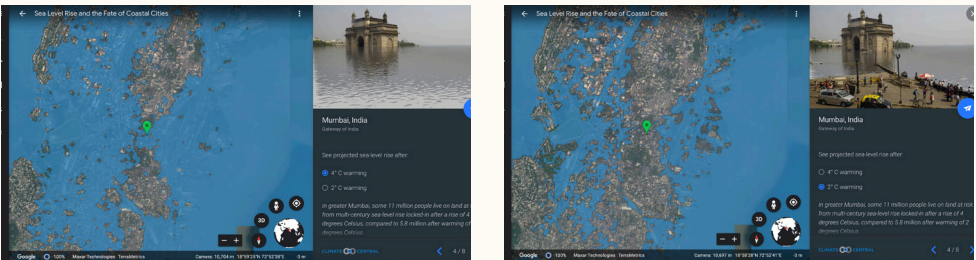


FIGURE 7.9
Google Earth Voyager
Feature of Google Earth
website that allows users
to explore and learn
through curated tours.

What it does:

Google Earth can also be accessed from the web, which has the same main features as the VR version that allows flying, walking, browsing, and curated tours. Here I am focusing on the Voyager feature because it is analogous to the tours feature in the VR version, but with additional information in a separate window on the right side of the page in the form of text, images, videos, and some interaction (Figure 7.9). These tours are grouped by themes such as nature, culture, travel, and education. The tour shown and described here is called Sea Level Rise and the Fate of Coastal Cities.

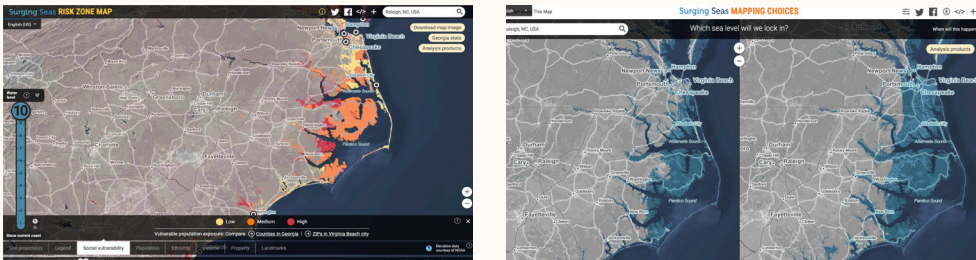
Relevance:

+ Similar to the VR version, the tours are a curation of predetermined destinations. The differences are that you can click through the locations at your own pace, and each location provides additional information. In the tour about sea level, the user can see two projections of sea level rise in each location, after either 2° C or 4°C of warming. This is useful in decreasing experiential and social distance by visualizing possible effects on a place and on people. Compared to many of the 360 video experiences, this allows for a much higher level of interaction.

– The ability to view multiple projections does not provide information about the probability or time-frame of the visualized possibilities occurring. This additional information would further decrease experiential distance as well as temporal. Although the differences between the two projections on the map are perceptible, they are rather visually subtle. The images on the right reinforce the projections on the map, showing a much more dramatic change because the people are replaced by water. If the additional information provided could be incorporated into the map, it may feel less fragmented for the user.

Surging Seas: Mapping Choices & Risk Zone Map, 2015

FIGURE 7.10
Surging Seas
Interactive website
published by
climatecentral.org that
shows projections of
sea level rise on coastal
cities.



What it does:

Surging Seas: Mapping Choices and Risk Zone Map are two separate maps published by climatecentral.org (Figure 7.10). For the purposes of this analysis, I will discuss them both here. Both sites allow the user to search for the coastal location they would like to see and choose various conditions, ranging from no carbon cuts to extreme carbon cuts, in order to view projections of sea level rise in that area.

The Risk Zone Map shows areas vulnerable to near term and long term flooding, vulnerability can be seen through filters such as population, ethnicity, income, property, and landmarks. There is also a slider the user can move through water levels in either feet (1-10 ft) or meters (0.5-30 m). The user chooses the water level and a condition in order to see the year in which it is predicted this water level would be reached under this scenario.

The Mapping Choices site has less data points to interact with, but allows the user to choose between two years, and two conditions, to see a comparison of the two scenarios in the selected location.

Relevance:

+
Both maps effectively compile many data points based on established research to visualize sea level rise's effects on coastal cities, potentially decreasing experiential distance. They also compare various scenarios based on conditions that we (as a society) still have the possibility to choose between, showing the user that something can be done about the future of these coastal cities. Additionally, the user can choose locations that may be personally relevant to them.

—
While the Risk Zone Map has more potential than Mapping Choices for decreasing social distance due to its social vulnerability filters, it is still a bit abstract in detailing what this means for the affected populations. While the sites imply to the user that there is a choice to make, there is no offer of additional information of resources that would point to how these conditions can be achieved or pursued.

Precedent Analysis

I analyzed precedents using the investigation framework (Figure 7.11). Precedents were evaluated based on the information provided and the tools provided for interaction with that information. Available information and tools were then categorized based on the level of agency, either high or low, and the dimension it most closely represents.

For example, I analyzed Our Home, Our People and categorized it as an example of the social dimension due to it's ability to allow a user to get closer to stories of people and places they may not personally identify or have experience with. I then categorized that feature as having high conceptual agency, because there are many storylines and locations which the user has access to. But, I categorized the same experience as having low interactive agency, due to only being able to interact with the video and stories through clicking around the screen to reveal more of the 360 photo, and rewinding or forwarding the video to manipulate the information presented. As compared to the Google Earth voyager tool, categorized as having high interactive agency due to the user having the ability to select which event or story they will enter and in what order, and having full control over how they move through each event space.

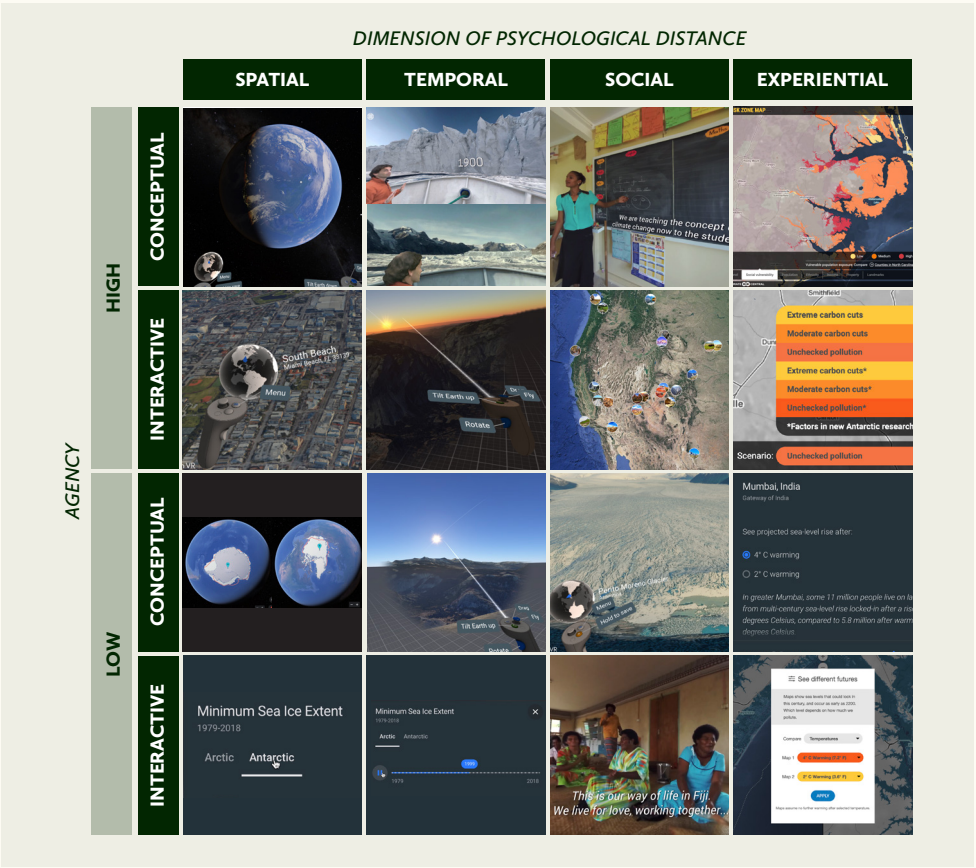


FIGURE 7.11
Precedent Analysis
Investigation framework
filled out with analyzed
precedents based on
levels of interactive and
conceptual agency.

STUDIES

STUDY 1. FROM TRADITIONAL MEDIA TO 3D SPACE

Subquestion 1: *In what ways are information and narratives from traditional media transformed and enhanced when brought into 3D spaces?*

In order to better understand how to successfully communicate climate change information in VR, this study analyzes the affordances and limitations of various forms of media channels, and their current tactics for communication. With the goal of gaining an understanding of the features used within various media channels and the success or failure of those features in creating awareness or motivating people towards action. This study consists of three investigations: a focus group, media channel analysis, and early design explorations.

I first designed and planned the focus group and media channel analysis activities, and then facilitated them with a group of thirty-eight students who were enrolled in GD 210: Image and Tech Tinkering during the Spring 2020 semester, taught by Dr. Derek Ham and with myself as the teaching assistant. This course, a required studio for second semester freshmen in the graphic design program at NC State, is an introduction to exploration with the reproduction and experience of imagery, and the technology relevant to current and future design practices. The context of this class provided the ideal environment in which to engage in discussion and analysis with students regarding the affordances and limitations of various media channels.

1A. FOCUS GROUP

For the focus group, I was the single moderator and engaged in discussion with the students by asking semi-structured questions. At the beginning of the session, the students were provided with sticky notes and prompted to document answers to various questions on the notepads (Figure 7.12). While there were eleven questions asked and discussed in total, students were only prompted to document their responses to eight of those questions on the notepads. The session was recorded with an audio device, and documented with photos. The audio recording and notepads served as the data collected for later analysis of the focus group.

My objective when creating the moderating questions was to elicit thoughts, feelings, or ideas from the students to gain insights into their dispositions towards the issue of climate change, how often they consume or engage with various media channels, their preferred media channels, and events or factors they perceive as having the potential to impact positive change in relation to climate change. The semi-structured format allowed the flexibility for myself and the students to pivot questions and topics to those deemed relevant and important in relation to the live dialogue between students.

The limitations to this method include the student’s knowledge of this project’s research context and my own disposition towards the issue of climate change, thereby introducing bias in both the students and my responses.

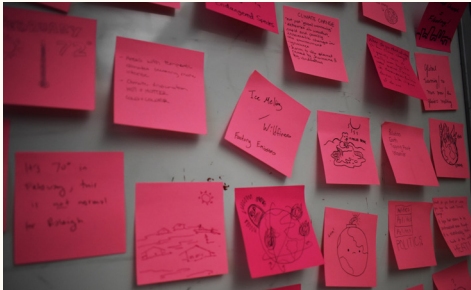
Questions

- 1. What do you think of when you hear the words climate change?
- 2. Do you see climate change as something that’s happening in other far away places, or closer to home?
- 3. What have you been seeing or noticing in the news in relation to climate change?
- 4. When thinking about climate change messaging in the media, what types of messages appeal to you?
- 5. What do you think design as a profession’s role is in climate change, if it has one at all?
- 6. How often are you engaged with issues related to climate change?
- 7. How optimistic or pessimistic are you about climate change, on a scale from 1-10?
- 8. Is there anything you’ve seen, read, heard, or experienced that has made you take action or make a change?
- 9. What is your preferred way to hear news about climate change?
- 10. What do you think of when I say sea level rise?
- 11. Where is sea level rise happening?

Outcomes

The intention of the discussion was to start with broad questions and become more narrow and specific throughout the discussion. If this focus group were to be redone I would minimize leading questions, and update the questions to be even more narrow and specific. Additionally, I would give each student a number to mark their sticky notes which would enable matching responses across questions and audio transcripts.

FIGURE 7.12
Focus Group
Students document responses to discussion questions on sticky notes during the focus group.



Thematic Analysis

I performed a thematic analysis on the data collected from the focus group. I identified patterns in the transcripts, notes, and my own recollection of the focus group in order to group themes often discussed or written. For the proceeding sections, quotes from students are highlighted based on their ability to represent each theme.

Accessibility of data and information vs. lack of calls-to-action, next steps, or solutions. When asked what kind of information appeals to or engages them, all students who responded verbally identified that receiving information about climate change issues is easy, but knowing how to interpret or act on that information is difficult.

“...I know these are problems but I don’t know what to do to fix it. A lot of it is like, these are the statistics, but I don’t know what that means.”

“...Actually acting on that information is difficult when the issue is so large.”
When asked what information they have been hearing or seeing in the news, one student mentioned that they see reports of catastrophic events happening globally with such frequency that they feel desensitized, and that the reports don’t provide much information about what you can do about it, causing them to feel helpless.

“We’re so used to seeing those things on the news. It’s hard when you don’t know what to do, it’s just the report but you’re not given a lot of like here’s what you need to do.”

“I go through a cycle of climate awareness. I’ll hear about something and then I’ll be like oh wow that’s really depressing I hate that. And then I try to see what I can do and there’s usually nothing so I try to forget about it to preserve my sanity, and it just keeps happening.”

When asked to respond on sticky notes about whether they have read, seen, or experienced something that made them take action or change, several students were not able to identify anything. Writing things like:

“I’m not really sure how to take action so I don’t.”

“I feel like all I can do is worry + fear. I don’t feel empowered. I feel like I can’t do or fix anything. I’m just one person, this problem is so much bigger than us as individuals.”

Visualizing impacts. One student expressed their belief that people are not able to quantify, visualize, or understand the effects of individual and personal actions and impacts.

“With a lot of big picture issues, people find it hard to realize how much or little of an impact they cause by doing something. They think oh recycling this one thing isn’t gonna change everything, so why should I?”

While students preferred a variety of media channels, a commonality between the descriptions was the desire to visualize impacts, estimates, and projections.

“Videos that address impact and actual physical effects that we see, because then you can sympathize or empathize more than you can with facts about how many degrees the earth is warming.”

“I like interactive websites, like the ones where you put in information about your habits and it gives you an estimate of how bad you’re messing up. Those inspire me, because it’s easier to understand what you’re doing wrong, what habits are the most harmful, and what isn’t actually that harmful.”

“I like video games that extrapolate climate change in the future, it’s nice to see what could happen if this happened. Me and my wife play ‘City Skylines’. It’s just city building but you have to manage pollution, how energy efficient your buildings are, when you build water treatment plants. If you build [the treatment plant] up river, your pollution goes down river and then all your people get sick. It’s great because you learn about how your city is supposed to be built in reality and you start looking at your city, and you’re like oh man this water pump is in the wrong spot.”

Individual responsibility vs. corporate and governmental responsibility. When asked about the designer’s role in climate change, it was difficult for the students to consider

applications of design beyond transforming data and statistics into understandable graphics and visualizations to aid in raising public awareness. One student described the anxiety of wanting to help but the fear of contributing to the problem by designing artifacts that use resources that are not environmentally friendly and ultimately create waste.

The conversation then became about individual, corporate, and political roles. Students discussed the actions and effects of individuals as compared to entities with larger impacts, such as corporations and policy makers. Students described the blame that is put onto individuals, while feeling strongly that companies, corporations, and policy makers are the only ones who can make substantial change, but do not or will not because of their self-interests and profits.

“Everyone in this room is thinking ethically about climate change, but I think the effect we have is negligible in the grand scheme of things compared to the people who are actually responsible for causing climate change... They try to make it sound like it’s our fault when the vast majority of carbon emissions, damage to the ozone layer, and dumping isn’t done by us, it’s done by corporations, huge factories, factory farming...”

“Nothing can actually get done to make solutions because of how corrupt it is and how much money is involved. It’s frustrating to be a normal civilian and you see all of that happening but the people who have the power to reverse climate change or help solve it are deciding not to because it serves their own self-interests.”

“People don’t see the cause of it, they’d rather blame the individual than look at the bigger picture thing, because it’s easier to blame the individual than to blame the system.”

Small changes inspired by learning from and about individuals. In contrast to theme #1’s sentiment of not knowing what action to take, students identified individual people and videos as being inspiration for making gradual and manageable changes. They described social media channels like Youtube, Twitter, and Tiktok as providing content in plausible, doable, creative, fun, and gradual ways. They also recognized how these small changes individually may have minor effects, but that there is the possibility for a ripple effect if passed on to their friends and family.

Two students talked about a teaching assistant they had who talked to their class about why she stopped buying from Amazon, and how this inspired them to also stop buying from Amazon. They mentioned learning about the working and living conditions of individuals who work for Amazon, which prompted another student to talk about how recognizing the conditions of people working in sweatshops inspired her to make changes. This showed that not only learning from individuals, but learning about individuals inspired change as well.

“I go on these watching sprees on youtube where people show off their day to day lives. I found this channel that focuses on sustainability and living minimally, making as little trash as possible. Watching videos like that shows that it’s doable. Watching things that make it seem like it’s plausible, people think it will turn your life completely upside down and everything changes, but there’s little ways to start making shifts that get you living a lifestyle that’s better. It would take a lot of people making that shift for the effects to be seen. But maybe you doing it will cause someone in your family to start doing it, it’ll cause that ripple effect. It’s easy to do it when the resources are there, but it takes a lot of research to find them.”

“A lot of the small changes I’ve done personally have come from twitter and tik tok, I have a very short attention span, when I have to read a giant infographic it goes in one ear out the other. A 10 second video shows boom boom boom, here’s what you can do, here’s a DIY, something creative, it almost seems fun. It makes you feel enabled to make small changes with the resources that you do have, it’s way more helpful than reading research that at the end of the day makes you feel hopeless.”

“The way [the TA] told us about [Amazon] was really helpful. she was talking about all the things she did and how they came into her life gradually, that you don’t have to make an overnight giant switch in your life. It was calming and helpful, you start with the straw thing and over time you make more adjustments.”

1A. Reflection

The focus group discussion provided insight into students’ shared frustrations and sentiments regarding climate change and the media’s communication of climate change issues. Student’s disclosed feelings of helplessness, responsibility, and inspiration. This provided a foundation for considering the possibilities of transforming and enhancing climate change communication. Additionally, since the students would be participating in further activities and investigations, the discussion provided a context for transitioning them into the next activities.

1B. MEDIA CHANNEL ANALYSIS

The second activity required students to engage with information about sea level rise across 4 distinct media channels and respond to a set of questions after each one. The objective of the analysis questions was to gain insights into what students could identify as features being used by the media channels to communicate information, what they found most or least helpful about these features, as well as how they perceived the features to connect to each dimension of psychological distance. The students were also asked to ideate on how they could use a specific dimension of distance to enhance the previously identified features. Lastly, they were asked to describe how that enhanced feature could be translated into a 3D space and facilitated through interactions.

Pre-Analysis Activity

FIGURE 7.13
Media Channels List
List of identified media channels, the four chosen for study 1b activity are highlighted.

TV Shows News Segments	VR Experiences 360 Videos Interactive experiences	Forums Reddit
Literature & Poetry Fiction Nonfiction	Games Board Games Video Games Card Games	Campaigns Celebrity & Corporations Organizations
Movies & Videos Fiction Fantasy Nonfiction Documentaries	Audio Radio Podcasts Songs	Art Paintings Multimedia
Articles Opinion Articles Online Newspaper Journal/Research Articles Magazine Articles Scientific Reports	Social Media Organizations Individuals	Graphics Posters Infographics Interactive Photographs
	Environmental News Services	Advertisements Billboards Graffiti Bumper Stickers

I presented the students with a list of media channels I compiled and organized (Figure 7.13). We then had a brief discussion about the affordances and limitations of various media. They were randomly paired and instructed to each pick one of the media channels from the list, then compare and contrast the affordances and limitations of the chosen channel. Teams then volunteered to share what they discussed with the whole group.

From the list of media channels, four were selected to use in the activity, based on these criteria:

- 1.The availability of similar content across media. For this activity I chose to focus on sea level rise as a case study of the effects of climate change. To keep the information analyzed consistent across media channels, I searched for information about sea level rise, and chose each channel based on the similarity of information.
- 2.The practicality of showing all thirty-eight students within a classroom setting, and one class period. I excluded media channels such as VR experiences that require a full HMD, due to the limitations in quantity of HMD’s available, and time it would take to set up each student within the HMD and experience. In place of a VR experience, I included 360 video due to the ability to use Google cardboard devices using students’ phones, which still deliver 360 content but are much more accessible and require less set up time.

Selected Media Channels

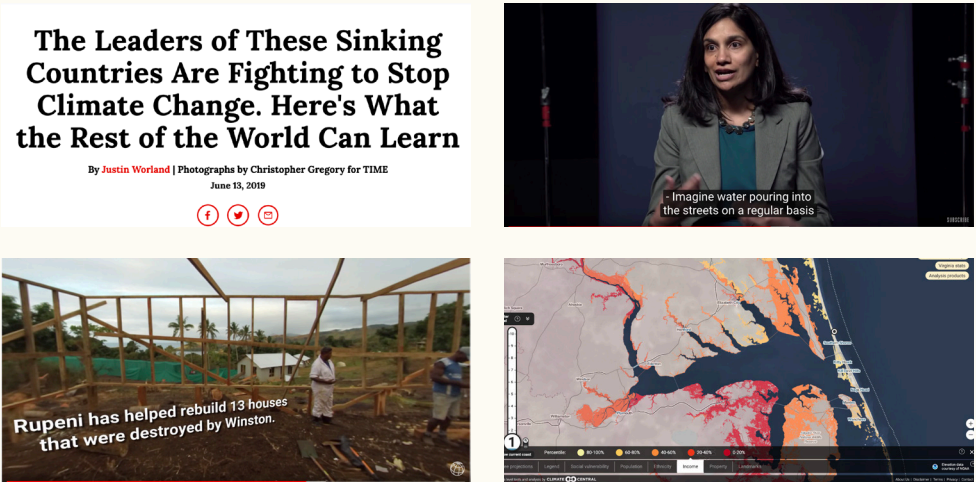


FIGURE 7.14
Study 1B Media Channels
Article, 2D video, 3D video, and interactive website used in the media channel analysis activity.

Article: How Leaders of Sinking Communities are Fighting to Stop Climate Change
2D Video: What Sea Level Rise Will do to Coastal Cities
360 Video: Our Home, Our People
Interactive Website: Surging Seas Risk Zone Map

Analysis Activity

Students were randomly split into four groups and instructed to watch, read, and interact with the provided media channels one at a time, answering a set of questions after each one (Figure 7.14-7.15). Each group was provided with four Google documents, one for each media channel, all documents contained the same predetermined set of questions. The groups answered questions collaboratively, with one member dedicated to documenting the answers within the Google document. Each group was randomly assigned one of the four dimensions of psychological distance in order to answer questions 5-6.

Questions

- 1. Which feature(s) were being used in this medium that facilitated the learning of the information?
- 2. What is helpful about this feature(s)?
- 3. What is unhelpful about this feature?
- 4. How does this feature touch on each of the dimensions of psychological distance?
- 5. How could your group’s assigned dimension be enhanced for each feature?
- 6. Based on your answer to number 5, ideate on how that feature would translate to a 3D space.
- 7. What could be the interaction to facilitate the information?

FIGURE 7.15
Media Channel
Analysis Activity
Students reading,
watching, and discussing
in groups during the
media channel analysis
activity.



Outcomes

I read through the Google documents and identified differences and similarities in the groups’ responses, looking for the positive and negative reactions to certain features.

Article. Students identified that the text in the article informs the reader by describing the issues at hand, but that there is a “massive” amount of text, making the experience not very engaging. They also described not being able to connect to the people in the story because the information is presented only through text and image. Two groups suggested the image and text could be translated into a 3D space as a 360 video format, with the text as audio.

Video. While one group described the focus in the video on New York City as helpful due to being able to connect to a “big-name” city, another group identified this as hard to connect to if a person is from another place. They appreciated the variety of information and said that hearing perspectives from real people made it feel more like a conversation. All groups suggested showing a variety of cities affected through channels such as 360 video, games, animations, and VR.

360 video. Students identified that the text captions overlay on the 360 video is ineffective in that they want to look around at the space, not the words, and that there are no indicators or incentives to look around. They note how the video recounts how the people and the village in the video have previously been affected, but doesn’t show those effects. And how they could be affected in the future, but only shows the people and village in the present moment.

They suggested enhancing this by having a more interactive experience of speaking with the people in the video, interacting with the environment, and seeing animations and predictions of past and future effects.

Interactive Map. Groups identified being able to zoom into specific cities as being effective as it allows you to view your own city but also others around the world. But they also noted the contrast between coastal cities that are visibly affected by sea level rise, and cities that are more inland that are not shown in this map to be affected. They still wanted to know what the less visible effects on inland cities are, such as to the economy. They also noted how being able to click through tabs to see how different demographics are affected was helpful in giving insight to who would directly be affected.

The groups suggested the image and text could be translated into a 3D space by showing projections of physical water levels in the context of a town, or street view, and being able to move through it from a first person perspective.

1B. Reflection

The students’ answers to the analysis questions provided a starting point for inquiry and identifying potential questions to address moving into the following investigation and studies. Such as how to:

1. Move from passive consumption of information, to more active forms
2. Make as many locations as possible available to appeal to a variety of distances and users?
3. Move between spatial dimensions, zooming in and out?
4. Show multiple views of a singular event?
5. Show projections of how this would also affect you in your area, even if it may be geographically unlikely to happen currently?
6. Show personally relevant locations and then prompt the user to visit the other places where similar impacts or effects are occurring?

1C. FROM 2D TO 3D

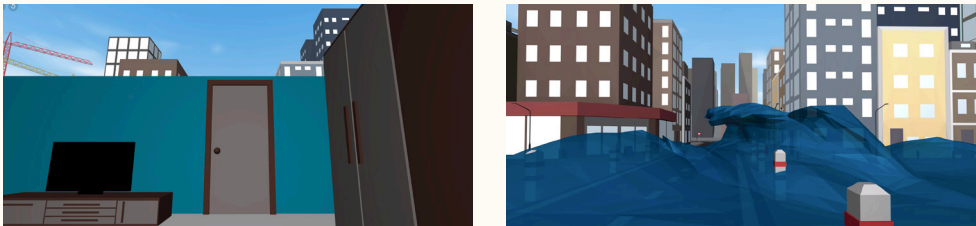
In the third investigation I used CoSpaces, a 3D building website, to translate and transform the article and video from the media analysis activity into a 3D environment, applying insights from the outcomes of Study 1a and 1b (Figure 7.16-7.17).

FIGURE 7.16
Early Study
Environment designed in CoSpaces translating digital article content into an interactive 3D environment.



I explored how to break up text from the digital article example while still keeping the important information and transforming passive engagement to active engagement. The user can move through the content spatially with full control over movement. As the user moves past the title and islands that represent sinking countries, they approach a globe that points to the geographic location of the island referred to in the article, Tuvalu. The user sees an animation of a small plane flying over the Pacific ocean, representing part of what is described in the article as an arduous journey to the island.

FIGURE 7.17
Early Study
Environment designed in CoSpaces translating 2D video content into an interactive 3D environment.



In the 2D video example, there are several times when scientists make statements asking the user to imagine certain scenarios, such as “Imagine water pouring onto the street on a regular basis, you open your door and you walk into a street filled with water”. I designed a 3D space that depicts a scenario where the user begins standing inside of a home, and can walk through the door to see streets flooded outside.

1C. Reflection

These early design explorations are quick studies in putting the insights and questions from Study 1B and 1C into practice. These mini studies are only one way to translate a given set of information into new 3D environments that allowed me to ideate on further possibilities and affordances.

Study 1 Reflection

This study overall grounds the larger investigation in the affordances and limitations of media channels. The focus group discussion revealed shared frustrations and sentiments in regards to the current state of climate change communication in the media. The media analysis activity identified valuable and potential features used within current media channels, that inspired early design explorations. The outcomes of these investigations place consequent studies and solutions in the current technological and media context in which they live.

STUDY 2. CODING INTERACTIVE SPATIAL WEBSITES

Subquestion 2: *How can a 3D environment be designed to facilitate interactions that decrease psychological distance to a climate change issue?*

After exploring possibilities for translating traditional media channel information into 3D spaces in Study 1, I was interested in how designers might approach designing a 3D environment using interactions that facilitate decreasing psychological distance to a climate change issue prioritizing only one of the dimensions of psychological distance. In this investigation the same students from Study 1 coded websites in A-Frame that teach about some aspect of sea level rise with the objective of focusing on one specific dimension of distance.

Methods

Myself, the instructor of record, and students worked together in a graphic design studio setting over a period of two weeks to develop and code interactive spatial environments. We met twice a week for 4 hours each meeting. In class time consisted of instruction on both technical and conceptual aspects of the exercise, including tutorials and troubleshooting of code, and feedback sessions in various group sizes, from individual and small group critiques with the instructor and myself, to larger presentations with all students. Out of class time was spent on further development of the code. At three points during the study (beginning, mid-way, and after completion) students were prompted to document and reflect upon their concept, what they were trying to convey about sea level rise, and how it related to their assigned dimension.

To begin the project, students self selected to work individually, or in groups of two. They were then randomly assigned one of the four dimensions of psychological distance. Once dimensions were assigned, students were presented with the following prompt:

Scenario

You’ve been hired by the city of Raleigh to educate people about rising sea levels in North Carolina.

Prompt

Design a scene, or series of scenes, that utilize interactions to teach citizens and residents of North Carolina about sea level rise in order to reduce psychological distance to you or your group’s assigned dimension of psychological distance (spatial, temporal, social, or experiential).

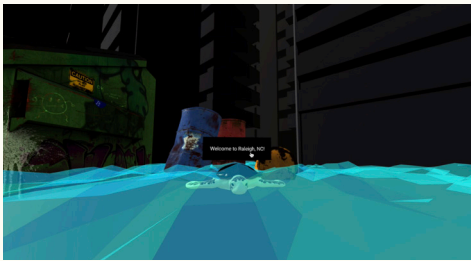
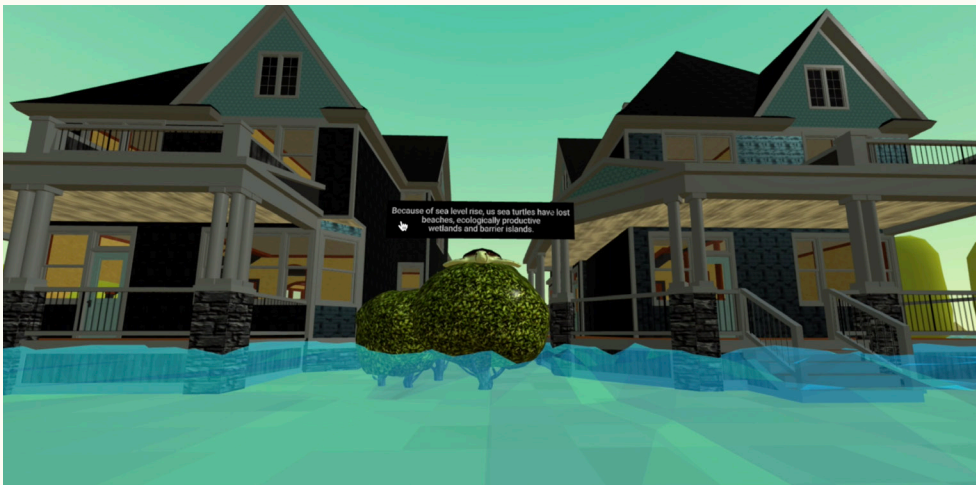
Outcomes

In the proceeding sections, final environments designed and submitted by students are highlighted based on their ability to represent each dimension’s themes. Although not all environments submitted are included here, those that are not represented are still included in the thematic analysis.

SPATIAL

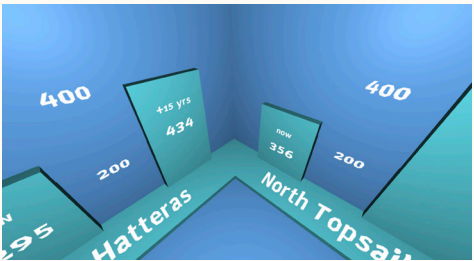
The environments described in this section focus on designing for the spatial dimension of psychological distance. Spatial distance refers to the perceived relationship between a person and a place or object. This can be thought of as the physical distance between an individual and the place where the event under consideration is taking place.

FIGURE 7.18
3D Interactive
Environment
Designed and coded by
Kate Warren, focusing
on the spatial dimension.



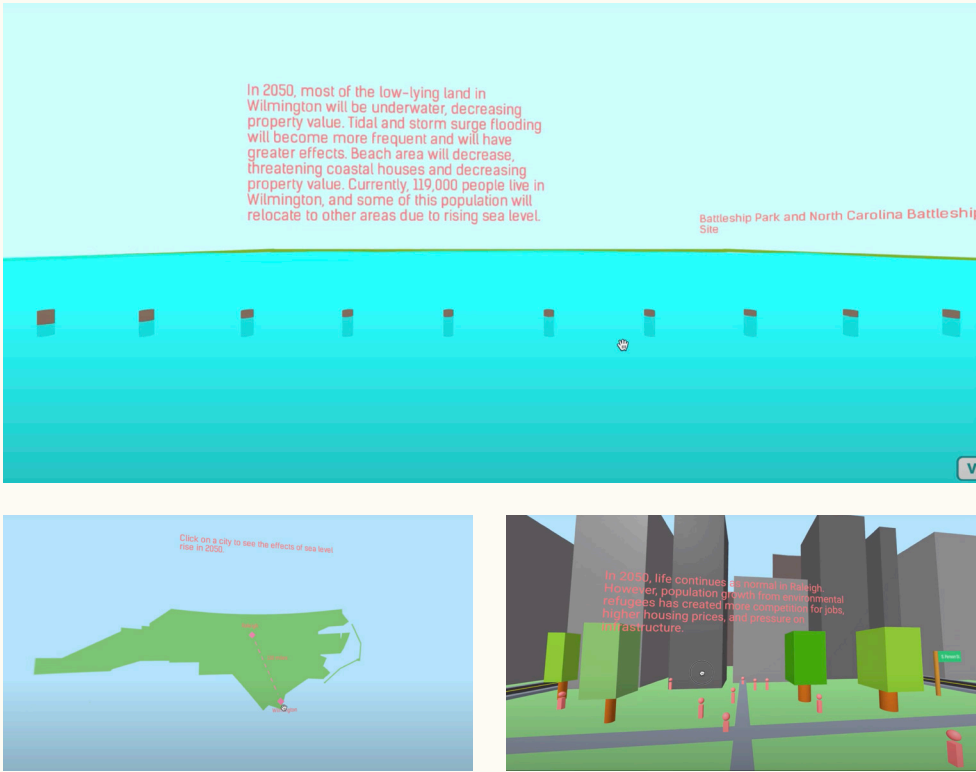
The environment shown in Figure 7.18 displays the effects of sea level rise on wildlife and their habitats. Through interactions with turtles, the user learns the geographic location, flood level, and year. The user follows the turtles through three locations in North Carolina—Nags Head, Greenville, and Raleigh. As they move through each location the user witnesses the turtles being pushed out of their habitat, as sea levels rise and the flooding moves further inland, so do the turtles.

FIGURE 7.19
3D Interactive
Environment
Designed and coded
by Kristina Rozakis
and Jennifer Dowden,
focusing on the spatial
dimension.



The environment shown in Figure 7.19 displays the effects of sea level rise in the US and North Carolina through kinetic cubes displaying statistics and data visualizations. In this abstract representation (as compared to the other environments highlighted throughout this study), the user is placed in a statistical room that transforms “flat” data into animated data visualizations.

FIGURE 7.20
3D Interactive
Environment
Designed and coded
by Jazz Moe and Grace
Herring, focusing on the
spatial dimension.



The environment shown in Figure 7.20 Displays the impacts of sea level rise on the coastal town of Wilmington, NC as compared to the impacts further inland in the city of Raleigh. The user moves from one city to the next by interacting with a map that provides some context for the distance between the two cities. While the effects on Wilmington are visually obvious through flooding, and Raleigh looks relatively normal, the text describes effects such as population growth from climate change refugees, effects on the job and housing market, and increased pressure on infrastructure.

TEMPORAL

The environments described in this section focus on designing for the temporal dimension of psychological distance. Temporal distance refers to the perceived relationship between oneself and an event in time. This can be thought of as the degree to which an event is removed from the present time, either in the past or future.



FIGURE 7.21
3D Interactive
Environment
Designed and coded
by Joel Weiss and Anna
Lawrence, focusing on
the temporal dimension.

The environment shown in Figure 7.21 displays hurricanes that broke storm surge records in Wilmington, NC. The user is in an enclosed space where each wall represents a hurricane and the year that hurricane broke the record for highest storm surge levels in Wilmington. As the user directs their gaze at each wall, the wall is activated, and the water rises to represent the height of the storm surge. This environment uses historical records to emphasize the time-frame in which climate change is affecting us, showing that while it took 62 years to beat the 1954 record, that record was then promptly beat 2 years later in 2018.

FIGURE 7.22
3D Interactive
Environment
Designed and coded by
Raney Wilson, focusing
on the temporal
dimension.



The environment shown in Figure 7.22 displays that sea levels are rising by about 0.5 inches per year, using historical events in time that are not related to climate change. The user interacts with buttons that show the rate of future sea level rise by years, in increments of 5. Clicking each button will show the user an important historical event that occurred 5, 10, 15, or 20 years ago. For example, clicking 5 will reveal to the user that gay marriage was legalized in the US only 5 years ago, providing an alternative perspective to connect to how quickly the sea is rising.

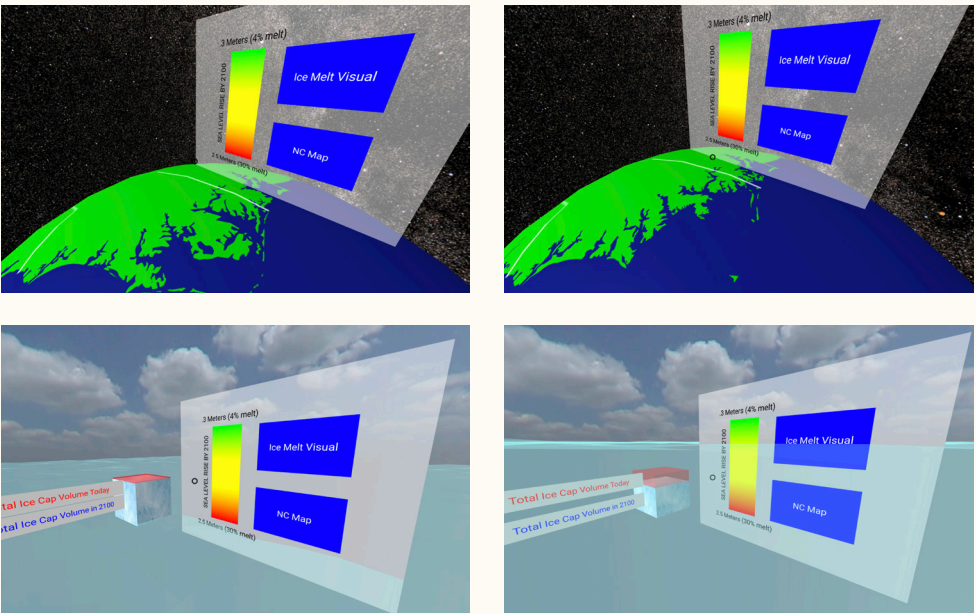


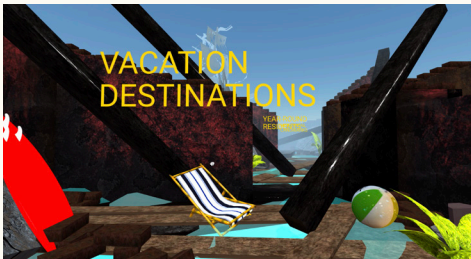
FIGURE 7.23
3D Interactive
Environment
Designed and coded by
Robert Robinson and
Sadie Tynch, focusing on
the temporal dimension.

The environment shown in Figure 7.23, displays the proportion of water contributed to the ocean by the Greenland Ice Sheet. The user interacts with the worst case, most likely, and best case scenarios by interacting with the bar graph. The user can also toggle between two representations of the data. One shows the proportions of glacial ice melt in the form of a cube, while water level rises to scale around you, the second at a geographic view on a globe, showing coastal land loss.

SOCIAL

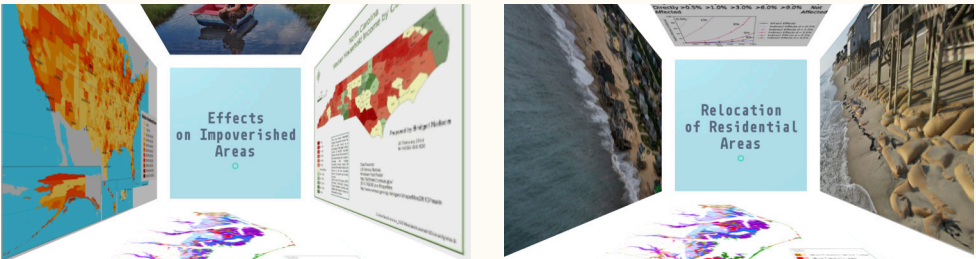
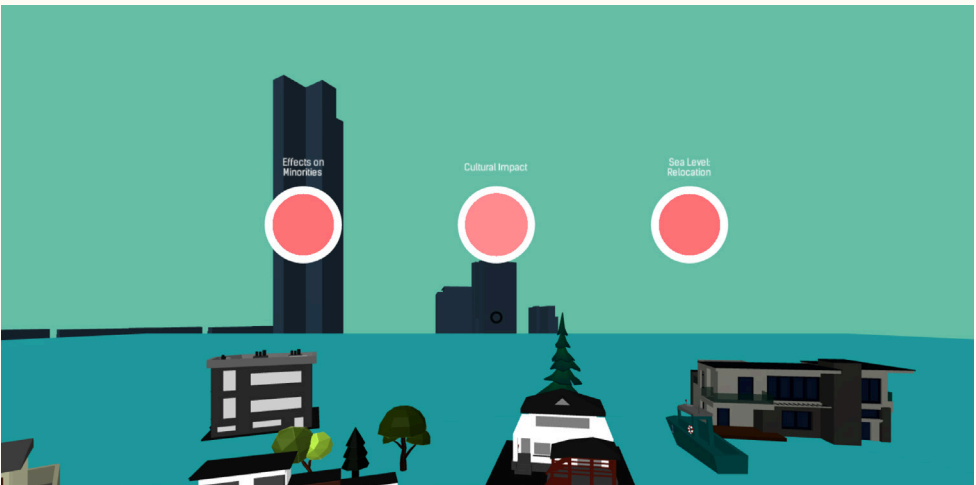
The environments described in this section focus on designing for the social dimension of psychological distance. Social distance refers to the perceived relationship between oneself and others. This can be thought of as the degree to which two or more groups or individuals are related to each other.

FIGURE 7.24
3D Interactive
Environment
Designed and coded
by Peyton Tucker
and Madeline Nocar,
focusing on the social
dimension.



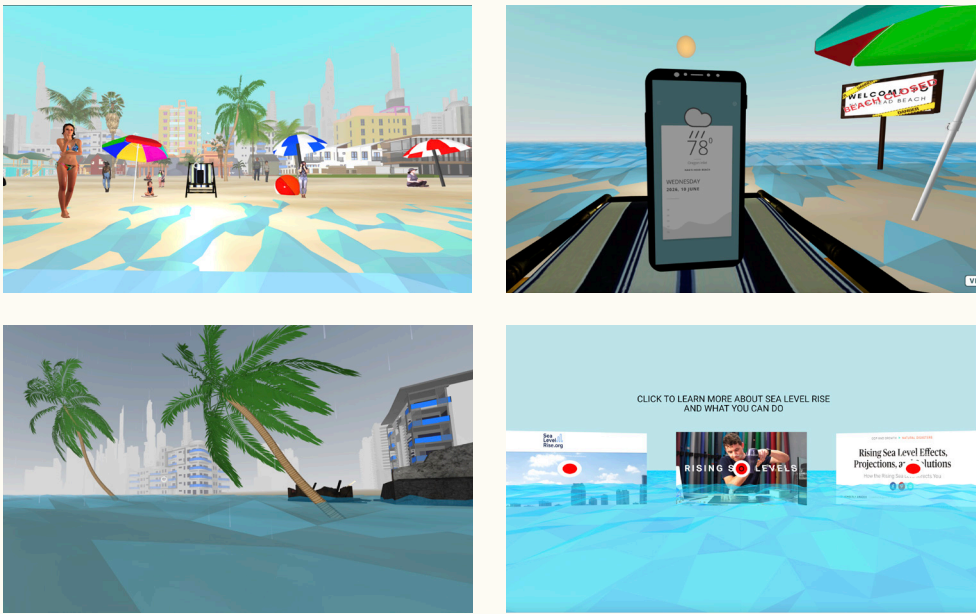
The environment shown in Figure 7.24 displays the consequences and destruction of sea-level rise on the coastal town of Wilmington in the year 2050. The user moves through a series of rooms that represent effects on historical landmarks, residents, and tourists in the town through the corresponding objects and text.

FIGURE 7.25
3D Interactive
Environment
Designed and coded by
Ashley Castrejon and
Kindyll Killian, focusing
on the social dimension.



The environment shown in Figure 7.25 displays the cultural impacts of sea level rise on the City of Raleigh, such as effects on impoverished areas and displacement of families. The user interacts with the space by looking at a plane up above to manipulate the rise and fall of the water level, and entering into separate rooms that project further data in the form of photos and maps.

FIGURE 7.26
3D Interactive Environment
Designed and coded by Arshi Jumma and Keymoni Sakil-Slack, focusing on the social dimension.



The environment shown in Figure 7.26 constructs a narrative in which the user is lying on Nags Head Beach, a location where sea level is predicted to rise 5.48 inches by 2030. Through interacting with a cellphone, the user is taken through several scenes as the beach is taken over by the rising sea levels. It is important to note that in this project, the story ends with a call to action, linking to resources on what the user can do.

EXPERIENTIAL

The environments described in this section focus on designing for the experiential dimension of psychological distance. Experiential distance refers to the perceived degree between imagining something and actually experiencing it. This can be thought of as the degree to which an event might actually occur vs. a hypothetical situation.

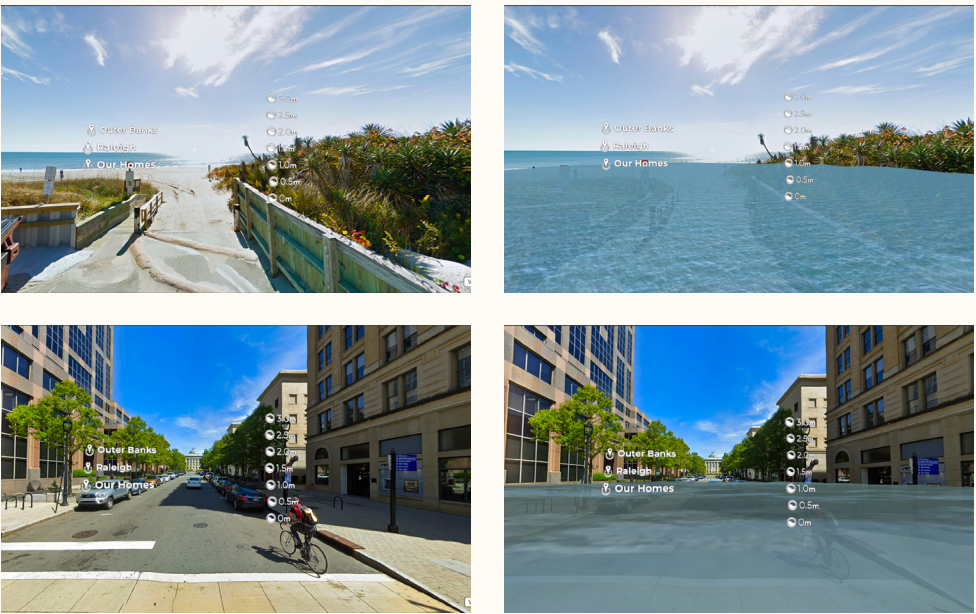


FIGURE 7.27
3D Interactive Environment
Designed and coded by Austin Bauwens and Dominic Cruz, focusing on the experiential dimension.

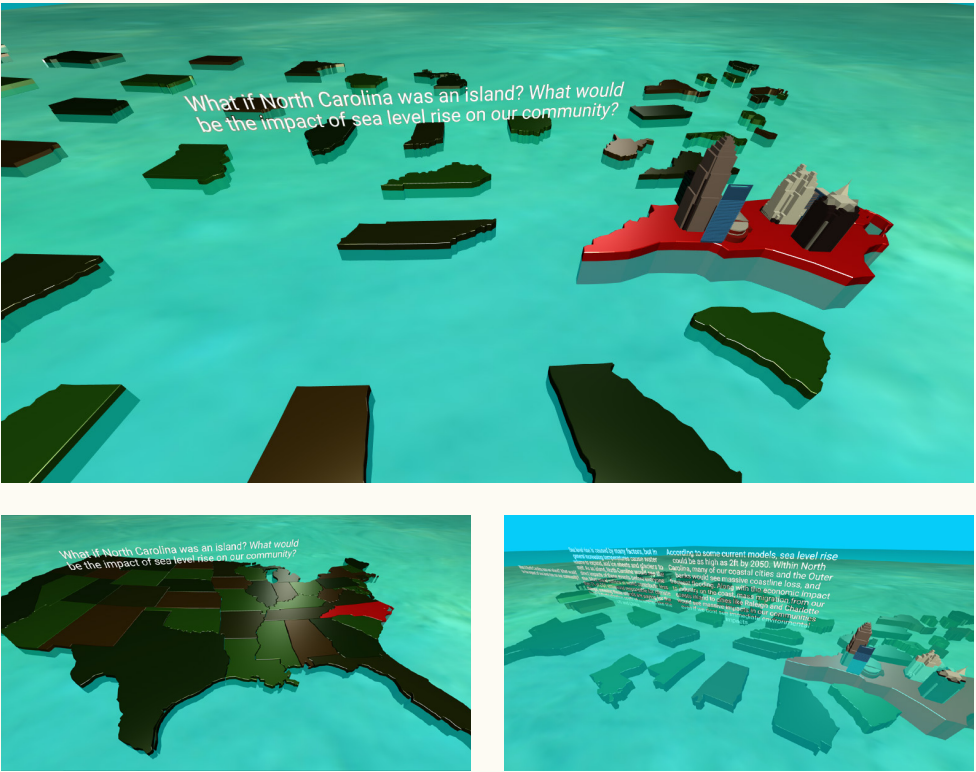
The environment shown in Figure 7.27 displays projections of what sea level rise looks like at several meters in a singular location. There are three locations the user can view, a beach on NC's coast, downtown Raleigh, and inside a home. This environment allows the user to move through projected situations, as well as geographic locations.

FIGURE 7.28
3D Interactive
Environment
Designed and coded by
Allie Wilson and Riley
Becker, focusing on the
experiential dimension.



The environment shown in Figure 7.28 displays projections of what sea level rise looks like in a residential neighborhood. The user can move through the streets of the flooded neighborhood and enter into a house to see the damage to personal belongings.

FIGURE 7.29
3D Interactive
Environment
Designed and coded by
Tucker Baumgartner,
focusing on the
experiential dimension.



The environment shown in Figure 7.29 displays an isolated view of the US, highlighting NC. When the user clicks on NC, the states begin to break apart turning each of them into an island. Each time the user clicks facts appear and the water rises. The final fact raises the water level back and provides links to further information such as documentaries.

Study 2 Reflection

Limitations. The explorations are limited by the students’ understanding of the theory of psychological distance and its associated dimensions. Regardless, they provide valuable insight into possible design approaches.

While each exploration is meant to focus on one particular dimension of psychological distance, this does not mean that other dimensions of distance will not be present within the environment. Research suggests that each dimension of psychological distance is always present at varying levels, and that changing one dimension can affect a person’s relationship to other dimensions, meaning that outcomes from each section may be applicable across dimensions.

Key Points. I analyzed the environments submitted for the coding activity from Study 2, based on presented concepts, objectives, designed interactions, and features. In the proceeding sections, key points are summarized for dimensions individually, then across all dimensions.

Spatial. The environments created for the spatial dimensions provided interactions that allowed the user to move through multiple locations, seeing data for each individual location. Sometimes the data was unique to the location, and other times the data was visualizing the same data set or projection in multiple locations. Another interesting concept was the ability to receive information through interacting with animals in the scene

Temporal. The environments created for the temporal dimension provided interactions that allowed the user to move through time at their discretion, see effects over time in a singular location, and see more than one form of data visualization for a singular data set. Another interesting concept was utilizing information on historical events as a means to providing a perspective of time.

Social. The environments created for the social dimension provided interactions that allowed the user to see information regarding impacts on a locations residents, economy, and history. These environments also utilized a first person perspective for moving through the environment.

Experiential. The environments created for the experiential dimension provided interactions that highlighted familiar artifacts, such as the items and objects inside of homes, as a way for the user to identify and connect this with their own homes or personal items. The environments also displayed climate change effects over time in multiple spaces.

Across all dimensions. Some features that were common across all dimensions included the ability to move through the environment in a self-guided manner, often from first person. The ability to move across both time and space, showing that temporal and spatial distance are always at play. Data provided was almost always represented in multiple visual forms, and many used narrative storytelling to move a user through the environments. Lastly, projections and simulations of possible futures were used across almost all environments, driving many of the interactions.

At the end of this exercise, students were asked to reflect on how they were attempting to decrease psychological distance through their interactive environments, how they hoped it would change users views or care for the topic of sea level rise, and what aspects

of designing and coding the environment changed their own views or care for the topic, if at all. About half of the students responded that the act of researching, learning, and designing did in fact increase their awareness and care for the issue as compared to before the activity. The other half of students expressed that while their awareness did increase, their care for the issue did not because they were already concerned previous to the activity. I became interested in the question of whether the process of designing the environment is equally as impactful as the final designed outcome in decreasing psychological distance. I discuss this further in the Future Work section of Chapter 8.

STUDY 3. THE SYSTEM

Subquestion 3: *How can we design tools that represent each dimension of psychological distance and interact as a system within a VR experience?*

The explorations in Study 2 show the possibilities for users to project scenarios, visualize impacts, and move through space and time freely. In this study, I create features for each dimension, and design them with a high level of conceptual and interactive agency. This means providing users with the information and tools necessary to interact, explore, and discover in a space that allows for a high capacity to investigate, act, direct, and lead the experience. I then explore how each dimension’s features interact with each other as a system within a virtual reality experience.

The Tools

SPATIAL



FIGURE 7.30
Maps Tool
Visualizing the ability to see many locations from various levels of distance.

Maps. In everyday life, it is difficult to decrease spatial distance as doing so means being able to travel to physical locations. Realistically, there are many limitations to being able to experience new places. We rely on photos, videos, stories, and maps to construct our mental image of a place we’ve never been. Tools like Google Maps, and Google Earth allow for virtual tours that are a great resource for learning about a new location. People may use these tools simply to get around, to understand where something is located in relation to themselves, to plan a future visit, or simply to learn about and become familiar with a place.

The most common feature in all of the explorations in Study 2, is the ability to move within a space and move through multiple locations. For the user to have the highest conceptual and interactive agency in the spatial dimension, the user should be able to move through space as they please, having access to as many locations and as many views of that location, as possible. I identified Google Earth as the ultimate platform to be able to do so, and used its interface as the basis for demonstrating how the spatial dimensions feature functionality would operate. Which is that users have access to interact with the globe at various levels, global, national, state, city, neighborhood, and street view (Figure 7.30).

TEMPORAL

FIGURE 7.31
Timeline Tool
Visualizing the ability
to filter events and
projections by selecting
dates on the timeline.

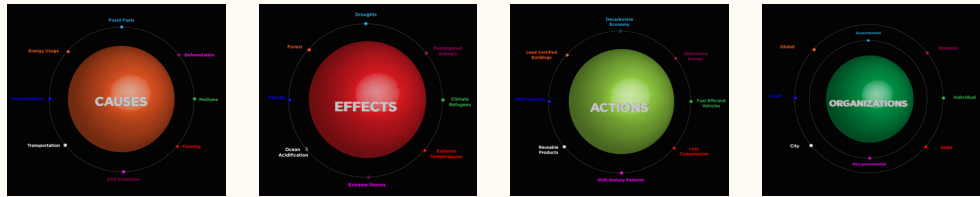


Timeline. Time is an important aspect of climate change communication. Knowing the historical context of earth’s climate and associated events provides invaluable insight to understanding the present moment we are in and predicting what is to come. According to the theory of psychological distance, we must bring past and future events in time closer to a person in order to decrease distance on the temporal dimension. Apparent in Study 2’s explorations of temporal distance is the usefulness of interacting with historical events as a way to gain perspective, and projecting visualizations of future climate change effects to understand impacts. This presents the need for a tool that allows the user to move through time.

For the temporal dimension, I designed a timeline feature with the standard day, month, and year options. The user can select past dates, futures dates, and between two dates in time (Figure 7.31). The information shown in the experience is related to the selected point in time. If the day and month options are off, the user will see all events relating to the selected year. If the day option is off, the user will see all events in the month of the selected year.

SOCIAL

FIGURE 7.32
Events Tool
Visualizing the various
event categories: causes,
effects, actions, and
organizations.



Events. According to the theory of psychological distance, a person perceives themselves as socially distant from people or groups who they believe to be culturally different, or even spatially different from them. In Study 2, students’ explorations of the social dimension showed a desire to understand climate change effects as they impact the lives, homes, communities, and cities of everyday people. But, looking at the results of the focus group in Study 1, even when students are aware of the impacts on themselves and others, they feel unaware of what actions they can take towards the relevant cause. This presented the need and opportunity for tying both impacts and actions together.

For the social dimension, I propose the "events" feature. Events are those that are tied to human activity. I identified four categories of events: causes, effects, actions, and organizations (Figure 7.32).

- Causes.** Any action, event, industry, or policy, that negatively contributes to climate change.
- Effects.** Any negative impact our outcome on the earth or people who inhabit it due directly or indirectly to the causes of climate change.
- Actions.** Any positive impact or action that positively contributes to fighting or trying to fight climate change.
- Organizations.** Any group of people working together to positively contribute towards fighting or trying to fight climate change.

To use the events, users can point and highlight the category they want to open, either choosing the category as a whole, or filtering the events by subcategory or several subcategories.

EXPERIENTIAL

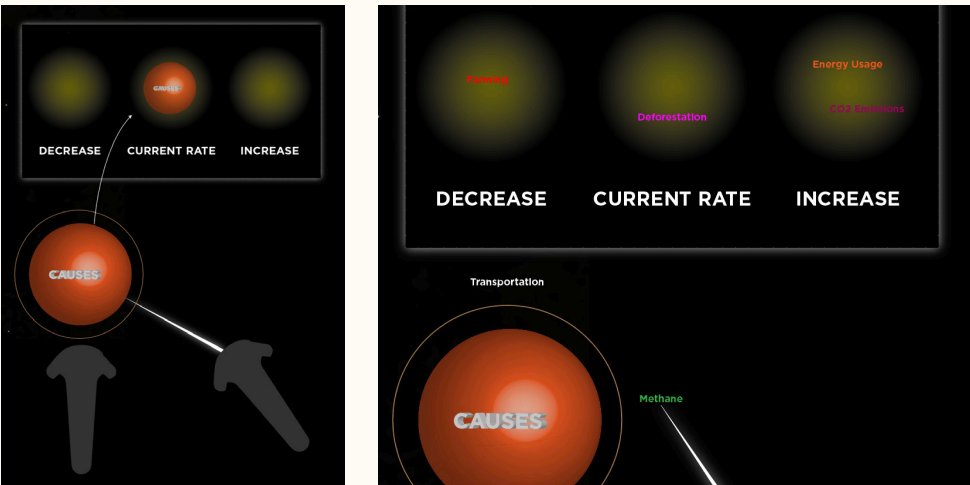


FIGURE 7.33
Projections Tool
Visualizing the ability to
see projections tied to
events, based on various
conditions.

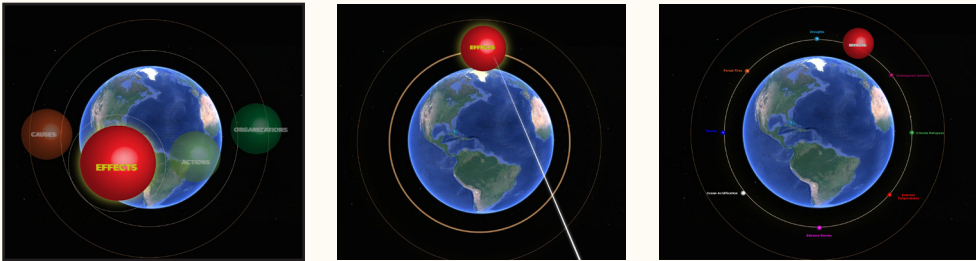
Projections. According to the theory of psychological distance, a person perceives events in relation to their probability of actually occurring or experiencing them. With climate change, while we can predict what events will occur, or the intensity of certain impacts, those predictions are based on certain conditions. The outcomes of climate change impacts vary depending on whether we continue negatively impacting the environment at the same rate as we currently do, or whether those rates are drastically higher or lower. In Study 2, students explored the ability to represent possible, probable, or certain futures.

For the experiential dimension, I explore a projection feature that allows the user to input certain conditions in order to project effects and impacts on not only future events but also past and present environments (Figure 7.33). Meaning that while the user can view projections of future probabilities, they can also see how events in the past would have played out under certain conditions.

How it works

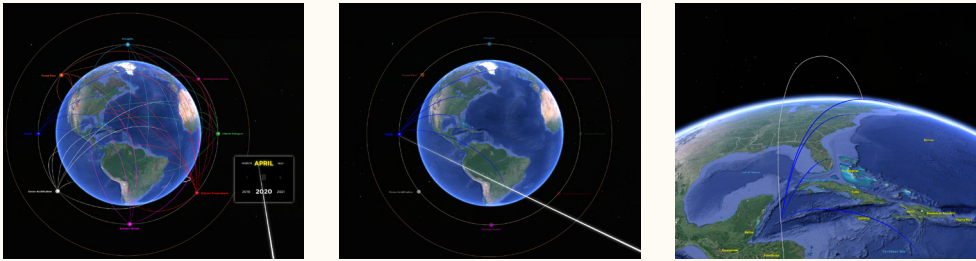
In order for the user to have a high level of agency over the experience, all features must be accessible at all times, capable of interacting with one another, and functional whenever possible.

FIGURE 7.34
Selecting Events
Visualizing the way a user can filter the map based on a category.



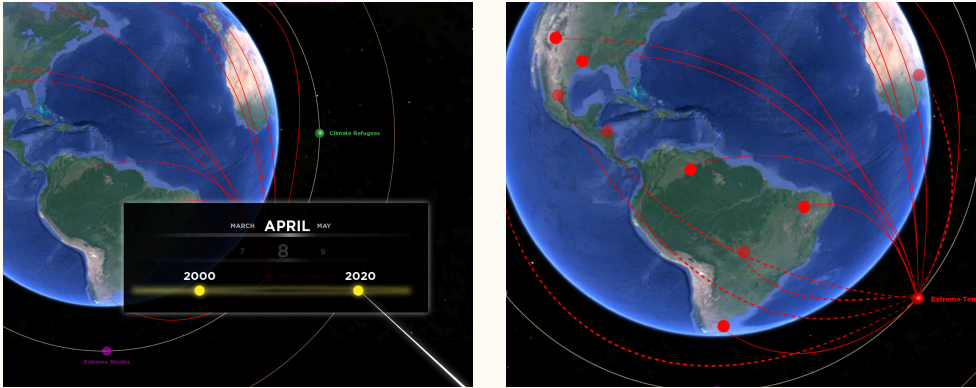
In the proposed system users can view the event they want to receive information about by selecting a category, multiple categories, or any number of subcategories (Figure 7.34). The user also selects a time-frame that filters the events relevant to the selected time-frame. The user can choose a singular date, or a starting date and end date, in which all events occurring between this time-frame will populate.

Figure 7.35
Event and Timeline Interaction
Visualizing the way date selection on the timeline interacts with events shown.



When the desired event(s) and time-frame(s) is selected, lines will be drawn to the geographic location in which an event (relevant to the selected categories) is occurring (Figure 7.35). These lines indicate to the user the geographic distribution and frequency of these events, and that they can zoom in closer to the location to receive further information.

FIGURE 7.36
Past, Present, and Future Event Visualizations
Visualizing the ability to select between two date, and how past events are differentiated from present events.



If the user chooses two points in time, the lines for past events and future events are differentiated by line type (Figure 7.36).

When events are selected, the projection feature can be utilized to view possible past, present, and future states of those events according to chosen conditions. New lines drawn will indicate where or when these projected events would have occurred or are likely to occur given the chosen conditions (Figure 7.37).

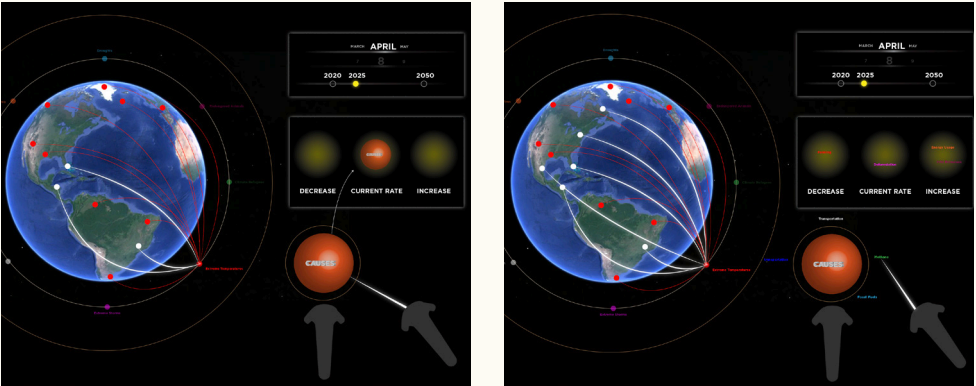


FIGURE 7.37
Events, Timeline, and Projections Interaction
Visualizing the way projections interact with the chosen events based on conditions and dates selected.

Utilizing the map feature by zooming into any location on the map, the user can follow event lines to a location and will have access to further information as it relates to the distance they are zoomed into. For example, if the user chooses the effects category, highlights extreme storms, and selects the year 2018 in the timeline, they will see all extreme storms that occurred during that year across the globe. They may follow any line, in this case if the user follows the line tied to a hurricane in North Carolina, as they zoom into the state, indicators of further data points appear (Figure 7.38).



FIGURE 7.38
Zooming into the Map
Visualizing the potential path of a user as they zoom in on a location, or follow an event line.

These data points are marked by icons representing social events which indicate available data about the economic and environmental impacts on individuals, families, or communities (7.38). Here, the projection feature is still relevant, as even at this spatial level the user can see what could have been or will be the impacts of these social events under various conditions.

Study 3 Reflection

Traditional media and current climate change communication is understood as the context of this investigation. Two main limitations of climate change communication in the media are: the inability to engage and immerse the user in a novel, exciting, and impactful way; and the failure to connect data, information, and stories with calls-to-action, resources, and next steps. Currently, If a person wants to learn in depth about climate change, they will need to consume information from many media sources. If they want to then find out what actions are being taken or organizations exist towards fighting climate change, that will be an additional search for information across media sources. Rather than the isolated, disconnected, fragments of climate change information and resources available across devices, the system explored in this study provides the user with access to a repository of climate change information and resources. This system is based on the idea that simple awareness does not cause change. A person must be aware, explore that awareness, and then act on it.

PART 4

Discussion

Discussion

DESIGN PRINCIPLES

Encouraging self-guided exploration / Tools & information as power

Does the experience or the user dictate the way the user consumes information? When presenting information and data to a user, the designer must consider what tools are provided to the user that allows them to interact with the information. In traditional forms of media, such as digital articles or videos, the user has little say in the way they navigate or consume the information. In VR there are opportunities for the user to interact with information in a way that is guided by their own intuition and curiosity. If you want the user to exercise their agency and improve their self-efficacy, the user should feel a sense of control and feel empowered to own the experience and explore freely, feeling that they have many options. While the designer should still consider how the interface helps guide the user through the experience so that they are not stuck or lost, the designer should not force the user to move through an experience in a certain timeline or time-frame. *See study 2 & 3.*

Customization is key

Climate change is a complex problem, with many causes, effects, and actions taking place at all times all over the world. This investigation explores the idea of a repository for real time information about climate change all over the world. It is important to bring all of this information together into one place in a way that it never has been before, but this can be an overwhelming amount of data to sort through. While users should know that the information is available, designer's should consider the ways we provide filtering tools that allow the user to focus on a specific set or sets of data at any given time. Further, these tools should allow a high degree of customization for users to set up their exploration space. *See study 3.*

Connection between information & action

Designers need to consider the call-to-action. How is it presented to the user, and how does the experience facilitate that action? As identified in Study 1, students continually expressed their frustration with traditional media channels not providing indications for next steps or solutions. This was also apparent in the precedent analysis, where most raised awareness, but did not provide any further guidance on what to do next with this information. We want awareness to lead to curiosity and investigation, that will hopefully then cultivate a desire and intention to act. It is not enough to provide a user with information that brings awareness and expect that awareness to transform into action. So, will the designer provide the platform and tools within which the user can act, or will they expect the user to find this somewhere else? *See study 1 & 3.*

FUTURE WORK

Virtual reality as a space for real time organizing & action

Just as the internet progressed to become a place where people could gather, interact, organize, and work together, we are starting to see virtual reality technologies be utilized for the same purposes. There is a proliferation of VR experiences being used for social interaction, such as AltspaceVR and VRChat. I believe there is potential within VR experiences for users to connect with and join other individuals, communities, and organizations that are working towards positive actions against climate change. Future work might investigate how to allow user generated content within an experience like the one proposed in this investigation. While there may currently be technical limitations to developing such experiences, VR technologies are evolving rapidly, and as we move forward, it is worthwhile to imagine the ways we can leverage the affordances of VR technology for connecting people to social causes. *See study 3.*

Designing as a tool for developing self-efficacy & agency

This research focuses on creating a designed system to be used as a tool for decreasing psychological distance and facilitating action. Following the activity in Study 2, I reviewed the students reflections on creating and coding the interactive 3D environments. I realized the potential power of the act of designing the environment itself, and allowing a person to be a creator rather than just a consumer. I believe the act of designing and making should be considered as a tool for decreasing psychological distance and increasing self-efficacy. In future work I hope to address the question of whether a VR experience, a design making experience, or a combination of both is the most effective for decreasing psychological distance and increasing self-efficacy in citizens.

CONCLUSION

No one individual has the power to take on the challenge of climate change alone. Therefore the transformation needed in society must be achieved by the people working together and believing in their capacity for collective efficacy and agency. In order to create the change needed, people must be aware of the circumstances that make up the reality of climate change. This research explores ways designers can approach designing interactions and

experiences within 3D spaces that will be effective in communicating about climate change in all of its complexity. The proposed design system in this investigation emphasizes the need to provide tools and resources that assist in fostering and facilitating such individual and collective awareness, effort, and action.

This research adds to the discourse on what designers can do to contribute to fighting this global crisis. This research also applies to fields outside of the design discipline, such as environmental communication, contributing to best practices for interventions and advocacy on issues related to climate change. Environmentalists can implement the findings and outcomes into their communication strategies.

While this research centers around the climate change crisis, the designed system is not contingent upon climate change to function. There are various global scale issues that can benefit from adopting similar strategies, such as health crises like epidemics and pandemics, and human rights issues like gender inequality and poverty. As emerging technologies like VR become more mainstream and accessible forms of media, this research adds to the growing discourse on the role of VR not just for entertainment and gaming but also for education and digital humanities.

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