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Virtual reality and its effects on sustainable development attitudes

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"The greatest danger for most of us is not that our aim is too high, and we miss it, but that it is too low, and we reach it."— Michelangelo Buonarroti. The present thesis is a product of an array of overcome personal fears and fortunate opportunities. One year ago, the idea of conducting experimental quantitative research was considered unfeasible. First, I had no experience with experimental methodology, and my greatest fear was statistical analysis. Second, the world was in the midst of a pandemic; hence university campuses, labs, and people´s fear did not offer the conditions for experimental research. Yet, I decided to overcome all the obstacles and achieve my academic dream.

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Chapter 1: Introduction

Sustainable development (SD) could be the most important concept in our time. Humanity faces an array of urgent challenges: rapid demographic growth, exacerbated inequality, democratic difficulties, armed and humanitarian crises, technological disruption, global pandemics, and the existential threat of climate change. In the last decade, researchers around the world have begun to utilize virtual reality (VR) as a method to understand and condition people's attitudes towards societal phenomena. VR is the only medium with the potential to block all perceptions of the "real world" and locate users in disadvantageous places and social contexts—even different bodies. This is why VR has been referred to as the "empathy machine." In the aftermath of adopting the 2030 SD Agenda, VR attitudinal researchers suggested that VR could be more effective than traditional media to elicit more favorable attitudes towards sustainable development. Additionally, the United Nations (UN) has claimed that VR could effectively improve donations' attitudes with anecdotal and not scientific evidence.

The first research aim of this study is to analyze the capabilities of VR content in generating attitudinal changes towards SD. The second aim is to explore how VR has elicited favorable donation attitudes towards SD causes. In both cases, VR is compared with traditional 2D content to explore if VR is more effective than a less immersive medium.

Background and context

Virtual reality (VR) refers to advanced computer-user interaction with head-mounted displays (HMD)—also known as headsets (Fox et al., 2009b, p. 95). Users explore digitally manufactured environments—including virtual places, objects, and people—to have engaging experiences through the senses (Damer & Hinrichs, 2014, pp. 1–2). The uniqueness of VR depends on its capacity to block the sensorial perception of the "real world" to locate the participants in scenarios that could be difficult to experience in other circumstances (Slater & Sanchez-Vives, 2016, pp. 2–38). Even though HMDs have been developed since the ´50s, the real technological momentum started a few years ago. Furthermore, VR is considered an upcoming technology (Mathysen & Glorieux, 2021, p. 1).

Virtual reality content develops in different ways. The most common is through computer-generated (CG) graphics (Waltermire, 2018, p. 11). Modern technologies also allow 3D topographic scanning of people and objects in the real world—this process is known as photogrammetry (Fernandez et al., 2021, pp. 1–2). Another common technique to create immersive virtual environments is through 360° videos, thanks to the development of cameras with multiple lenses that could capture an all-around perspective of a real environment (Gómez Cruz, 2017, pp. 28–31). It is also possible that diverse techniques fuse and create hybrid experiences (Teo et al., 2019, pp. 1–3).

Immersion is a core concept while including VR in social phenomena. Immersion refers to the capacity of a technological device to create sensory "input." For example, a 3D television is more immersive than a regular 2D monitor—at least visually—whereas VR is more immersive than a 3D television. Each technology has its level of technological

immersiveness—i.e., immersion capacity. Virtual reality is the only medium that offers total immersiveness—unparalleled to any other invention in history (Daghir, 2017, p. 19).

Immersion mediates presence—fundamental precept in VR operation (Ahmed, 2018, pp. 21–22; Damer & Hinrichs, 2014, p. 17). Scholars argue that the higher levels of presence in participants, the more remarkable changes in human reactions. In other words, VR is more immersive than traditional media. Hence it creates a more profound illusion of presence, and finally, this presence condition evokes quasi-real human reactions. VR has proven to elicit more effects than traditional media in many subjects: emotions (Bujić, Salminen, et al., 2021; Bujić, Xi, et al., 2021; Durnell, 2018; Martin, 2014; Mimnaugh, 2018; Navarrete et al., 2012; Seinfeld et al., 2021; Sellers, 2020) and higher levels of empathy (AlBasri, 2019; Banakou et al., 2020; Bowman et al., 2020; Kandaurova & Lee, 2019; G. M. Kim, 2019; Loon et al., 2018, 2018; McEvoy, 2015, 2015; Passig et al., 2007; Rodenbaugh, 2020, 2020; Stepanova et al., 2019). Most scholars have embraced the categorization of VR as the "empathy machine" since the power to locate people in a very different context from their own. Imagine a male user has had a peaceful and accommodated life. Suddenly, in a VR experience, the same user can embody a refugee woman in a Middle East refugee camp. The male participant might have never experienced extreme vulnerabilities.

Thanks to the VR effects of people´s presence and embodiment, researchers realized that VR could have the potential to be a new generation method to induce prosocial attitudes in people. This is how VR attitudinal studies were created. Prosocial attitudes are defined as the type of beliefs that will benefit other members of society (Penner et al., 2005, p. 366). For example, adopting fewer racist attitudes via VR intervention might benefit ethnic

minorities in such a society. The study of attitudes is relevant because they influence our conception of the world and conduct human action (Forgas et al., 2010, pp. 9–12). Social scientists—including political scientists—have adopted social psychology theories and methodologies in the last century to understand how attitudes are generated and transformed over time.

VR does not elicit attitudinal and behavioral changes simply due to the presence and embodiment effect. VR requires professional and new immersive storytelling techniques to elicit prosocial changes effectively—the message should be effective. Narrative immersion and narrative persuasion are considered storytelling elements in this study—to describe the experimental stimulus.

VR attitudinal studies have covered some sustainable development (SD) issues in the last years. SD could be the most relevant concept in our time. Defending and acting towards sustainable development appears unavoidable since today's world faces many existential threats. Education for sustainable development (EDS) is the specific academic area that tries to understand how to spread knowledge and encourage favorable attitudes and behaviors towards sustainable development. UNESCO has been the agency leading world efforts towards this goal since 1992. In 2015, the 2030 agenda for sustainable development—global political agenda agreed by member states of the General Assembly of the United Nations (UN) with 17 goals to be achieved before 2030—included EDS within goal number four. Gradually more actors are involved in realizing that aim, especially schools, multidisciplinary scientific communities, the private sector, and NGOs.

Some VR attitudinal studies have shown the potential of virtual reality towards certain pillars of sustainable development compared to lower immersive methods. In the following lines, I present some of the most important studies regarding the intersection between VR attitudinal studies and sustainable development. Ball suggests that VR could create more significant positive environmental attitudes, conservation attitudes, and intentions for activism than 2D media (Ball, 2019, pp. 90–102). Jones and Sommer proved that VR content is more effective in eliciting pro-migrant attitudes and behaviors than written journalism (Jones & Sommer, 2018, pp. 17–19). Bujic et al. argue that VR content can create more favorable attitudes towards human rights compared to 2D media and written content (2020, pp. 1407–1409).

The studies above were solely related to sustainable development but not intended to explain the interception between VR and SD as a broader phenomenon. One single study tries to assess the power of VR in SD attitudes with a larger scope. Muntean et al. completed a study in 2018 and 2020 with a basic qualitative methodology. Most VR attitudinal research has utilized experimental design since a significant amount of control is needed—Muntean did not fulfill and generated a sizeable methodological bias. Since then, there has not been another VR experiment that intends to measure attitudinal changes towards sustainable development with a larger scope.

ESD scholars have developed more innovative and accurate ways to measure attitudes towards sustainable development in the last ten years (Biasutti & Frate, 2017, p. 217). Sustainable development in the scientific community is understood to have four operational pillars: environmental sustainability, social sustainability, economic sustainability, and

education—the last proposed in recent years by ESD scholars (Nousheen et al., 2020, pp. 1–3; Tomislav, 2018, p. 85). The research niche is to understand VR effects on SD attitudes with novel EDS measurement.

Recent research claims VR could be better than traditional persuasive techniques to incentivize pro-donation attitudes towards some SD causes. Yoo and Drumwright proved that VR content is more effective than conventional 2D media to increase donation intentions towards humanitarian causes, similar results to Kandaurova and Lee´s prosocial donation study (2019, pp. 571–579) and Nelson´s nature conservation donation study (2020, pp. 1–18). These existing studies have two limitations. First, they only included donation questions towards very specific subjects—e.g., coral reef conservation—that do not explain SD donation attitudes with a broader scope. Second, the current research of VR and donation attitudes do not measure attitudinal change—i.e., their experimental designs did not measure donations attitudes before the VR stimuli. Researchers cannot argue that VR stimuli change peoples´ attitudes with this design. It only suggests that VR might be more effective than other media at one point in time. This creates a gap to be filled.

Structure of the study

In the first chapter, readers will find the introduction where a brief explanation of the study´s background and context is developed. Later in the chapter, the overall structure of the thesis is explained. In chapter two, the justification of the study is discussed. In this chapter, we briefly discuss the relevance of VR for social scientists and as a successful disrupting technology. Additionally, a list of potential beneficiaries of the expected research findings is

included. The third chapter operationalizes the research problem by explaining research aims, objectives, and questions.

In the fourth chapter, the literature review, the research aims will be situated in the existing literature. First, the most relevant concepts of VR will be introduced—very important for readers unfamiliar with VR technologies. Second, VR attitudinal studies are explained, and the most significant studies covering sustainable development (SD) attitudes are presented. Finally, we contextualize and justify the two research niches: VR and attitudinal change towards SD—four pillars measurement—and VR and donation attitudinal changes towards SD causes.

In the fifth chapter, the study´s methodology is explained. First, the rationale behind the experimental method and measurements are explained. After having introduced the measurements, the operational hypotheses are presented. In the end, the chapter covers the recruiting process, sample characteristics, groups and conditions, experimental procedure, experimental stimuli, equipment, gratification, and ethical considerations.

In the sixth chapter, results and a discussion of the results are presented. First, we provide statistical results for each hypothesis. After each hypothesis´s result, a discussion covers three elements: finding significance, comparing results with previous literature, and the result´s limitation. At the end of the chapter, the general relevance and limitations of the study are presented. Finally, readers can find the study's conclusion in the seventh chapter. Partial results were found. VR seems to be more effective than traditional video to generate attitudinal donations. However, SD attitudes do not reflect attitudinal changes in most SD

pillars. Results also suggest that VR is not more effective than videos to change people´s attitudes towards the SD. In this chapter, the main insights for future research are also suggested.

Research justification

VR has many powerful characteristics in two dimensions: a method for social scientists and successful disrupting technology—i.e., previous technologies are set aside, and the new grow exponentially (Herrera-Quintero et al., 2019, pp. 1–2). Regarding VR as a method for social science, there is no more immersive tool than VR to block all external world stimuli, remove temporal and spatial limitations, and captivate all participants' attention (David O. Dowling, 2020, p. 146; Heim, 2014). Fortunately, VR is now affordable for many researchers, and its use is more friendly to non-computer experts (Fauville et al., 2020, p. 104; Nezami et al., 2020, p. 4; Parsons, 2019, p. 2). Additionally, VR offers social scientists the possibility of creating scenarios difficult or impossible to control and replicate in the real world (Fox et al., 2009b; Lanier, 1992; Slater & Sanchez-Vives, 2016, p. 20). VR might be the most important invention to promote the perspective-taking of other people´s realities and has been labeled as the “empathy machine” (Hasson et al., 2019, p. 11; Nunes & Lee, 2019, p. 309). Finally, virtual reality represents a compelling and dominant paradigm for experimentation in the XXI century (Giuseppe Riva & Waterworth, 2014, p. 12)

As a successful disruptive technology, VR is expected to double its market by 2024, which means that more people will use VR and create a new job and consumer market (Alsop, 2021; Verma et al., 2021, pp. 16–17). Smart glasses—some of them with VR capabilities—promises to be the following human-computer communication method leaving behind

cellphones and impacting human activities (Escherich & Moar, 2020; Peacock, 2020). Finally, VR is receiving billions in investments to be the next stage of the internet—embodied internet. Technological leaders and governments are already discussing the impact of VR social media after the serious discussion of the leverage of the metaverse—the conglomerate of virtual worlds (Dwoskin et al., 2021; Newton, 2021). VR will transform the way humans perform certain activities—e.g., in the medical and military areas (Novet, 2021; Slater & Sanchez-Vives, 2016, pp. 1–4).

For explanatory purposes, I decided to list the relevance of this research by possible stakeholders.

For political science:

1. For many years, experimental research was peripheral in political science (Williams & Morton, 2010, pp. 3–6); now, it is core in the development of the discipline to prove "secure causal inferences" (Ostrom, 2010, pp. 1–19).
2. Political thinkers through history—like Weber—have considered attitudes as a necessary concept for explaining the world (2009, pp. 100–115). Political scientists since the 1940s initiated a rich and complex journey in the study of political attitudes (Voinea, 2016, pp. 30–42).
3. Attitudes due to persuasive messages is a phenomenon commonly studied by political scientists (Holbrook, 2011, pp. 9–11)
4. Virtual reality represents a compelling and dominant paradigm for experimentation in the XXI century (Giuseppe Riva & Waterworth, 2014, p. 12).

5. Political Scientists have shown no interest in experimental VR methods since the commercial availability of the technology in the mid-2010s (Mathysen & Glorieux, 2021, p. 2). There has been a new wave of lab research among political scientists (Bol, 2019, pp. 167–169). It is necessary to include VR in the lab design methodologies and explore its potential regarding political agendas.

For researchers using VR as a method towards attitude change:

1. Most VR attitudinal studies include a post-test-only control group design due to different factors—most common time and economic constraints. This model only describes the effect of VR consumption just after the stimuli, and usually, VR is compared to other media or techniques (control group). This model does not have the power to claim attitudinal changes in participants since initial attitude levels were not gauged. On the other hand, a pre-test-post-test control group allows us both results: measuring the effect of the stimuli and it allows attitudinal change discussion. This dissertation encourages using the latter lab design for future VR attitudinal studies.
2. This study also proposes that researchers utilizing a pre-test-post-test control group design must be careful to apply the pre-test on-site to maintain internal validity.

For international organizations, charities, and NGO´s:

1. With this study, the UN could have—for the first time—scientific evidence to corroborate or refute if VR could help incentivize attitudes towards sustainable development—in the four pillars of the concept.

2. With this study, international organizations, charities, and NGOs that work with the 2030 agenda can better decide if to begin, continue, or stop investing in VR campaigns to spread SD positive attitudes and increase donations.

For governments:

1. Most governments should consider SD as a relevant political agenda since they are linked to binding international agreements—e.g., the Paris agreement— and non-binding treaties—e.g., the 2030 SD agenda or the New Urban Agenda. If favorable data are found, governments might decide to invest or not in VR content and technologies to be integrated into the educational curricula and in this way spread attitudes towards SD to their citizens—especially among young generations with more significant chances of technological adoption (Olson et al., 2011, p. 123).
2. If favorable data are found, governmental agencies—other than educational authorities— interested in creating favorable attitudes towards SD could start investing in VR campaigns—e.g., the environmental ministries or the urban planning agencies.

For the private sector:

1. If favorable data are found, private companies interested in the SD agenda could use VR campaigns to incentivize pro-social change. Big companies such as Coca-Cola and Volkswagen have used VR in the past (Herranz de la Casa et al., 2019, pp. 185–192), and they usually launch prosocial campaigns in traditional media. They could make mixed VR and traditional campaigns.

2. Journalistic outlets are already attentive to VR immersive narratives (David O. Dowling, 2020, p. 147). This research could help news editorial boards—with interest in SD—have a scientific basis at the moment to decide whether or not to invest in VR content. Some news outlets, like Aljazeera (Tilve, 2020), could push forward this VR tendency, and others might leave, as the BBC did in 2019 (Feltham, 2019). News outlets need data to decide.
3. Visual artists interested in sharing sustainable development messages could have some data about VR as a tool to change people's attitudes. This study´s findings might offer some information to them to decide whether or not to invest in VR narratives.

Research aim, objectives, and questions

This study aims to analyze the effectiveness of VR to elicit greater positive attitudinal change in comparison with 2D media towards two areas: sustainable development—and its moderator variables— and donation attitudes towards SD causes.

First research objective: To understand if VR is more effective than 2D media to elicit positive attitudinal change towards sustainable development (SD).

Second research objective: To understand if SD knowledge, political ideology, and gender are moderator variables of SD attitudes.

Third research objective: To understand if VR is more effective than 2D media to elicit positive attitudinal change towards donating to social causes.

First research question: Is VR more powerful than 2D media to elicit positive attitudinal change towards SD?

Second research question: Are gender, SD knowledge, and political ideology moderator variables of SD attitudes?

Third research question: Is VR a more robust method than 2D media to elicit positive donation attitudinal change towards SD causes?

While the use of VR is immense across disciplines—education, medicine, psychology, neuroscience, marketing, journalism (Atkins, 2020, p. 3)— the scope of this thesis is determined into the study of VR as a method for attitude change. We study two specific attitudes: attitudes towards sustainable development and donating attitudes towards sustainable development causes.

Chapter 2: Literature review

The literature review chapter will include different sections. First, the technical concepts of VR will be introduced, which are important for the reader to keep an engaging conversation in the following chapters—especially in the discussion chapter. Second, the nature of VR attitudinal studies is explained, and the most significant studies that intersect VR and sustainable development (SD) attitudes are introduced. Finally, we contextualize and justify the two research niches: VR and attitudinal change towards SD—four pillars measurement—and VR and donation attitudinal changes towards SD causes.

Main concepts in VR

Types of digital realities

There are different types of virtual realities virtual reality (VR), augmented reality (AR), and mixed reality (MR). The umbrella term—extended reality (ER)— encompasses all types of digital realities reality A brief description of each is presented in this section.

Virtual reality

Virtual reality (VR) is a digitally manufactured space that humanity could access by wearing high-tech computer equipment —usually head-mounted displays (HMD) or headsets—(Fox et al., 2009b, p. 95). The digital experience is created through 360VR videos, computer-generated (CP) graphics and, photogrammetry—the 3D topography scanning of real objects. A combination of techniques can be utilized (Fernandez et al., 2021, pp. 28–31; Waltermire, 2018, p. 11). VR equipment enhances participants´ actions through the senses (Lv, 2020, p. 9593). The user is located in a virtual world (also known as a virtual environment). They live

a quasi-real experience where they can interact with other environments, objects, and people —due to substituting the primary sensory data from the "real" world with CP input (Damer & Hinrichs, 2014, pp. 1–2). Simulated reality (if not "exactly real") operates below the so-called "reality horizon" (Slater & Sanchez-Vives, 2016, p. 2). The uniqueness of VR is that it can simulate real social experiences challenging to have in the real world, like running with bulls in Pamplona (Watson, 2017, p. 21), being in the space (Stepanova et al., 2019), or being in the middle of a war (Yu et al., 2018). The other key element of VR is the possibility to create "unreality" experiences that defy the laws of physics—e.g., being in a world where gravity is different—(Datallo et al., 2018) and logic —e.g., creating a virtual experience with someone that has already passed away[1] (Stein, 2021). The goal of VR is not to substitute "in world-reality." The ultimate goal is to create extraordinary experiences within and out the boundaries of in-world reality that could make an impact on people and might even help to have a sustainable world (Slater & Sanchez-Vives, 2016, pp. 2–38).

VR 360° video is another way to create events apart from mere computer-generated (CG) graphics—it is also possible to merge VR and VR 360 production techniques to get hybrid experiences. The virtual scenario is recorded using a special 360° camera, which usually includes multiple cameras to cover all angles—and it is processed with computer software to unify all recorded material and create an all-surrounding view. This video can be displayed in a highly immersive fashion with a head-mounted display (HMD) —just as CG

[1] This experience conducted in South Korea by a TV network with cutting-edge technological graphics brought a big discussion on the unreality power of VR and possible ethical limitations (Stein, 2021, pp. 13–14).

graphics. VR 360° content can also be displayed on other devices such as cellphones, tablets, of computers with deleterious effects on immersion and presence (Cummings & Bailenson, 2016, p. 272) —forthcoming concepts.

Augmented reality

Augmented reality (AR) is another immersive technological application that should not be confused with VR. Augmented reality refers to the capacity of a system to superimpose digital content, precisely 3D objects, over the real world. The environment becomes data-rich, providing an enhanced perception of the "real world" through information (Speicher et al., 2019, p. 537). For the AR to operate, it is necessary to use smart glasses or a smartphone with a camera (Ahmed, 2018, p. 33; Durnell, 2018, p. 148). The most common reference might be Pokémon Go. With the power of AR, you could point into the sky with your device and reveal constellations and information about it, or you might focus on a building and watch the architectural history of the building (Heim, 2014, p. 10). Although AR devices (cellphones or smart glasses) assume first-person perspective (1PP), there are different levels of presence and virtual illusions (forthcoming) that are not suitable for AR —VR with overpasses AR (Tussyadiah et al., 2018, p. 13).

Mixed reality

Mixed reality is one complicated term. Even among experts, there are contradicting statements. Speicher et al. conducted rigorous qualitative research to define this concept with numerous technological experts and academics. They argue that MR is considered in different ways: 1) a strong AR with more functionalities—with the possibility of full

immersion and hence the possibility of using VR and AR interchangeably. For others, mixed reality is different from AR because the virtual object anchors to the real world, and you can manipulate them; this means that the user can interact with real and virtual objects simultaneously, usually with advanced hands tracking systems (Goo et al., 2020, p. 135; 2019, pp. 1–12). One example of an MR application is when a doctor interacts with a 3D hologram of a patient´s heart amid the surgery. This use might have an effect in increasing successful medical interventions. The doctor can manipulate the image (rotate, zoom in, zoom out)—holograms are dynamic and interactive with a better morphological knowledge during surgical and interventional preparation (Brun et al., 2019, p. 883).

Other scholars and technological leaders consider that MR is the same as AR. Milgram et al., who are world-recognized researchers for their Reality Continuum Theory, support this claim. The argument is that (in one extreme) we have a fully real environment ("real world") and in the other an entirely virtual environment. Everything in between is considered MR, and therefore AR is one modality of MR. Others have a more radical approach by claiming that people will not perceive differences among digital realities (Speicher et al., 2019, pp. 2–4).

Technological Immersiveness

Technological immersiveness is a fundamental concept for the understanding of VR. Immersion is commonly conceived as the product of particular technology that enables the creation of a multimodal sensory "input" to the user (Giuseppe Riva & Waterworth, 2014, p. 1). Immersiveness and immersion have been used interchangeably in the last decade. Either

concept refers to the technical capacity to offer fidelity (visual, auditory, and haptic). The system can be classified into different levels of technological immersiveness—commonly referred to as low and high degrees of technological immersiveness. System X is more immersive than system Y when system X can replicate what the system Y transmits, but system Y cannot reproduce system X′s output (Slater & Sanchez-Vives, 2016, p. 5). For example, a computer can duplicate the content of a printed newspaper, but there are many characteristics of the output of a computer that a printed newspaper cannot produce; hence the computer is more immersive—the computer cannot reproduce a video, for instance. In the auditory field, if you want to listen to a recorded concert, a small speaker of 3v cannot create the same output as a 3D audio set of 500v with seven sorrounding speakers; therefore, the latter offers a high level of immersion.

Technological immersiveness should not be confused with the so-called "immersive media" that refer to technological devices that simulate unmediated sensory experiences, including VR simulations, AR games, or 3D movies (Breves & Heber, 2020, p. 333). Immersiveness goes beyond this categorization. This research does not embrace the term immersive. Other media might have immersiveness like immersive literature, immersive theater, immersive theme parks, or immersive art expositions—among others (Gröppel-Wegener & Kidd, 2019, pp. 12–15).

Differentiating levels of technological immersion is a recurring methodology in social science and VR studies. Most researchers intend to understand the effects of VR in comparison with other immersive devices since the early development of VR in social science (Fox et al., 2009a, p. 4). Typically, scholars compare VR experiences with 2D videos

on a screen (Ahmed, 2018; Kandaurova & Lee, 2019; G. M. Kim, 2019; Nelson et al., 2020; Passig et al., 2007; Stepanova et al., 2019; Waltermire, 2018, 2018). Another group of researchers even controls three levels of immersion—VR, 2D, and written content (Bujić et al., 2020; Bujić, Salminen, et al., 2021; Rodenbaugh, 2020). Another social scientist—who employs VR—creates innovative experimental approaches, like comparing two VR computer-designed experiences with different avatars (forthcoming) and narratives[2] (Loon et al., 2018). Complementary approaches compare VR within-site real experiences (AlBasri, 2019; Herrera et al., 2018; Mimnaugh, 2018; Sellers, 2020), and others VR versus AR (Bujić, Xi, et al., 2021). Less severe studies try to understand VR effects without any control group (Brautović et al., 2017; Coghlan & Carter, 2020; Muntean et al., 2019, 2019; Tussyadiah et al., 2018). The VR method will entirely depend on the research question and the researcher's imagination.

Presence

The concept of presence presents insightful categorizations and might be the most important VR literature. Lee (2004) encompasses three crucial aspects of presence. Spatial presence refers to the feeling of being there—in another place in virtuality— and losing yourself in the mediated environment (Fox et al., 2009a, p. 98). Social presence refers to the feeling of being with others in a virtual world—(Biocca et al., 2001). Finally, the personal presence refers to the feeling of a virtual self-representation (avatars) as an extension of the self (Ratan

[2] This type of experiment is very expensive since there is a need for advanced immersive graphics design. Additionally, researchers paid one hundred dollars for a participant at Stanford University (Loon et al., 2018, p. 3).

et al., 2007, p. 167). Spatial presence and social presence are the most scientifically studied aspects of presence.

As explained before, scholars defend that the level of technological immersiveness supposes a differentiated level of presence—the higher level of immersiveness, the increased sense of presence. However, this pattern does not always occur. There is a ceiling effect[3] in which individuals do not reflect changes in presence, no matter the immersive system (Bujić et al., 2020, p. 4). Hence the subjective feeling of presence influences the efficacy of the virtual intervention rather than the level of immersion.

Presence is a subjective concept that has been gauged in the last decades with no definitory measurement. There have been attempts to create standardized questionnaires to measure presence like the suggested model presented by the VR leading researcher at Microsoft, Mar Gonzalez-Franco (2018). World-recognized researchers like Slater have argued that academics should go beyond questionnaires after decades of research on presence. Robust claims argue that the best way to report presence is through physiological measurements with specialized equipment (Schwind et al., 2019, pp. 1–4). Finally, another measurement problem is that applying paper-based questionnaires after virtual stimuli breaks the virtual presence and creates a systemic bias in the experiment (Putze et al., 2020, p. 10). Those are the two reasons I decided not to measure presence in this research.

[3] Meaning that the independent variable (technological immersiveness) has no effect on the dependent variable (presence levels).

Embodiment and avatars

Sense of embodiment (SoE) describes how a person replaces their own body for a virtual one. Embodiment requires detachment from physical constraints (Mavi Sánchez-Vives, 2019; Slater & Sanchez-Vives, 2016, p. 8). For this to occur is necessary to have the minimum level of technological immersiveness available: an HMD with head tracking. The embodiment process is a set of activated sensations while being in a virtual body. The first element for embodiment is place location, i.e., the space where people believe they are located with the body. The second is a sense of agency[4] , which means having intentional control of the body— the stronger the illusion, the more probable to produce a sense of agency (Gonzalez-Franco & Lanier, 2017, p. 5). Third, a sense of body ownership—i.e., a self-attribution of the virtual body (Banakou & Slater, 2014, p. 17680; Longo et al., 2008, pp. 978–980).

The brain can easily alter human morphology and adapt to new body conditions. It has been proven that people can assimilate asymmetric human bodies (longer arm even additional arms), different body sizes (embodying a child body), and even characters with no human characteristics (Banakou et al., 2013; Guterstam et al., 2011; Slater & Sanchez-Vives, 2016, pp. 7–8). One example is the human possibility to adapt into animal bodies (Won, Bailenson, & Lanier, 2015, pp. 1–4; Won, Bailenson, Lee, et al., 2015, p. 242). The first person to explain the power of SoE was Jaron Lanier in the late 1980s (Slater & Sanchez-

[4] Agency is studied within virtual worlds with the same psychological measurements as in the real world.

Vives, 2016, p. 7)—one of the founders of modern VR—, since then, embodiment has been an essential topic for the scientific community, especially neuroscientists and social scientist.

Different procedures can achieve SoE. One approach is the avatar exposure— for 10 minutes approx—using a virtual mirror reflection. The participants see themselves in a digital mirror, and the projection of the virtual mirror allows participants to see their new bodies. The body articulates the participant's movements—visuomotor synchrony (Banakou et al., 2020, p. 2; Padrao et al., 2016, p. 8).

Virtual worlds

Michael Benedikt was one of the first virtually pioneers who began the virtual worlds' idealization. He was an architect that suggested the design and characteristics of "cyberspace." He considered a virtual world an illusory space in which objects are not real in the matter, and the laws of physics and mathematics could be broken (Heim, 2014, p. 4). Jaron Lanier, the father of VR, considered an infinite possibility for interaction limited by human imagination (Conn et al., 1989, p. 8). Virtual worlds block sensory input from physical reality, the principal goal (Biocca & Levy, 2013, p. 134).

VR offers the possibility of generating scenarios that are not easy to set or are potentially dangerous for people in the real world —e.g., visiting a refugee camp in the middle of a war zone. Most of the scenarios will be too expensive or unviable to achieve in real-life conditions (Fauville et al., 2020, p. 92). Another benefit of social experiments with VR is that researchers can simulate experiences locating participants in different temporal

settings (Parsons, 2019, p. 25). In terms of creating virtual experiences, VR has no constraints as you might encounter in the real world (Lanier, 1992).

VR and attitude change capabilities

Attitudes and attitude change

Attitudes are evaluative responses towards an object. The object can be concrete (e.g., chocolate), abstract (e.g. gender equality), inanimate (e.g. money), people (e.g. Elon Musk or oneself), groups (e.g., the KKK or far-right politicians). The origin of attitudes is a broader discussion in the academic world. Attitude formation might be inseparable from attitudinal change since attitude creation will change current attitudes. Change in attitudes will be referred to hereafter as attitudinal change.

Attitudes are relevant, but simultaneously they carry some limitations. On the one hand, Attitudes have several flaws. Humans tend to evaluate objects rapidly—sometimes, evaluating what is good and bad might require less than a second. Although this serves us for easier "knowledge organization" processes, this could create dangerous antisocial predispositions (Bohner et al., 2002, p. 4; Forgas et al., 2010, p. 3).

Sources of attitudinal change in VR

Narrative immersion

VR does not produce any prosocial change per se in people. The power of VR to change attitudes broadly depends on the creators' intention—journalists, filmmakers, scientists, marketers, or any other storyteller. People who use VR methods to create attitudinal changes tend to use the power of immersive storytelling with narrative persuasion elements.

Narrative immersion is a framework proposed by Ryan (2015), who considers four dimensions to understand narratives in VR and 360—some dimensions also apply for written media. The first dimension is spatial narrative immersion that refers to the setting (location and time) of the story—composition of the virtual world. The second dimension is temporal narrative immersion that refers to the story and the organization of events. This dimension also focuses on the characters and all elements around them. The third dimension is spatio-temporal narrative immersion, which is how the audience is incorporated into the plot. They could be a character that interacts, an observer, or an inanimate object in the virtual experience. The fourth dimension is emotional immersion, which refers to how the user feels with the setting, the story, and the interaction in the experience. This is more closely linked to the story event, i.e., the conflict and the consequences of the characters' actions (Elmezeny et al., 2018, p. 8; Jarvis, 2019, pp. 106–114). Narrative immersion dimensions will be used to explain the characteristics of the audiovisual content used as the stimulus in this study.

Narrative persuasion

Narrative persuasion researchers refer to how the information within narratives can alter people´s perceptions of reality. Mechanical and digital technologies efficiently persuade audiences (Rouse, 2021, p. 8); however, in the last decade, studies have shown that immersive technologies such as VR and VR 360 could produce even broader changes in people's views.

One important drawback in the persuasion argument is that the persuasive message does not generate attitudinal change *per se*. The change comes from one´s idiosyncratic

cognitive reaction to a persuasive message (Forgas et al., 2010, p. 10). This claim belongs to the cognitive response model, the most prominent model that develops how persuasion works (Forgas et al., 2010, p. 10; Voinea, 2016, p. 19). Another limitation is the use of narrative persuasion of VR and VR 360 for antisocial propaganda or audience manipulation (Rouse, 2021, p. 8). Manipulations are one of the main concerns in VR ethics constantly studied in the last decades (David O. Dowling, 2020, p. 3; Fox et al., 2009a, p. 5; Metzinger, 2018, pp. 12–14).

Immersion-presence-(empathy)-attitude change

VR and VR 360 have high levels of immersiveness. The scientific community broadly accepts that immersion mediates presence (Ahmed, 2018, pp. 21–22; Damer & Hinrichs, 2014, p. 17). The fundamental element of "presence" is what enables VR to be labeled as the "empathy machine"—i.e.., a powerful artifact that could make participants step into the shoes of others—usually geographically distant and disadvantageous[5] (Bujić et al., 2020, p. 1407; Nunes & Lee, 2019, p. 309). We must be cautious since not all VR attitudinal researchers agree that VR elicits empathy. There is no general agreement that empathy mediates prosocial attitudinal change in the same line. Recently, a new wave of authors positioned themselves against the classification of VR as the "empathy machine" (Rouse, 2021, pp. 1–

[5] "Empathy machine" term was popularized by Chris Milk, a filmmaker who worked for the UN in 2015. His ideas were found eco with prior work of pioneer VR journalist and researcher Nonny de la Peña (Rouse, 2021, p. 4).

3), and they show no empathic changes after VR immersive prosocial persuasive experiences (Van Damme et al., 2019, p. 2067)

What is also under discussion is whether higher levels of presence in the participant might elicit or alter people's attitudes. Prosocial attitudes refer to the category of evaluative responses that the general society considers beneficial to other members of the same society (Penner et al., 2005, p. 366). volunteerism and donations are naturally considered prosocial (Craig et al., 2021, p. 136). However, countless attitudes and behaviors could fulfill the category "prosocial."

VR and sustainable development attitudes

There is an extensive history in the evolution of sustainable development as a term. Various political activities have referred to sustainable development globally, from the U Thant Report by the UN in 1969 to the UN 2030 Agenda for Sustainable Development. SD could be the most important pressing political agenda of our time in the midst of rapid demographic growth, exacerbated inequality, democratic difficulties, armed and humanitarian crises, technological disruption, global pandemics, and climate existential threats (Bras, 2019, pp. 107–109; Dabla-Norris et al., 2015, pp. 3–5; Dembinski et al., 2019, pp. 105–107; Masson-Delmotte et al., 2021, pp. 5–13; Sadin, 2021, pp. 30–33; Tomislav, 2018, pp. 67–70). Some countries are forced to consider sustainable development by legally binding treaties—e.g., the Paris agreement (Dimitrov, 2016, pp. 1–3)—and not binding still relevant compromises—e.g., the new urban agenda and the 2030 agenda for SD.

The 2030 agenda offers a contemporary understanding of the concept and comprises 17 goals and 169 targets to be accomplished by 2030, representing a colossal political and technical mission (Miola & Schiltz, 2019, pp. 2–4). Understanding SD with such large parameters might be very complex, so scholars have embraced Elkington's triple bottom line concept in 1994. This term refers that SD in the phenomenon that is in the balance between three pillars: 1) ecological sustainability—preserve environmental conditions for economic practices and quality of life, 2) social sustainability—maintain the rule of law, identities, diversity, race, religion, equality and other human rights, 3) economic sustainability—achieving income and decent living standards (Tomislav, 2018, p. 85).

As a method, VR has found a prolific way to study different attitudinal phenomena that juxtapose with the pressuring political agenda of sustainable development. All of these studies have been conducted in the aftermath of the adoption of the 2030 Agenda for Sustainable Development. In the next section, we include a non-exhaustive list of VR attitudinal studies intended to tackle specific subjects within certain pillars of SD.

VR and gender violence

VR has proven successful in gender violence reduction. Reducing gender violence is goal number 5 of the 2030 Agenda. First, gender violence is a political weapon broadly used during political and social turmoil (Blackburn, 1999, pp. 433–435) and a daily technique for oppression and control (Ghanim, 2009, pp. 23–39). Seinfeld et al. have proved that when male offenders experience domestic violence as female targets, males improve facial recognition of fearful female expressions. This was tested neuroscientifically due to brain

activity. Other studies have been conducted in the last decade to support the claim towards gender-violence reduction, usually due to other gender embodiment and first-person perspectives (de Borst et al., 2020, pp. 2–14; Gonzalez-Liencres et al., 2020; Krämer et al., 2018). This approach has reached the praxis level. VR per Genere is a continental European program to use VR to reduce gender violence (European Commission, 2021). Perpetrators of gender violence in Barcelona have received VR rehabilitation since 2018 (EFE Barcelona, 2018).

VR and peace and justice

Peace and justice are part of goal number 16 in the SD Agenda. Hasson et al. utilized VR 360 videos to understand how immersive perspective-taking could be more effective than traditional perspective-taking—i.e., narrate context and ask participants to occupy someone else's perspective—in peace and conflict resolution. They use VR 360 videos related to the ongoing Israeli-´Palestinian conflict in first-person and third-person perspectives. They film their own VR 360 videos and then test the variables with laboratory-controlled experiments and survey measurements. The results indicated that by creating immersive perspective tacking of an outgroup—Palestinians—Israeli people elicit more empathy and pro-reconciliation values (attitudes): values appreciation (greater humanization), attribution of Palestine as less threatening (fear as a variable), intentions to compensate the Palestinian, higher consequences for Israeli soldiers that used excessive force. The traditional perspective-taking was not close to the effectiveness that VR perspective tacking achieved five months after the stimuli. The author claim VR could be used for perspective-taking in conflict resolution on a global scale (2019, pp. 1–14).

Law enforcement is one of the most relevant mechanisms for achieving justice, especially since the civil movement black lives matter and the assassination of George Floyd (Silverstein, 2021). Non-VR simulators have been largely used in law enforcement training (Lamb, 2020). However, new policy dynamics will allow VR to use as one technique to create empathetic judgment regarding justice offenders and victims. Experts are already designing programs to train officers to recognize people who might experience a mental health crisis (Kratzig, 2019) or how to behave if officials need to socialize with victims of trafficking (Borrelli & Greer, 2021, p. 155).VR experiments have proven efficient even in the opposite context, how vulnerable populations—e.g., people with autism—could improve law enforcement interaction through VR (Parish-Morris et al., 2018, p. 55).

VR and environment

The environment is mainly addressed by goals 13, 14, and 15 of the 2030 Agenda. According to the Intergovernmental Panel on Climate Change (UPCC) of the UN, environmental degradation is an existential threat for humankind. Environmental policies and changes in people's environmental attitudes and actions are required to avoid catastrophic events (2021, pp. 1–41). The scientific community has foreseen the use of VR technologies to change environmental attitudes to counter such effects. Breves and Heber compared VR 360 videos with regular 2D videos under experimental design with survey-type measurement. The results indicated that VR 360 produced more commitment to nature and elicited a stronger effect on environmental connectedness. In Ball, VR experiences produced larger effects than 2D videos regarding general environmental attitudes, elephant conservation attitudes, oceanic attitudes, and connectedness with nature. The research also reported stronger

intentions for activism (Ball, 2019, pp. 90–102). VR has devoted special attention to environmental purposes; this might be where VR has proved to be more effective in promoting environmental literacy, attitudinal change, and behavioral change (Nelson et al., 2020, pp. 1–21). Fauville et al. reviewed and categorized a rich list of VR environmental studies (2020)—while considering VR as a method.

VR and migration

The 2030 Agenda recognizes the contribution of migration towards SD. Migration is a transversal topic across all SD goals (Migration Data Portal, 2021). Additionally, political attitudes towards migrants and refugees are an active area of research for political scientists (De Coninck, 2020; Dempster & Hargrave, 2017; Verkuyten et al., 2018). Attitudes towards migration have the power to polarized societies (Albada et al., 2021, pp. 6–10) and even create dramatic political shifts (Schaub et al., 2021, pp. 687–688). At the beginning of VR experimentation, Passig et al. concluded that VR perspective taking could improve perspective-taking of native students towards new incoming migrant students compared to movies—2D media (2007, pp. 2–13). In more recent studies, VR 360 journalistic videos proved to be more efficient than written journalistic content to elicit empathy, favorable attitudes toward migration. They expressed behavior to take political to favor migrants (Jones & Sommer, 2018, pp. 17–19). Alejandro Iñárritu—the acclaimed filmmaker—even produced Carne y Arena, a VR 360 experience where the participant embodies a migrant crossing the desert and being chased by border officials. Iñárritu claimed that attitudes change in an age of a desensitized society (Dziekan, 2018; Oscars, 2017). Attitude change with this stimulus has not been measured scientifically, but that intent in the future might be valuable.

VR and human rights

The 2030 agenda promote all human rights considered in the Universal Declaration of Human Rights and envisage a world with universal respect for human rights (Curry, 2019). Human rights are transversal in the 2030 Agenda. Bujic et al. aimed to investigate how VR360 degree video could potentially induce more prosocial attitudinal change towards human rights than 2D videos and written text—this is one of the few studies that assess attitude change while collecting pre-stimuli data on participants attitudes. They used laboratory-controlled experiments and survey measurements as research designs with already existing journalistic VR 360 videos. The results indicated that VR 360 journalistic videos elicit greater attitudinal change towards some human rights—not all of them— compared to 2D content and written content. There was no significant attitudinal change difference in some human rights compared to VR and 2D content. The researcher argues the use of journalistic VR to go against the psychological phenomenon of "compassion fade"—the fewer people are in need, the less empathetic and less willing to help from people (Dickert et al., 2012, pp. 100–103)—that usually occurs in large scale crisis (2020, pp. 1407–1422).

Research niche one: VR and four-pillars sustainable development

One single research—presented in two papers— aimed to analyze VR and SD attitudes with a broader scope and not limit their research to a single SD goal. Muntean et al. conducted a study at the UN Headquarters in New York at UN High-Level Political Forum on Sustainable Development in July 2018. They intended to use original VR 360 videos to assess knowledge

and attitudes towards sustainability. Since this is the only resource I have to compare my argument, I ought to be critical and build upon the case of VR for Sustainable development.

The study conducted by Muntean et al. had several methodological flaws: 1) researchers used a qualitative research approaches when quantitative studies are broadly more efficient for this type of studies—this reduce significantly the internal validity of the study 2) participants did not receive the same stimuli—they could choose between different videos and even had the chance to watch more than one— this reduces the capacity to analyze the power of one single stimuli and increase the stimuli input in people who watch more than one video making then not suitable for inter-subjects comparation, 3) there was not control for age with the participants—in VR "as method" studies age should be controlled due the potential that age has in technological acceptance, 4) gender was not controlled—usual confounding variable in attitudinal studies and technological acceptance studies, 5) the venue was not optimal for the study—as recognize by the experts in the following paper— a crowded summit creates bias—people was predisposed to a sustainable development mood—and increase the error for the amount of distractions participants experience, 6) researcher did not share the questions they asked to the participants—limiting the replicability of the study, 7) because of the methodological approached they had no control group therefore we have no clear data of the effectiveness of the study in comparison with other media, 8) researchers cannot make attitudinal changes claims without a pre-test—measurement of the attitudes before the stimuli—and the researchers did, therefore the research questions are invalid.

A novel way to measure SD attitudes

Although most scholars embrace the triple bottom line approach to SD, there are different approaches to SD. This situation has created certain limitations to a homogenous measurement of attitudes towards SD. Validated questionnaires of SD initiated in the last decade—some measurements have become available since then (Biasutti & Surian, 2013; Michalos et al., 2012; Olsson et al., 2015). Since 2015, some researchers have abandoned the three-pillar approach and began to include education as a new pillar in SD. Experts argue the transversality of education. Since then, new measurements have appeared now with four dimensions (Nousheen et al., 2020, p. 6). Biasutti and Frate´s measurement for SD attitudes offer a balance and well-constructed instrument. It includes an approach of the four dimensions of SD. The four pillars are 1) environment—i.e., awareness of resources and its fragility, human activity, and its effects in policies, 2) economy—i.e., economic growth and limits, economic impact in society and the environment, consumption, and global justice, 3) society—i.e., democracy, freedom of speech and people conflict resolution, and 4) education—I.e., enhancing capacity on people to address sustainability issues for effective participation and decision making. This is a politically oriented questionnaire compared with previous questionnaires. It does not ask about a personal commitment to the environment, the economy, society, or education. It asks participants about their political views towards the political actors and political agendas of each dimension.

There has been one single VR attitudinal study that has tried to explain VR effects of SD with a broader scope with a doubtful methodological design. There is a research niche that needs to be developed. The first aim of this research is to explore the capacity of VR to

elicit attitudinal changes in SD with the best ESD measurements available. This study also compares attitudinal changes results towards SD between VR and traditional 2D video to understand if VR is a more powerful medium in altering attitudes.

Research niche two: VR and donation attitudes towards sustainable development

Donation attitudes theoretically speaking belong to behavioral intentions of attitude-expressive behaviors. Both terms refer to attitudes towards possible action—e.g., "I will donate 100 dollars to charity" (Holbrook, 2011, p. 3). Behavioral intentions are relevant to understand and less complex to analyze than actual behavioral changes. Behavioral changes require that the actions of the participants should be monitored to corroborate if certain stimuli change behavior in an individual. Some scholars might argue that only great technology companies could report behavioral changes accurately since the degree of control on users´ behaviors information—e.g., Google (Przybylski, 2019). This is why most behavior studies do not study behaviors but behavioral intentions. From now on, this study will refer to behavioral intentions as attitudes.

In the last years, VR has been widely used in fundraising campaigns of consolidated institutions private institutions—e.g., General Electric, Volkswagen, or Coca Cola—. Most importantly, humanitarian organizations have seen VR's potential to spread their messages and gain support by offering a first-person perspective (1PP) of the social problems. Some institutions are the International Federation of Red Cross, Save the Children, Doctor Without Borders, OXFAM, and Amnesty International (García-Orosa & Pérez-Seijo, 2020, pp. 99–101; Herranz de la Casa et al., 2019, pp. 185–192). VR academic experiments have backed

the shift towards VR campaigns. Yoo and Drumwright concluded that VR 360 videos are more effective than 2D videos to increase the participant´s donation intention in humanitarian causes (Yoo & Drumwright, 2018, pp. 11–24). Kandaurova and Lee while also reported that VR 360 videos were more effective than 2D videos to elicit higher intentions to donate money in prosocial activities (2019, pp. 571–579). Nelson found that VR 360 generated a larger donation intention towards biodiversity conservation efforts than traditional video (Nelson et al., 2020, pp. 1–18). These studies compared VR with other less immersive media, but they did not include pre-test to measure original donation attitudes. No VR attitudinal studies claim VR could generate donation attitudinal change, an important research gap.

This research maintains SD attitudes at the centerpiece. There is an important connection point between SD and donation attitudes. United Nations and Virtual Reality project stated to create VR content to spread awareness on sustainable development. UN officials argued that the VR 360 documentary *Cloud Over Sidra*—the life of a 12-year-old refugee in a Jordan refugee camp— helped raise funds from an expected amount of $2.3 billion to $3.8 final generated amount at the UN´s summit on global SD in 2015. Officials have no scientific evidence for that claim; this claim remains anecdotal. Another anecdotal comment was made by Patrick Rose—director of communication for UNICEF New Zealand— who stated that after watching UN VR short documentaries (5-8 minutes), one of six people donates which is twice the normal donation rate (Harris, 2015; UN Virtual Reality, 2021). However, the data of such claims are not public, and the statement cannot be confirmed. The UN, since 2015, has continuously invested in more VR professionals and campaigns (Programa de las Naciones Unidas para el Desarrollo, 2015, 2019). VR and its

potential to change attitudes towards donating to SD caused are a research gap that needs to be filled.

The second aim of this research is to explore the capacity of VR to elicit attitudinal changes in donation attitudes towards SD causes. This study also compares donation attitudinal changes results with VR traditional 2D video to understand if VR is more effective in changing such attitudes.

Chapter 3: Methodology

The methodological chapter firstly explains the rationale behind the experimental design and the study measurements. Later, the operational hypotheses are presented. Finally, the chapter covers the most important elements of the experiment: the recruiting process, sample characteristics, groups and conditions, experimental procedure, experimental stimuli, equipment, gratification, and ethical considerations.

The rationale for the experimental design

As noted before—regarding Muntean et al.´s analysis— better methodologies should be used to determine how VR and VR 360 videos could create attitudinal changes towards sustainable development. In fact, from all the different studies presented in the last section—violence reduction, peace and conflict, human rights, migration, environment, and sustainable development— only one study proved to use a proper methodological design to discover attitudinal changes with pre-test and post-test experimental design. The other studies assessed attitudes with a post-test design—with no parameters to analyze attitudinal changes in the same individuals—to compare the VR effects with other media.

Bujic et al. was the only study that utilized a pre-test post-test experimental design to measure attitudinal change. Bujic et al. was used as a practical guideline for this dissertation (2020, pp. 1407–1425). However, an experimental element diminishes the reliability of their data. These scholars first sent the pre-test by mail and then applied the post-test on-site within a controlled environment. Researchers cannot compare pre and post-data collected from two completely different collection environments. An unlimited number of variables could

potentially alter the credibility of online pre-test data—e.g., non-control for distractors and non-control for respondent identity verification.

This project experimental design reduce such biases—researchers usually do not rely on pre and post-test because it is expensive and time-consuming; however, it is the most proper way to measure attitudinal changes (Archer & Berdahl, 2015, pp. 188–207; Gouldthorpe & Israel, 2013, pp. 1–4; Holbrook, 2011, pp. 146–148; Lam & Bengo, 2003, p. 8). Another pre-post control group design was in Rodenbaugh; however, she did not define interval time between pre and post-test which makes her research questionable (2020, pp. 39–42). Finally, this research encourages easier, new, and systematic ways to measure SD attitudes developed last decade.

Measurements

Controlled variables

This research controlled for gender and age variables. I gathered a gender-balanced sample for the following reasons: 1) attitudinal change does not occur the same for males and females (Woloschuk et al., 2004, p. 522), that claim also includes political attitudes (Atkeson & Rapoport, 2003, pp. 495–498); 2) woman are associated with greater empathetic and prosocial behaviors than men (Christov-Moore et al., 2014, pp. 604–620); 3) men and woman have different decision processes towards new technologies (Edison & Geissler, 2003, pp. 142–143; Venkatesh et al., 2000, pp. 33–36)—VR is a technology. Additionally, I wanted to know if gender was a moderator variable in attitudinal change; hence our groups had to be balanced.

Age was controlled—we only accepted people between 18 and 29 years old following the Pew Research Center sampling stratification in technological related research (Anderson & Rainie, 2012)— due to the following reasons: 1) VR is a new technology 2) media information through traditional media (like 2D television) is effective less persuasive for people under 30 years (Boyle et al., 2014, p. 2), 3) reduce high variations in age (Ball, 2019, p. 45), 4) young adults in their 20s have less money and therefore less capacity to donate than older populations (Yoo & Drumwright, 2018, p. 22), 5) technological adaptation to new technologies depends on age, younger adults use a greater breadth of technological devices than older adults (Olson et al., 2011, p. 123), 6) the use of technology depends on the age of the user (Joshi et al., 2019, p. 108; Vaterlaus et al., 2015), 7) technological affinity has also been discussed to be different between younger and older generations (Edison & Geissler, 2003, pp. 137–139). Due to this rigorous control, we can discuss whether age is a moderator variable.

Attitudes towards SD (dependent variable)

This study operates with the SD attitudes questionnaire created by Biasutti and Frate. The measurement includes 20 self-reported 5-point Likert scale items in the four pillars of SD—5 items per pillar. Possible answers range from "strongly disagree" (1) to "strongly agree" (5). This research refers to "pillars," factors, or dimensions. The questionnaire has a Cronbach's alpha of .854 (2017, pp. 214–226).

This is a politically oriented questionnaire that—compared with previous questionnaires—does not ask about a personal commitment to the environment, the

economy, society, or education. It asks participants about their political views towards the political actors and political agendas of each dimension—appendix B. The questionnaire required the same cultural adaptation procedure and a back adaptation design used for political ideology. Finally, the measurement holds an acceptable Cronbach value of 0.78 for the pre-test and a good Cronbach value of 0.80 for the post-test.

Donating to SD causes (dependent variable)

A 4-point Likert scale was designed to gauge donation intentions to SD causes. This measurement includes seven donating subjects: environment, help to migrants, gender equality, education, health, labor rights, and poverty. The questions refer to seven SD priority causes to the Mexican context but the list of causes is larger (Comisión Especial para el seguimiento a la implementación de la Agenda 2030, Senado de la República, 2021, pp. 4–24). See Appendix D. The questionnaire holds an excellent Cronbach value of 0.91 for the pre-test and a good Cronbach value of 0.80 for the post-test.

Knowledge about SD (moderator variable)

Education is considered a core element for spreading sustainable development values. From 1992 until today, Education for Sustainable Development (ESD) is a world educational agenda leveraged by UNESCO with the commitment to incentivize SD knowledge and attitudes with the educational curricula of the member states. ESD is part of the Agenda 2030 within goal 4 (UNESCO, 2020). People need to be literate to have attitudinal and behavioral change towards the SD (Fauville et al., 2020, p. 2). Teaching SD content leads to a favorable attitudinal change in the subject (Nousheen et al., 2020, pp. 9–10). We measure knowledge

of SD with the self-report 20-item questionnaire (with a Cronbach's alpha = .084) created by Michalos et al. in 2011 and refined in 2012 (Michalos et al., 2011, p. 397, 2012, p. 220). The questionnaire holds an acceptable Cronbach alpha value of 0.77. The measurement required the same cultural adaptation procedure and a back translation design used for political ideology.

Political ideology (moderator variable)

Political ideology has been referred to as a mediating variable in some VR attitude change research. On the one hand, conservatives are considered reluctant to accept information unrelated to their ideals. Additionally, conservativism has a negative relationship with prosocial attitudes and behaviors. On the other hand, already liberal advocates tend to show greater empathy, perspective tacking, prosocial attitudes, and behavior—e.g., donate— but lower attitudinal changes. (Atkins, 2020, p. 80; Bujić, Xi, et al., 2021, p. 15; Hasson et al., 2019, p. 4; Patané et al., 2020, p. 1; Rodenbaugh, 2020, pp. 32–76).

This study explored three different ways to measure political ideology: two single self-reported questions and one more elaborated scale. The first self-reported question was, "In politics, people generally talk about "left" and "right." Do you consider yourself leaning towards left or right?" Possible answers were left, center-left, center, center-right, and right (INEGI & SEGOB, 2012). The second self-reported question read as follows "How do you identify your political ideology? Possible answers were very liberal, liberal, moderate, conservative, and very conservative (Bishin, 2004). This study seriously criticizes the single item self-reported questions on political ideology. For that reason, the operational

measurement was a more innovative and possible accurate manner to measure this phenomenon—an elaborated critic on the political ideology measurement is developed in the general limitations section of this study.

The ideology Consistency Scale was developed by Pew Research Center and measures how people indirectly lean towards liberal and conservative views. There are ten items with dichotomous options—one liberal and another conservative. A liberal response counts "-1" and a conservative response "+1," getting results that range from -10 (liberal) to 10 (very conservative) (Dimock et al., 2014).

Since these scales were suitable for the political context in the USA and it was in English, I required a cultural adaptation procedure and a back adaptation design to create equivalence and accuracy of the measurement for the Mexican sample. For that reason, I hired a professional translator who is a native American English speaker with an advanced level of Spanish and knowledge about Mexican culture. Additionally, she had a major in international affairs, and—knowledge about the targeted culture and subject are important for cultural adaptations and translations (Hambleton & Kanjee, 1996, pp. 148–150). She translated the measurement from English to Spanish—the translated version. Then, I hired another professional translator—majored in history—who was a native Mexican speaker and advanced English speaker to create the back-translated version—she translated the translated version. In the end, a political expert —who worked for many years as a faculty member of the International Relations Department at Benemérita Universidad Autónoma de Puebla (BUAP)— native Spanish speaker with advanced skills in English and I created a committee to compare the translated version and the back-translated version. Both versions have to be

as similar as possible at the review; if not, the committee analyzed the differences, located the origin of the problem, and agreed on appropriate language or cultural context changes. Exceptional explanations of the process exist (Griffee, 2001; Isart Gil, 2017, p. 21; Rojas-Ospina et al., 2019, p. 6).

Research hypotheses

Sustainable development attitudinal change (composite measure)

H.1.1 Consuming content in VR leads to a positive effect on SD attitudinal change (four pillars).

H.1.2 Consuming content in video format leads to a positive effect on SD attitudinal change (four pillars).

H.1.3 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (four pillars).

Sustainable development attitudinal change (by pillar)

Environment

H.2.1 Consuming content in VR leads to a positive effect on SD attitudinal change (environmental pillar only).

H.2.2 Consuming content in video format leads to a positive effect on SD attitudinal change (environmental pillar only).

H.2.3 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (environmental pillar only).

Economy

H.2.4 Consuming content in VR leads to a positive effect on SD attitudinal change (economic pillar only).

H.2.5 Consuming content in video format leads to a positive effect on SD attitudinal change (economic pillar only).

H.2.6 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (economic pillar only).

Society

H.2.7 Consuming content in VR leads to a positive effect on SD attitudinal change (societal pillar only).

H.2.8 Consuming content in video format leads to a positive effect on SD attitudinal change (societal pillar only).

H.2.9 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (societal pillar only).

Education

H.2.10 Consuming content in VR leads to a positive effect on SD attitudinal change (educational pillar only).

H.2.11 Consuming content in video format leads to a positive effect on SD attitudinal change (educational pillar only).

H.2.12 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (educational pillar only).

Moderator variables in sustainable development attitudes

H.2.13 Sustainable development knowledge is a moderator variable to SD attitudes.

H.2.14 Political ideology is a moderator variable to SD attitudes.

H.2.15 Gender is a moderator variable to SD attitudes.

Donation attitudinal change towards social causes

H.3.1 Consuming content in VR leads to positive donation attitudinal change towards social causes.

H.3.2 Consuming content in the video leads to positive donation attitudinal change towards social causes.

H.3.3 Consuming content in VR leads to a stronger positive donation attitudinal change towards social causes compared to video format.

Recruiting

Due to the COVID-19 pandemic, there was no access to university campuses and laboratories—where usually most of the VR experiments are held. I reached people through social media with the help of Lourdes Rodríguez Farrera (student of communication science at Universidad Iberoamericana Puebla). One professional marketer—Denisse Camarillo, who majored in marketing communication at Benemérita Universidad Autónoma de Puebla—created a poster (appendix E) shared on different social media for a couple of weeks. People reached us back via WhatsApp, Facebook Messenger, and voice calls. Interested people received additional emails answering their questions with remaining questions about the project. Few participants required multiple confirmations since the mail instructions were not followed; therefore, we arranged the meeting via text or voice message. We used

setmore—an automatic online appointment scheduling service to send automatic reminders to participants one day before their meeting. We use notion—a working management online app— to control the participation stage of the volunteers and other relevant information (annex 5). There was extreme caution in the information divulged to the participants before the experiment to avoid research bias.

Sample characteristics

Participants had two limitations to participate: 1) they had to be between 18 and 29 years old—as mentioned in the controlled variables section, 2) they should be free of any medical condition that could have severe consequences while consuming VR via HMD—e.g., seizures, serious mental conditions, vision problems among others. These limitations were explained in the recruitment stage. We finally gathered 28 women and 32 men for a total sample of 60 participants. Ninety-six percent of the participants live in the metropolitan area of Puebla. Around 80% of the participant were between 18 and 25 years old, and around 20% were between 26 and 29.

"For detecting even small effects as Cohen's d of 0.4 (Cohen, 2013) using a one-tailed paired t-test with the statistical power of 80% and alpha set to 0.05, the recommended minimum total sample size in the compared groups is 41 participants, as calculated in G*Power v. 2.1.9.4. As such, the total number of participants comfortably exceeds the minimum threshold" (Bujić et al., 2020).

Groups and conditions

The experimental method was a pre-test-post-test control group design proposed by Campbell and Stanley for political science experimentation in 1963 (Holbrook, 2011)—figure 1. All the participants answered the pre-test. Then the participants were divided into two groups—one experimental and the other control. The experimental received VR stimuli, and the control group received 2D video format—table 1. The groups were controlled to maintain gender balance and political ideology balance— I did not want that the aleatory procedure created gender differences in groups, and I also wanted to have balanced ideological groups. To do so, I divided all participants into ideological results from the Ideological Consistency Scale. People with results ranging between -10 and -4 were labeled as "liberals," between -3 and -3 as "moderate," and between 3 and 10 "conservative." Since no conservative results appeared, the category was deleted.

Then I clustered all "liberal males" with a random team generator software—*random list*. I distribute such male participants for both experimental and control conditions. The same procedure was used for "moderate males," "liberal females," and "moderate females." As a result, the VR experimental group included 10 "liberal men," 6 "moderate men," 10 "liberal women," and 2 "moderate women." The 2D control group ended with 9 "liberal men," 7 "moderate men," 13 "liberal women," and 2 "moderate women." 2 liberal women that participated in the pre-test and were assigned to the VR group did not come to the next session. Therefore, you may notice not perfect distribution. However, that difference is not statistically significant, and balanced was maintained. The total number of participants was 59—32 males and 27 females. This is the first VR as method research I´ve seen that

equilibrated for political ideology in the experimental and control group. It is important to stress that I only had access to participant numbers since we did a bit ask for names in the pretest; this assured randomization—the highest personal priority.

Table 1

Explanation of experimental and control groups conditions

Group	Condition	Technological immersiveness	In-text abbreviation	Output device	Mode of control	Content type
Experimental	HMD-360	High	VR	Oculos Quest 2	Head movement	360 VR video
Control	Monitor video	Low	Video	Samsung Tab S6 lite 10.4”	No users´ control	2D traditional video

Procedure

Two venues were available for data collection. The intention was convenient for participants in different areas of the Puebla metropolitan area. Thus, I received participants in both locations on different days of the week. Pre-test data collection took place between July 12^{th,} 2021, and August 1^{st,} 2021. After scheduling their meeting, participants assisted in the pre-test session. First, participants read and signed the consent form. Participants were briefed on the procedure and were asked if they had remaining questions. After all, questions were solved, participants answered the pre-test questionnaire on a tablet, a tablet stand, and a stylus—they could also answer with their fingers. Participants were asked If they were well hydrated before their participation; if not, water or coffee was provided—there was a time interval of fifteen minutes between participants for such purposes. Participants were asked if

the zoom and brightness of the tablet screen were good; if not, changes were made. Participants answered the survey in an office-style room with a desk, two chairs, and some bookcases— room changes in both venues were made to have pretty similar conditions. The pre-test participation required between 15 to 25 minutes, depending on the participant. After participants answered the pre-test, I scheduled the post-test with at least two weeks' time-lapse to forget their answers (Gouldthorpe & Israel, 2013, pp. 1–4).

Post-test data collection took place between July 27th, 2021, and August 11th, 2021. Participants knew their group condition the same day of the second meeting. Participants in the VR condition followed the procedure. They entered the room, and a swivel chair was in the middle of the room. They were briefed on the experiment procedure. Then, HMD was adjusted—interpupillary distance, focus, comfort, and audio quality were assessed for all participants. 2) participants watched four VR 360 videos for a total stimulus time of 18 minutes. VR participants were offered two options to leave the immersive experience: standing or seated in a swivel chair— since they required full rotation in the 360 environments. Twenty-seven participants were standing during the entire procedure, and only one decided to sit in the middle of the experiment. The videos were transmitted within the HMD from YouTube VR. Videos were already downloaded and set in a playlist with automatic reproduction. Additionally, I had full knowledge about what participants were watching thanks to the HMD streaming option—I was monitoring that there were no technical problems. After watching the video, participants were asked to answer the post-test questionnaire using a tablet-like in the pre-test—the post-test required between 5 to 12 minutes, depending on the participant.

For the control group, conditions were similar. First, participants were seated in a chair and received instructions on the post-test procedure. Then, their chairs were adjusted, and the screen was calibrated according to the ambient light to watch the videos with adequate brightness. Control group participants watched the same stimuli on a tablet. Videos were properly centered on the screen to offer the cinematic view that the filmmakers intended. Participants were instructed verbally not to touch the screen—since these videos are interactive while watching them on non-VR devices. The videos were also downloaded and placed on a playlist with automatic reproduction on YouTube Premium. After watching the videos, participants answered the post-test on a tablet.

Some conditions applied for both groups during the post-test: participants were not allowed to take their phone during any measurement, and VR and screen participants used noise-canceling headphones.

Stimulus

The discussion is that this thesis is not VR as technology but its output, VR content, and experiences[6]. I created a measurement to decide what videos to be included as part of the stimulus. This study is the first research I have encountered that justifies the stimulus selection transparently and reflectively (annex) compared to studies that did not employ original audiovisual materials. This measurement was created to find the VR360 videos that

[6] VR as technology needs to be comprehend in order to identify the nature of VR content. Most VR attitudinal researchers refer to "virtual reality" in their articles´ names and abstracts, however what they have analyzed was the effect of "VR content/experiences" (created by people like designer, journalist, filmmakers, scientists).

encompass five sections: functionality, high quality, the four pillars of SD, charity symbols, and international agencies asking for donations.

Functionality refers to two elements that served as the initial filter: 1) it had to be in Spanish (since the sample was Mexican); 2) it had to be available on YouTube premium (to download them and avoid technical problems). Then with the help of a colleague—Lourdes Rodriguez (mentioned in the recruiting section)—fourteen initial videos were assessed. A metric was designed to assign points per dimension. The high-quality section included three elements: storytelling (0 to 3), audio quality (0 to 3), cinematography—which allow a greater understanding of the message (0-3). Bad quality content could seriously affect VR's attitudinal effect and might create limitations in the experiment, like McEvoy´s study (2015, p. 3). The four pillars were assigned from 0 to 3 points per pillar. A fifth pillar was added for further exploratory analysis. The appearance from agencies of the United Nations was included (0-3), and charity stimulating features of the content were included too (0-3)—which might be useful for the donation variable.

Fourteen videos were assessed, from which four videos were chosen as the experimental stimuli—the ponder table is included as appendix D. This final stimulus is considered a sustainable development persuasive message. Due to clarity in the next sections, this term will be referred to as “content”—VR content or video content depending on how stimuli were received. The total time for stimuli was 18 minutes. This amount of time was considered optimal since the average time of VR sessions for first-time users is 16 minutes and for returning users 20 minutes (Sujay, 2019).

The first video was *En la piel de un refugiado, la historia Alain contada en 360°* (In the shoes of a refugee, the story of Allain narrated in 360°)—6 minutes long. The creator was the Spanish Commission for Refugees, an NGO founded in 1979 whose prime goal is the promotion of asylum of vulnerable displaced people (Anna Lindh Foundation, 2021). The video includes all four dimensions of narrative immersion. Spatial immersion (place) was located in various computer-generated, and real environments—this technique and the final quality were remarkable for creators. Temporal immersion (story) narrated the journey of an African migrant that went from Congo to Spain—from the eruption of the problems in his country until the cultural adaptation of the adoptive country. There is one single character named Allain. Regarding spatiotemporal (participant perspective), the viewer was a spectator with no interaction with Allain. The video presents techniques of narrative persuasion—especially creating engagement with the character. For example, Allain narrates his own story. The images and words were crude and direct. Most of the scenes are emotionally appealing—narrative persuasion overlaps with the fourth dimension of narrative immersion (emotional immersion), so the latter will not be mentioned. The immersive audio quality is professional, which is important for immersive persuasion—De la Peña considers audio as important as the image to keep users engaged (David O. Dowling, 2020, p. 7). This video is considered "video 1".

The second video was *La Estrella de la Mañana 360 (The morning star 360)—4 minutes long.* UNICEF produced the video in 2016 as a campaign video for indigenous children and climate change. Spatial dimension: Guerrero, México, depicting "real" virtual environments with no CG graphics. Temporal dimension: the video narrates the values and

worldview of a little indigenous girl who resides in the ñu savi indigenous community in the aftermath of hurricane Manuel (in 2015), where family members died, including her mother. After the disaster, Indigenous people were forced to migrate (Castillo, 2019). Spatiotemporal: the participant is an observer with no interaction with the characters. Narrative persuasion was present. For example, the little girl was the narrator of her own story, and the dialogues and the framing of the indigenous children were emotionally driven. Finally, audio is professional, and it includes emotional music. At the beginning and end of the video, the UNICEF logo appeared for a couple of seconds. At the end of the video, a message appears, "after emergency children are the most vulnerable, it is in your hands to give them back hope donaunicef.org.mx," and the logo appears again. This video is considered "video 2".

The third video was Demo Video 360 ACNUR—3 minutes long. The video was produced by 93 Metros, an international interactive multimedia company. Spatial dimension: a refugee camp in Azraq, Jordan, at that time, the video explained that 30,000 people lived there as of June 2021; they accommodate 120,000-130,000. The situation now is much worst (UNHCR, 2021). Temporal dimension: the story describes how the refugee camp operates and how the people live in such conditions. Spatiotemporal: the participants were observers since there was no interaction with the depicted people or the narrator. Several techniques were used for persuasion. The narrator stressed the child refugee condition, and the images depict the great need for better living conditions. Immersive audio is very professional and includes emotional music. This was a prep video for the fourth video who intended to be the most important. In this video, the relevance of ACNUR has been mentioned four times, and

the logo of the United Nations High Commissioner for Refugees (UNCHR) is appreciated at least six times. This video is considered “video 3”.

The fourth video is Video 360: llegada a un campo de refugiados (360 video: the arrival to a refugee camp)—5.5 minutes. The video was produced by 93 Metros, and ACNUR distributed it as a part of a larger donating campaign in 2016. Spatial: it transitions from different locations, a civil home to the Azraq refugee camp. Temporal: the video tells the story of a person whose house is bombed on a normal day. Then he walks towards nowhere and appears in a truck heading to a refugee camp. There the person is scanned and receives instructions about living in the camp. Spatio-temporal: this is the most immersive since you are the character who lives the experience. Despite not having CG interaction, some characters make you feel that you exist in the virtual environment with certain actions like talking to you and looking at you. Narrative persuasion was in much of the experience. The first scene where your house is bombed and your brother asks you to run is very emotional. The last scene where a dozen children run after you to run is significantly emotionally persuasive.

The sound is magnificent in the entire video, with potent emotional appeal. In this video, the logo of UNHCR appeared at least eight times and the logo of ACNUR at least three times. This video is considered “video 4”.

Equipment

VR experimentation with the control group requires equipment. For the experiment, an HMD Oculus Quest 2 128 GB—probably one of the best options in the mass consumer market.

Since there was no access to the university´s laboratories, I had to buy it—the market price was $399 US dollars. Noise isolation headphones were Audio-Technica m50x—high-quality headphones. A bookstand was used as a tablet stand to make the questionnaire process more ergonomic. The Control group used a Samsung Tab S6 lite as a monitor. This tablet is 10.4" and has a very good resolution (1200 x 2000 pixels). Getting the equipment was a long planning process—one year— since I received no funding for this research.

Qualitative and statistical analysis

The literature review was developed through a flexible deductive coding approach with Atlas TI. For the quantitative analysis, R studio 4.1.1 and STATA 16 were used.

Participant's compensation

Participants had access to unlimited coffee and sorted diverse cookies before—while waiting for participation turn— and after- in both pre and post-test. After the pre-test, participants received a box lunch, and after the post-test participation, volunteers received a package with traditional Mexican candies with a value. Total investment in the coffee break and gratifications cost around $350 US dollars. People traveled from distant places to participate, and it appeared appropriate to compensate them. This study was not in-campus research that would probably facilitate procedures due COVID pandemic.

Ethical considerations

VR experimentation should follow strict ethical guidelines. I adapted the Atkins VR study consent form from the University of Ohio (2020, p. 204) for this research. This consent form includes the following elements: research title, name of researcher and adviser, institution, a

summary of the study, explanation of the study, risks, and discomforts—related to the use of VR—, benefits, confidentiality, use of data for further research, compensation, the contact information of the researcher, other clauses that followed the Helsinki protocol, and signature. The consent forms are being kept physically and digitally. In the last decade's distinct codes of VR ethics have been disseminated and formulated (Parsons, 2019, p. 17). These actions offered formality and certainty of the method for cutting-edge social science research.

Chapter 4: Results and discussion

This chapter will cover the statistical analysis results and a broad discussion of the findings. The research question, objective, and corresponding hypotheses will be reestablished to offer greater clarity to the reader. The chapter will follow the same order as the hypotheses presented in the methodology chapter. The results component will include descriptive statistics—if applicable—and inferential statistics tests and results. Immediately after the results, a detailed discussion will follow on each hypothesis. This discussion will encompass three elements: results relevance, comparison with previous studies, and limitations.

Sustainable development is the first subject to be analyzed and correspond to the following research objective and research question:

First research objective: To understand if VR is more effective than 2D media to elicit positive attitudinal change towards sustainable development (SD).

First research question: Is VR more powerful than 2D media to elicit positive attitudinal change towards SD?

To answer the first research question, we develop two different testing approaches. The first statistical analysis includes the complete twenty questions of the SD attitudes questionnaire—to which we refer as composite measurement. The composite measurement would provide a general change in the attitudes of all four dimensions of the SD. The second method was to separate SD by a pillar (environment, economy, society, and education) and revise attitudinal change by each one. This allows us to understand what pillars of SD the stimuli had on impact.

Four pillars of SD (composite questionnaire)

We analyze the four dimensions of SD—composite measure. First, we ran a Shapiro-Wilk Test to know if the variables' data were normally distributed. Secondly, significant differences between the pre and post-tests by the group—virtual reality (VR) and screen (2D)—were analyzed. Then, significant differences between attitudinal changes scores of VR and 2D were tested. Confidence intervals were set at 95%. This process required three working hypotheses to answer the first research question under the composite questionnaire—H.1.1, H.1.2 and H.1.3.

Results composite measure

H.1.1 Consuming content in VR leads to a positive effect on SD attitudinal change (four pillars).

SD pre and post-test data of the VR group presented a normal distribution of the data. A t-test was conducted to find significant differences between means of pre and post-test in the VR condition. The results suggest that there is not a significant difference between the pre-test (M = 4.13 SD=.44) and post-test (M = 4.17 SD = .43), t(26) = -0.839, p = 0.408.

H.1.2 Consuming content in video format leads to a positive effect on SD attitudinal change (four pillars).

SD pre and post-test data of the video group presented a normal distribution of the data. A T-test was conducted to find significant differences between means of pre and post-test in the video condition. The results suggest that there is not a significant difference between the pre-test (M = 4.16 SD = .31) and post-test (M = 4.22 SD = .3), t(31) = -1.558, C.

H.1.3 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (four pillars).

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference between the attitudinal change towards SD of the VR group and the video group. The results suggest no significant difference in attitudinal changes between the two groups—composite measurement— $F(3, 114) = 0.482$, $p = 0.694$.

Discussion SD composite measure

H.1.1 and H.1.2 results suggest that consuming persuasive content, whether in VR or video, generate no effects on sustainable development attitudes while considering the four dimensions of the questionnaire—environment, economy, society, and education. No significant difference was found between the VR attitudinal change and video attitudinal change. With such results, the three hypotheses are rejected. These results answered in one way the first research question.

This measurement—and the variables within it— was applied for the first time within VR attitudinal studies. The second aim of this research was not to use the same variables of past studies but to propose a measurement for SD attitudinal change lacking in the academic world. Thus, it would be unreasonable to compare results to previous studies. Yet, we can contrast methodologies that used composite measures in the past and possible limitations that might have influenced the negative result.

The first testing approach using the composite measure was ambitious and mostly exploratory since it was not expected to find a significant attitudinal change due to some

reasons. First, considering four completely different dimensions into one measurement, computing scores and getting favorable changes is difficult. One limitation is that researchers cannot estimate a precise and proportional amount of stimulus for each measurement dimension. Even though the stimulus was carefully selected to cover the four dimensions of SD, this is not a precise science, and some areas might be more stimulated than others. As described in table 2 (next page), the videos cover unproportionally the four pillars of SD. Most videos in our stimulus directly tackled the economic and societal dimension, and the environment and education dimensions were secondarily addressed. Therefore, if there are changes in one dimension and no changes in another, overall changes could be diminished. This is a common problem with VR stimuli in attitudinal studies. The four videos could be more linked to the economic and social constructs than the education and environmental dimensions regarding this study stimuli.

Bujic et al. also applied a composite measurement to gauge human rights attitudinal change. The measured included three dimensions. As the case with our composite measure, Bujic et al. did not encounter favorable results while considering the entire composite measure. They decided to cluster the statistical analysis by dimension—in our case, by each pillar (2020, p. 1415).

The relevance of this finding lies in the fact that testing composite measures with considerably different dimensions might not be accurate. As the next section argues, more insights could be offered if the researcher separates the composite measure into dimensions.

Table 2

Four selected videos (stimuli "content") and their scores per SD pillar

	Video 1		Video 2		Video 3		Video 1		Total
	Evaluator 1	Evaluator 2	Evaluator 1	Evaluator 2	Evaluator 1	Evaluator 2	Evaluator 1	Evaluator 2	
Enviroment 0-3pts	2	2	2	3	1	1	0	0	11
Economy 0-3pts	3	3	2	3	3	3	3	3	23
Society 0-3pts	3	3	2	2	3	3	3	3	22
Education 0-3pts	3	2	3	3	2	2	1	1	17

Note. The full table is in Appendix D.

SD by pillar

The measurement of SD attitudes has four pillars. This section followed the same statistical procedure used for the composite questionnaire. First, we ran a Shapiro-Wilk Test to know the normal distribution of the data. Secondly, significant differences between the pre and post-tests by the group—virtual reality (VR) and screen (2D)—were analyzed. Then, significant differences between attitudinal changes scores of VR and 2D were analyzed. Confidence intervals were set at 95%. To answer the first research question—regarding each SD pillar—twelve working hypotheses were developed—H.2.1 to H.2.12—three hypotheses per SD pillar. This hypothesis will be the second approach to answer the research question ono.

Environment pillar

Results environmental pillar

H.2.1 Consuming content in VR leads to a positive effect on SD attitudinal change (environment pillar only).

Pre-test and post-test data regarding the environmental pillar in the VR group presented normal data distribution. A t-test was conducted to find significant mean differences between pre and post-test in the VR condition regarding the environmental pillar. The results suggest that there is not a significant difference between the pre-test ($M = 3.71$ $SD= 0.7$) and post-test ($M = 3.74$ $SD = 0.6$), $t(26) = -0.280$, $p = 0.781$.

H.2.2 Consuming content in video format leads to a positive effect on SD attitudinal change (environment pillar only).

Pre-test and post-test data regarding the environmental pillar in the video group presented normal data distribution. A t-test was conducted to find significant mean differences between pre and post-test in the video condition regarding the environmental pillar. The results suggest that there is not a significant difference between the pre-test ($M = 3.83$ $SD= 0.55$) and post-test ($M = 3.81$ $SD = 0.7$), $t(31) = 0.307$, $p = 0.760$.

H.2.3 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (environment pillar only).

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference in the attitudinal change towards SD—the environmental pillar— between the VR and video groups. The results suggest no significant difference in attitudinal changes between the two groups regarding SD attitudes—environmental pillar—$F(3, 114) = 0.223$, $p = 0.879$.

Discussion environmental pillar

H.2.1 and H.2.2 suggest that consuming persuasive content, whether in VR or video, generates no effect on sustainable development attitudes while solely considering the environmental pillar. There was no significant difference between the VR attitudinal change and video attitudinal change. Thus, the three hypotheses are rejected.

As mentioned before, these study variables have never been used in previous work, and it isn't easy to justify the proper comparison. Previous studies that reported favorable attitudes in the VR groups could be explored to see potential elements that favored positive attitudinal results towards the environment.

The first contrast with previous VR attitudinal research on environmental attitudes is that previous measurements were not politically motivated. In Breves and Heber, for example, the reported favorable attitudes on the measurement "commitment to nature"—intended to measure participants´ commitment to nature. Items that included behavioral intentions—intentions about possible action in the future—were included, such as "I am interested in strengthening my connection to the environment in the future." In contrast, the environmental pillar of the questionnaire—used for this research—did not measure behavioral intentions. The questions in the measurement evaluate a political positioning in the environmental agenda and their perceptions about actors. The items ask, for example, "when people interfere with the environment, they often produce disastrous consequences" or "biodiversity should be protected at the expense of industrial, agricultural production." Respondents are not directly subjected to the

questions, creating different results. This pattern will appear in other studies that present favorable attitude results.

Ball measured environmental, attitudinal changes with VR content—no video group was included—with two questionnaires. The questions' wording is very similar to the phrasing of this study´s questionnaire. He measured pre and post-test of two measurements, “general environmental attitudes” and “oceanic attitudes.” In his research Ball achieved a positive attitudinal change for the first (pre-test M = 4.82 SD = 0.66 and post-test M = 5.06 SD = 0.75) and a negative attitudinal change for the latter (pre-test M = 5.60 SD = 0.89, post-test M = 5.29 SD = 0.79). In tandem with Ball´s insights, our results suggest that environmental attitudinal change with VR is not assured (2019, pp. 65–86).

Many different elements could play a role in eliciting positive environmental attitudes, and without a doubt, the stimulus is one of the main factors. As noted in table 2, environmental elements were the least present features in the stimuli—achieving just 11 out of 24 points in the selection criteria. The environment was not broadly covered, except for video 2— which means the persuasive message regarding the environment could have been weak but still effective to keep initial attitudes. Negative attitudinal changes are also possible after stimuli similar to Ball´s oceanic attitudes.

One last potential limitation could be the sample characteristics. Ball´s sample average age of 20.82 was similar to our average sample age of 23.5, and age for both studies was controlled; therefore, age was not considered a factor. Political ideology certainly differs between the two samples. Although participants' ideology was controlled for both studies,

the average mean was 2.72 (ranging from 1 liberal to 5 conservatives), almost leaning to conservative (Ball, 2019, p. 65). On the contrary, this study sample´s ideology is mostly liberal concerning the two measurements utilized for political ideology. It is believed that while experimenting with liberal samples, positive attitudinal changes are less and that conservative samples elicit greater attitudinal change (Bujić et al., 2020, p. 1421; Emler et al., 1983, pp. 1073–1075; Passini, 2014, pp. 89–93). In conclusion, there are chances that the liberal sample of this study affected the attitudinal change results.

Economy pillar

Results economy pillar

H.2.4 Consuming content in VR leads to a positive effect on SD attitudinal change (economy pillar only).

Pre-test and post-test data regarding the economic pillar in the VR group presented normal data distribution. A t-test was conducted to find a significant mean difference between pre and post-test in the VR condition regarding the economic pillar. The results suggest that there is a significant difference between the pre-test (M = 3.84 SD= 0.64) and post-test (M = 4.01 SD = 0.63), $t(26) = -2.060$, $p = 0.049$.

H.2.5 Consuming content in video format leads to a positive effect on SD attitudinal change (economy pillar only).

Pre-test and post-test data regarding the economy pillar in the video group presented normal data distribution. A t-test was conducted to find significant differences between means between pre and post-test in the video condition regarding the economic pillar. The results

suggest that there is a significant difference between the pre-test (M = 3.84 SD= 0.48) and post-test (M = 4.07 SD = 0.39), t(31) = -2.775, p = 0.009.

H.2.6 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (economy pillar only).

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference in the attitudinal change towards SD—economy pillar only—between the VR and video groups. The results suggest no significant difference in attitudinal changes between the two groups regarding SD attitudes—the economic pillar— F(3, 114) = 1.518, p = 0.213.

Discussion economy pillar

Hypotheses H.2.4 and H.2.5 confirm a significant attitudinal change in the VR and video condition regarding the second pillar of SD—economy. There are at the moment no VR attitudinal studies that measure economic, political attitudes; therefore, there are no studies to compare objectively. These results were expected since the stimuli ("content") most directly addressed a narrative where sustainable economic development was centrally emphasized—achieving 23 points out of 24 in the stimuli criteria (see table 2). The results are important because they confirm that VR works to elicit attitudinal changes. Results are even more relevant since it appears to be pioneering research that studies attitudes towards a sustainable economy—see questions 6 to 10 in appendix B. The video condition also reported significant attitudinal changes in the economy. The results could be potentially explained by the accuracy of the narrative, persuasive content to address that subject area compared to the other three.

Despite favorable attitudinal changes in VR, there were not strong enough to claim statistical differences compared to the video condition; therefore, H.2.5 is rejected. The outcome answers negative to the research question one—at least in the economic factor. This result goes against some previous findings. According to the literature, the greater immersiveness of the media, the stronger the "presence" condition, and hence, it could elicit more attitudinal effects than traditional media. VR has elicited greater attitudinal changes in the past, but it does not always occur. Bujic et al. obtained similar results. In the factors where the narrative media had a positive attitudinal effect, there were no significant differences between the VR and 2D (video) groups in three out of the four dimensions of the questionnaire. This means only one dimension in Bujic et al. elicited favorable results towards VR over video.

Societal pillar

Results societal pillar

H.2.7 Consuming content in VR leads to a positive effect on SD attitudinal change (societal pillar only).

Pre-test data regarding the societal pillar in the VR group did not present normal data distribution. A Wilcoxon signed-ranks test was conducted to find significant differences between means between pre and post-test in the VR condition regarding the societal pillar. The results suggest that there is not a significant difference between the pre-test (Md = 4.6 n= 27) and post-test (Md = 4.6 n = 27), V = 62, p = 0.931.

H.2.8 Consuming content in video format leads to a positive effect on SD attitudinal change (societal pillar only).

Pre and post-test data regarding the societal pillar in the video group did not present normal data distribution. A Wilcoxon signed-ranks test was conducted to find significant differences between means between pre and post-test in the video condition regarding the societal pillar. The results suggest that there is not a significant difference between the pre-test (Md = 4.6 n= 32) and post-test (Md = 4.6 n = 32), V = 132.5, p = 0.625.

H.2.9 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (societal pillar only).

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference in the attitudinal change towards SD—societal pillar only—between the VR and video groups. The results suggest no significant difference in attitudinal changes between the two groups regarding SD attitudes— the societal pillar— F(3, 114) = 0.392, p = 0.758.

Discussion societal pillar

H.2.7 and H.2.8´s results suggest that consuming persuasive content in VR or video generates no effect on sustainable development attitudes on the societal dimension. Both hypotheses are rejected. H.2.9 is also rejected since there are no significant differences between the VR and video groups to elicit attitudinal change.

This study´s variables have never been used in previous work, and it isn't easy to find a feasible comparison. Bujic et al. (2020, p. 1417) found the most similar measurement to the societal pillar. These researchers assessed social security attitudes as a composite questionnaire dimension of human rights attitudes. Social security was an 8-question measurement that asked participants about their attitudes regarding access to an adequate standard of living like housing and health. The societal pillar of the SD measurement—the

5-questions measurement—also asked for health services and welfare. Still, other items are completely different variables, focusing on an international agenda of social sustainability with items like “reducing poverty and hunger in the world is more important than increasing the economic well-being of the industrialized countries” or “each country can do a lot to keep peace in the world.” The two measurements, despite having similarities in a couple of items, composition vary, and hence they are not comparable. Bujic found a significant statistical difference in the social security dimension in VR and video groups. Although the stimuli were centered in the social dimension, our results do not indicate the same outcome—this pillar achieved 22 out of 24 points in the content criteria (see table 2). These results were not expected. The section “general results limitations " explains the possible explanations of the results.”

Education pillar

Results education pillar

H.2.10 Consuming content in VR leads to a positive effect on SD attitudinal change (education pillar only).

Pre-test and post-test data regarding the education pillar in the VR group did not present normal data distribution. A Wilcoxon signed-ranks test was conducted to find significant differences between means between pre and post-test in the VR condition regarding the education pillar. The results suggest that there is no significant difference between the pre-test (Md = 4.4 n= 27) and post-test (Md = 4.4 n = 27), V = 84, p = 0.965.

H.2.11 Consuming content in video format leads to a positive effect on SD attitudinal change (education pillar only).

Pre-test data regarding the education pillar in the video group does not present normal data distribution. A Wilcoxon signed-ranks test was conducted to find significant differences between means between pre and post-test in the video condition regarding the education pillar. The results suggest that there is no a significant difference between the pre-test (Md = 4.4 n= 32) and post-test (Md = 4.6 n = 32), V = 136.5 p = 0.486.

H.2.12 Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (education pillar only).

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference in the attitudinal change towards SD—education pillar only—between the VR and video groups. The results suggest no significant difference in attitudinal changes between the two groups regarding SD attitudes—education pillar— F(3, 114) = 0.103.

Discussion education pillar

The results of H.2.10 and H.2.11 indicate no attitudinal change in the education pillar while consuming persuasive content in VR and video conditions.

H.2.12´s results also suggest a no different effect on attitudes between VR and video content. The three hypotheses are rejected.

The results are not comparable with existing literature since the measurement has been utilized for the first time in this study. The existing literature mainly focuses on assessing VR

compared to traditional teaching methods to elicit knowledge gained or students' attitudes towards specific subjects—they do not ask about education policy attitudes. For example, Sellers compare VR educational geology experiences with traditional outdoor field trips. Additionally, she applies a pre-post control group test to assess attitudinal changes of participants towards geology interest (Sellers, 2020, p. 4). Another example is Formosa et al. that created a virtual educational experience to elicit knowledge gain and positive attitudinal change towards psychosis. Both studies covered education and attitudes but not attitudes towards education which this study aimed to address The results were not expected since the stimuli broadly tackle the educational dimension— getting 17 out of 24 points in the content evaluation (see table 2).

Moderator variables in sustainable development attitudinal change

Second research objective: To understand if SD knowledge, political ideology, and gender are moderator variables of SD attitudes.

Second research question: Are SD knowledge, gender, and political ideology moderator variables of SD attitudes?

Research hypotheses are:

H.2.13 SD knowledge is a moderator variable to SD attitudes.

H.2.14 Political ideology is a moderator variable to SD attitudes.

H.2.15 Gender is a moderator variable to SD attitudes.

To analyze the possible intervening effect of SD knowledge, political ideology, and gender in SD attitudes, a statistical model—known as difference in differences—was

designed and run. Results indicate that sustainable development knowledge positively impacts sustainable development attitudes with a 95% confidence ($p < .001$). Each unit increase in the scale of SD knowledge increases the value of SD attitudes in .553 units—in terms of the 5-point Likert scale. In conclusion, SD knowledge has a strong moderating variable on SD attitudes, and hence H.2.13 is accepted.

Political ideology was included in the same difference in differences model. Results indicate that political ideology affects sustainable development attitudes with 95% confidence ($p = .003$). Political ideology has an inverse relationship with the value score of SD attitudes. One unit increase in the scale of political ideology reduces the score in SD attitudes in .032 units. Remember that the values of political ideology range from -10 (very liberal) to +10 (very conservative); this is the reason for the inverse effect—the more conservative, the less favorable attitudes toward sustainable development. To conclude, political ideology is a moderating variable to SD attitudes, and hence H.2.14 is accepted.

Gender was included in the same difference in differences model. Results indicate that gender has no significant effect on sustainable development attitudes with 95% confidence ($p = .242$). These results reject H.2.15, which means that gender is not a moderating variable to SD attitudes.

In the differences in differences model, we also observe an R2 value of 0.429—which includes just moderating variables. This value means that sustainable development knowledge and political ideology explain the 42.9% variation of sustainable development attitudes. For including just two variables, this percentage is notably high.

Discussion moderating variables

The results of H.2.13 and the additional data (R2 = 0.429) suggest that knowledge on sustainable development is relevant to explaining SD attitudes. The findings are especially important in different aspects. First, they offer broad information to education sustainable development (EDS) stakeholders. These stakeholders are a vast number of actors such as governments—especially education ministries—, international organizations, NGOs, the private education sector, and basically, any actor interested in changing people's attitudes towards SD through knowledge sharing. Making people know what SD means, its values, and why it is important might change peoples' attitudes towards SD. According to these results, efforts like those initiated by UNESCO in the early 90´s—to spread knowledge on sustainable development—could be relevant actions towards attitude changes of people. These first results also confirm previous claims in which scholars argued that SD knowledge—sometimes also named SD awareness—is needed to change people's attitudes (Ambusaidi & Al Washahi, 2016, pp. 3–6; Fauville et al., 2020, p. 2; Muntean et al., 2019, p. 4; Nousheen et al., 2020, pp. 9–10). EDS research in the last years includes modern measurements to offer scientific justifications. This study could have an important role in the growing discussion of the significance of SD knowledge on SD attitudes.

The results of H.2.14 suggest that political ideology moderates sustainable development attitudes. These results are relevant for two reasons: first, they justify the control for political ideology in the experimental and control group, and second, this is the first study I have encountered that proves that political ideology has an impact on SD attitudes. Biassuti, Michalos et al., Nousheen et al., Saqib et al., Ambusaidi, and Al Washahi—experienced

researchers in studying SD attitudes—have not included political ideology as an intervening variable in their research which might be a costly methodological mistake. This study offers evidence to integrate political ideology in the next SD attitudinal research as a potential intervening variable —moderator—or control political ideology in their groups' distribution. A large corpus of the literature suggests the effect of political ideology on attitudes, for example, Atkins, Hasson, Patané, and Rodenbaugh (2020, p. 80; 2021, p. 15; 2019, p. 4; 2020, p. 1; 2020, pp. 32–76). Yet, this is the first study that relates political ideology's effect on SD attitudes.

The results of H.2.15 suggest that gender does not significantly affect SD attitudes. Since the novelty of SD attitude research, there is no previous research supporting the claim that gender influences SD attitudes; however, multiple studies suggest that gender could influence people’s attitudes. Researchers like Woloschuk et al. or Atkeson & Rapoport claimed that attitudes and attitudinal change between women and men are different (2003, pp. 495–498; 2004, p. 522). Neuroscientist Christov-Moore et al. argue that this phenomenon occurs because of the greater empathic levels and prosocial behaviors that women have compared to men (Christov-Moore et al., 2014, pp. Although scientific evidence exists linking gender as an intervening variable for attitudes, H.2.15´s results did not indicate some effect between gender and SD attitudes.

Donation attitudinal change towards SD causes

Donation attitudes to SD causes were the third explored subject, and it corresponds to the following research objective and research question:

Third research objective: To understand if VR is more effective than 2D media to elicit positive attitudinal change towards donating to social causes.

Third research question: Is VR a more robust method than 2D media to elicit positive donation attitudinal change towards SD causes?

To answer the third research question. First, we ran a Shapiro-Wilk Test to know if the variables' data were normally distributed. Secondly, significant differences between the pre and post-tests by the group—virtual reality (VR) and screen (2D)—were analyzed. Then, significant differences between attitudinal changes scores of VR and 2D were tested. Confidence intervals were set at 95%. This process required three working hypotheses to answer the third research question, H.3.1, H.3.2, and H.3.3.

H.3.1 Consuming content in VR leads to positive donation attitudinal change towards SD causes.

Pre-test and post-test data regarding the monetary donation to SD cause in the VR group present normal distribution. A T-test was conducted to find significant means differences between pre and post-test in the VR condition. The results suggest that there is a significant difference between the pre-test ($M = 2.74$ $SD= 0.57$) and post-test ($M = 3.04$ $SD = 0.46$), $t(26) = -4.780$, $p < .001$.

H.3.2 Consuming content in the video leads to positive donation attitudinal change towards SD causes.

Pre-test and post-test data regarding the donation to SD causes in the video group present normal data distribution. A T-test was conducted to find significant means differences between pre and post-test in the video. The results suggest that there is a significant difference between the pre-test ($M = 2.64$ $SD= 0.74$) and post-test ($M = 2.96$ $SD = 0.51$), $t(31) = -3.311$, $p = 0.002$.

H.3.3 Consuming content in VR leads to a stronger positive donation attitudinal change towards social causes compared to video format.

An analysis of covariance (ANCOVA) was conducted to determine a statistically significant difference in the attitudinal change towards donations to SD causes between the VR and video groups. The results suggest a significant difference in attitudinal changes between the two groups regarding attitudes to SD causes $F(3, 114) = 3.021$, $p = 0.032$. The changes in the VR group are statistically different from those in the video group. The group that consumed VR content experienced significant positive, stronger effects than those in the video condition.

Discussion: donation attitudinal change towards sustainable development causes

The results of H.3.1 and H.3.2 confirmed significant differences between pre and post-test scores in the VR and video conditions. This finding suggests that the stimuli generated positive donation attitudinal changes for both conditions towards SD causes. As mentioned before, this research is the first I have encountered in assessing attitudinal changes regarding donations. Most VR attitudinal research does not include a pre-test, and therefore, they are not suitable to compare.

The results were partially expected. On the one hand, as mentioned in the measurements section, the last three videos suggest the participant donate—with the appearance of institutional logos and written messages. There are chances that such elements were effective, and therefore the results in both groups seem to be favorable. However, there were some doubts about a possible favorable outcome since the stimuli did not directly tackle some of the questions on the measurement directly—e.g., health and gender equality. In general, the message was effective enough to elicit positive donation attitudinal change.

More important is the result of H.3.3, which suggests that the VR group's attitudinal change was significantly stronger than the video group with 95% confidence. H.3.3 is accepted, and research question three is answered positively. This might be the most important finding in the study variable donation attitudes towards SD causes was the only measurement that confirmed greater attitudinal changes in VR over 2D content—video. Thanks to these results, there is evidence that VR could potentially create more positive attitudinal changes than less immersive media. Additionally, these results support the previous general claim regarding the capabilities of VR to change attitudes in comparison with traditional media—confirming relevance for its study. This result also encourages the assumption that other intervening factors played a role in the attitudinal change concerning SD attitudes—in their four pillars.

General findings and relevance

Table 3

Summary of hypotheses results

		HYPOS #	HYPOTHESIS DESCRIPTION	OUTCOME
SUSTAINABLE DEVELOPMENT ATTITUDES	COMPOSITE	H.1.1	Consuming content in VR leads to a positive effect on SD attitudinal change (four pillars).	Rejected
		H.1.2	Consuming content in video format leads to a positive effect on SD attitudinal change (four pillars).	Rejected
		H.1.3	Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (four pillars).	Rejected
	ENVIRONMENT	H.2.1	Consuming content in VR leads to a positive effect on SD attitudinal change (environment pillar only).	Rejected
		H.2.2	Consuming content in VR leads to a positive effect on SD attitudinal change (environment pillar only).	Rejected
		H.2.3	Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (environment pillar only).	Rejected
	ECONOMY	H.2.4	Consuming content in VR leads to a positive effect on SD attitudinal change (economy pillar only).	Accepted
		H.2.5	Consuming content in video format leads to a positive effect on SD attitudinal change (economy pillar only).	Accepted
		H.2.6	Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (economy pillar only).	Rejected
	SOCIETY	H.2.7	Consuming content in VR leads to a positive effect on SD attitudinal change (society pillar only).	Rejected
		H.2.8	Consuming content in video format leads to a positive effect on SD attitudinal change (society pillar only).	Rejected
		H.2.9	Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (society pillar only).	Rejected
	EDUCATION	H.2.10	Consuming content in VR leads to a positive effect on SD attitudinal change (education pillar only).	Rejected
		H.2.11	Consuming content in video format leads to a positive effect on SD attitudinal change (education pillar only).	Rejected
		H.2.12	Consuming content in VR elicits greater positive attitudinal change towards sustainable development (SD) compared to video format (education pillar only).	Rejected
	MODERA.	H.2.13	Sustainable development knowledge is a moderator variable to SD attitudes.	Accepted
		H.2.14	Political ideology is a moderator variable to SD attitudes.	Accepted
		H.2.15	Gender is a moderator variable to SD attitudes.	Rejected
DONATION	SD CAUSES	H.3.1	Consuming content in VR leads to positive donation attitudinal change towards social causes.	Accepted
		H.3.2	Consuming content in the video leads to positive donation attitudinal change towards social causes.	Accepted
		H.3.3	Consuming content in VR leads to a stronger positive donation attitudinal change towards social causes compared to video format.	Accepted

The detailed significance of each finding has already been discussed. However, there are still elements to analyze while considering a broad picture of this study´s results. According to

table 3, there were partial results in the study. First, concerning research question one, the stimuli seemed ineffective in eliciting attitudinal changes in most dimensions, except for the dimension economy. Additionally, none of the results in the sustainable development measure confirmed that VR is more powerful than traditional video in eliciting greater attitudinal changes towards SD. For research question 2, SD knowledge and political ideology are moderating variables of SD attitudes. About research question 3, there were favorable results in all the expected outcomes. There were attitudinal changes in both groups, and the changes were greater in the VR group. VR seemed more effective than traditional video to elicit positive donation attitudinal changes. At least according to these results, the implications might be the following. Remember that these implications might be limited to our sample characteristics: urban young adults—18-30 years in Mexico. To achieve clarity, the significance is divided by actors—this might not be an exhaustive list:

For researchers using VR as a method towards attitudes:

1. Researchers have to cautions while cataloging VR as the "empathy machine"—at least regarding VR360 experiences that do not employ embodiment. Attitude changes for traditional video are not found uniformly.
2. Researchers working on EDS interested in SD attitudes should include knowledge of SD in their measurements since it appears to be an important intervening variable
3. Researchers should include political ideology in their measurements to continue exploring the role of political ideology in attitudes.

For international organizations, charities, and NGO´s:

1. According to the results, organizations, charities, and NGOs interested in changing people´s attitudes towards sustainable development could use either VR or traditional video campaigns since both showed similar effects. Traditional video campaigns might be cheaper and easier to produce than VR campaigns.
2. According to the results, organizations, charities, and NGOs interested in changing people´s donating attitudes towards SD causes could benefit from VR narratives. At least in terms of donation attitudes, VR elicits favorable results than traditional video.
3. Investing in SD education seems to be favorable due to the relevance this element has in SD attitudes.

For governments:

1. Governments could invest in VR and traditional video campaigns to promote SD attitudinal change. They appear to have similar results.
2. Governments should invest in education towards SD to spread SD knowledge since the latter might be one important prelude for SD attitudes.

For the private sector:

1. Private companies could invest in VR and traditional video campaigns to promote SD attitudinal change. They appear to have similar results.
2. Private companies interested in fundraising towards SD causes could use VR to increase donations compared to traditional video campaigns.
3. Journalistic outlets could invest in VR and traditional video campaigns to promote SD attitudinal change. They seem to elicit similar results.

4. Journalistic outlets interested in fundraising towards SD causes could use VR with probable greater gains than traditional video campaigns.
5. Visual artists interested in changing SD people´s attitudes could work with VR or video since these results suggest they generated similar impacts.
6. Visual artists interested in fundraising towards SD causes could likely use VR more than traditional video campaigns.

General research limitations and justifications

Novelty

There are two main limitations for understanding attitudes with VR as a method: the technology's novelty and the experimental design's external validity. First, VR is in the early adoption stage as a medium. People´s attitudes towards the new medium are molding. Important research has already been conducted to know people's attitudes towards VR and VR content (Adanin, 2020; Bujic & Hamari, 2020; Godulla et al., 2021; Roque Hernández et al., 2019; Sellers, 2020). VR reality is shaping a new audience, and people, in return, are analyzing the potential of VR to create virtual experiences. VR is in a similar moment to it was between theater and movies. Some time was needed to create narrative techniques for the new medium and create valuable experiences and scientific appliances (Slater & Sanchez-Vives, 2016, p. 3).

Regarding VR, attitudinal studies—as a research area— is still in the exploratory phase (Bujić et al., 2020, p. 1407), despite the rapid scientific acquisition of the methodological approach. It might take some time to have a nourished scientific background and begin to talk more seriously about VR for attitudinal change.

Stimulus

The stimulus limitation of the non-proportional coverage on each pillar has been previously discussed. However, another four limitations regarding the stimuli could impact the results: stimulus repetition through time, stimulus duration, and stimulus quality. First, stimulus repetition through time is a broadly debated factor in the exploratory phase of VR attitudinal studies. For a very long time, attitude change theory had considered that repeated exposure to the stimulus could increase the likelihood of conditioning people´s attitudes (Bohner et al., 2002, pp. 72–75). Participants' constant stimuli would require a different experimental method—a longitudinal experiment. This approach is far more complex and expensive than pre-post-test control group design and far more difficult than a post-test control group design—the most common approach in VR attitudinal studies. Most academic research employs non-longitudinal studies; however, there are some exceptions. Herrera and AlBasri utilized longitudinal VR stimuli with positive results. Unfortunately, these studies did not compare VR with less immersive media but traditional in-person intervention techniques (2019; 2018). There is a gap in comparing different media technologies—different levels of immersion—and attitudes in longitudinal experimentation. It is possible that this methodological design could offer more reliable evidence on attitudinal change than a single-time stimuli approach.

Secondly, stimulus duration is also a not-agreed experimental condition. Researchers have found favorable attitudinal changes with minimal amounts of stimulus. For example, Hasson´s study—whose stimuli lasted one minute—was enough to elicit prosocial attitudinal changes. Other virtual experiences lasted less than 3 minutes with favorable results like

Atkins—3 minutes stimuli—or Ahmed—2 minutes—(2018; 2020). On the other extreme, long stimuli have been studied like Heys, which employed an immersive stimulus of 90 minutes (2020). The total amount of stimulus covering the four pillars of SD in this study was 18 minutes which was considered enough to change attitudes potentially. VR content or video content does not always elicit positive attitudinal changes. Multiple studies confirm that attitudinal changes were not observed despite considerable duration as it happened in Van Damme et al.—5-minute stimuli— and Bujic—7-minute stimuli. There is no consensus on experience duration to elicit changes, but a longer stimulus in one subject might be more effective. Presence scholars bring one indirect claim on minimal duration. Some research in the early phases of virtual reality claimed that it takes 15 minutes to reach VR sense of presence with no solid scientific justification (Tamborini et al., 2004, p. 344)—yet, presence alone cannot justify the stimuli duration.

Embodiment and content interactivity is a third limitation regarding the type of stimulus. All the studies mentioned in the results and discussion chapter refer to studies that utilized VR360 experiences and not computer-generated (CG) interactive VR. The later technique offers enhanced experiences due to some powerful elements that are not comparable to VR360 (Jung & Lee, 2004, p. 80; Mabrook, 2021, p. 2099; Steed et al., 2016, p. 1404). First, interactive VR could offer the participant sense of embodiment. The most recognized and world-leading researchers utilized embodiment to elicit empathy. An embodiment also increases the sense of presence the agency of the user (Jung & Lee, 2004, p. 80; Mabrook, 2021, p. 2099; Steed et al., 2016, p. 1404). In an interactive VR experience, the participants can freely walk and interact with the virtual environment and objects. VR360

only offers participants the capacity to decide where to watch (Gonzalez-Franco & Lanier, 2017, p. 5; Taylor Owen et al., 2015, p. 36). Embodiment and interactivity capacity of the stimulus could potentially create more powerful experiences and elicit greater attitudinal changes with possible drawbacks. For example, embodied and interactive experiences to be more distractive, and participants could lose the persuasive narrative.

Lastly, narrative immersion and persuasion could have had a relevant role in the results—despite having controlled videos quality to some degree. Repetition, duration, embodiment, and interactive features are important elements of the stimulus; however, the message to be transmitted could be dominant. The success of VR to promote itself as the "empathy machine" has depended on clever storytelling techniques like those developed by De la Peña in the last decade. Maybe the content producers of our stimuli were not good enough to effectively elicit narrative immersion and persuasion; therefore, the results were not favorable in some hypotheses. The message is effective when it produces effects (Nelson et al., 2020, p. 1). As mentioned in the methodology chapter, this study developed a measurement to assess the quality of the audiovisual content (appendix D). Therefore, only professionally produced videos were included as part of the stimulus. Additionally, the visual and auditory equipment used in the VR and video groups were very high quality. I would seriously doubt that content quality would have greatly impacted this study´s results.

Geography and political ideology

The second general limitation is the sample´s geography—external validity. The study results´ generalizations might be limited to other populations. Medicine mostly considers that human bodies around the world are similar. People in Mexico, for example, are receiving

vaccines from all over the world tested with non-Mexican samples for emergency use. The Sputnik vaccine that I received was proven with a Kazakhstani sample. In contrast to medicine and other natural science approaches, people´s minds are far more complex to consider them similar and scalable. Many social-psychological aspects of each determined group could alter attitudes depending on many factors, for example, race (Enos, 2014, p. 3701), socioeconomic status (Brown-Iannuzzi et al., 2017, pp. 18–19; Navarro-Carrillo et al., 2018, p. 585; Piff et al., 2010, pp. 780–782) and age (Anderson & Rainie, 2012; Joshi et al., 2019, pp. 101–102; Vaterlaus et al., 2015), political ideology (Patané et al., 2020, p. 167) among other components. To some extreme, even neighborhood context might influence political attitudes and behavior, an important principle of political geography in elections (Weaver, 2014, pp. 874–876). This is the reason I controlled for certain variables that were considered relevant. To summarize, many socio-psychological characteristics of the sample will impact the attitudinal study. We cannot generalize experiments´ results that study political attitudes as explained by Holbrook (2011, pp. 148–150). For example, if we study gender attitudes in Iran and Canada, the results might be very contrasting. The same limitation could appear if we study and compare democratic attitudes in China and Germany.

Our sample was predominantly liberal, and that feature could have a relevant effect in our measurement for prosocial attitudinal changes. It has been suggested that an existing liberal viewpoint allows for greater scores in prosocial attitudinal measurements like donation intentions (Farwell & Weiner, 2000, pp. 845–846). In contrast, the more liberal the sample is, the smaller positive prosocial attitudinal change, while conservative views allow for a greater shift in attitudes (Bujić et al., 2020, p. 1421; Emler et al., 1983, pp. 1073–1075;

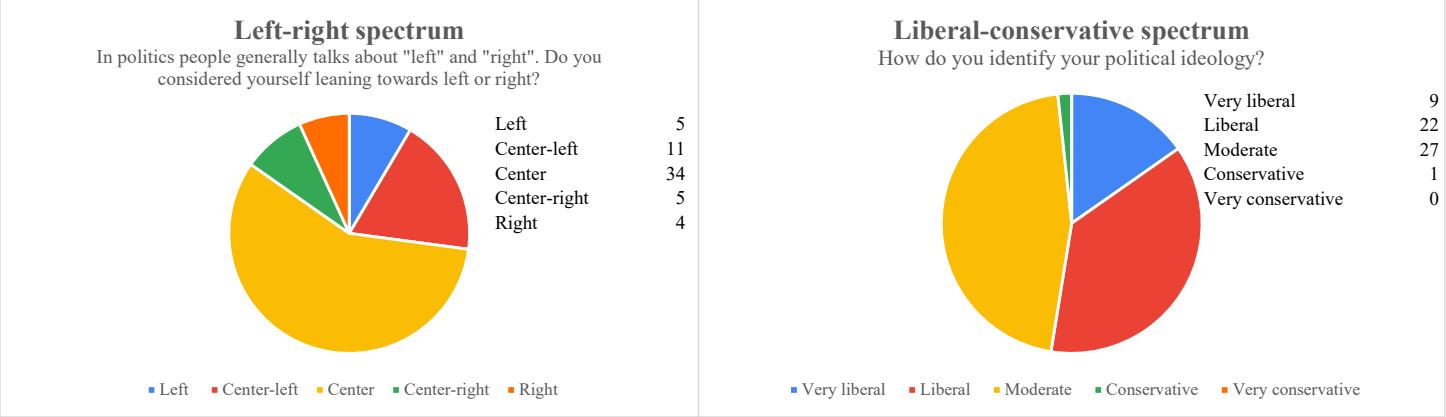
Passini, 2014, pp. 89–93). This theoretical claim can effectively justify our results. Studies like Ball with broader positive attitudinal changes included more conservative samples. Bujic et al. also considered that their liberal-leaning sample could have affected their results on reduced attitudinal change. It is important to consider that very few studies investigate attitudinal change, and most literature assesses single-time attitudes. Controlling for political ideology could be an important step forward—since few VR attitudinal studies controlled for a political ideology, although this element might generate exploratory limitations. Finally, as suggested by the hypothesis of moderator variables, political ideology has an important role in positive attitudes towards sustainable development, confirming the relevance to control and measure for political ideology.

There are some caveats in the political ideology limitation of this study. For example, this is one of the few studies that measure political ideology through the Ideology Consistency Scale—another example is Rodenbaugh (2020). I defend that this measurement is the more creative and accurate attempt to measure political ideology than traditional ways to measure political ideology. Political attitudes studies in general—including VR attitudinal studies—traditionally employ a single self-reported ideology question to measure political ideology. Researchers generally ask in two different fashions: "how do you identify your political ideology," with results ranging very liberal or very conservative (Atkins, 2020, p. 183; Hasson et al., 2019, p. 4); another common way to ask about participants´ political ideology is "how do you identify yourself in the spectrum between left and right" with possible answers ranging left to right.

Despite this single item question dominating much research on political ideology, I criticize the simplicity of the measurement, the possibility of a respondent getting confused on what political ideology is or what left or right means, and some other cultural limitations for understanding conservatism. To support my critic against the single item measurements on political ideology, I asked my sample for their political ideology in three different ways, as mentioned in the measurement section. Results between single-item self-reported questions on the left and right spectrum and the liberal and conservative spectrum contradict (see figure 1).

Figure 1

Comparison of single-item questions' results on political ideology



As you may notice, there is a contradiction between the two graphs. A conservative sub-sample of nine people appears on the left-right spectrum—five "center-right" and four "right." However, while asking within the liberal-conservative spectrum, those "conservatives" disappear. There might be some reasons for these results. First, people might not be sure about the meaning of political ideology or right and left in practical terms. Secondly, right-wing people in Mexico can tolerate being considered right-advocates but not conservatives. Mexicans could have conflicting reactions while listening to the word "conservative." In the Mexican educational system, leaders that fought against conservatism are considered heroes in the nation-building process— like Benito Juárez, Francisco I.

Additionally, the current Mexican president of Mexico—Andrés Manuel López Obrador—has an active daily campaign to disqualify "conservatives." To sum up, Mexicans might find it difficult to swallow the idea of conservatism for themselves due to these contradictions and reasons. I argue that the best way to ask about ideology is a more innovative and indirect way to measure political ideology, like the Ideology Consistency Scale (ICS). The scale was back-translated and culturally adapted for increased validity for this study.

I recognized that another similar scale could be created for a Mexican context. Hopefully, a political scientist working in this area could develop at least one rigorous measurement as the ICS. It seems that Mexican political scholars have stopped creating novel ways to measure political ideology. The Mexican literature on political attitudes takes into account only traditional forms as the reader might find in Gómez-Tagle et al. (2012) Hernández García et al. (2019) , or INEGI & SEGOB (2012).

Controlling for political ideology in this research does not refer to having an equal number of liberal and conservative participants but distributing them equally in the experimental and control groups. This process avoids the existence of a possible confounding variable with political ideology. The aim is to get a random sample and then calibrate it in two groups according to their ideology scores.

Some people might argue that it is necessary to have an equal number of conservative and liberal participants. However, this might be complex and inaccurate. First, getting conservative samples among young populations is very hard in liberal democracies. For example, in the work of Bujic, only 10% of participants of the random sample described themselves as conservatives. For example, if conservative people represent 10% of the volunteers in the experiment—as happened in Bujic—researchers would require conducting at least 300 pre-tests to get a conservative sample of 30 people—like the one used in this study. This way of experimentation is unfeasible for most researchers.

On the other hand, even while looking deliberately for conservative samples within right-wing political parties or church movements, there is no guarantee that the samples will reflect conservative attitudes on the ICS questionnaire. Second—as mentioned before—political ideology measurements are not an exact science, and there are still many limitations to overcome. As this study argues, some measurements could reflect a conservative sample and others not—the two political ideology spectrums were contradictory. Finally, there is no methodological bias in the sample because recruitment and designation to the experimental and control groups followed randomization standards.

By juxtaposing the geographical limitation and the political ideology constraints, it might be interesting to conduct similar VR attitudinal research on other Mexican contexts—at a city or state level—to analyze possible attitudinal the differences. For example, in the Mexican context, social researchers on attitudes might expect different attitudinal results from a Guanajuato City sample—commonly known as one of the more conservative cities in Mexico—and Mexico City sample—probably the most progressive liberal city in Mexico. Political culture studies in Mexico—studies on political attitudes—are usually studied with subnational scopes, as Hernández García et al. (2019) explained.

Finally, political scientists did not use experimental designs due to the design's reduced external validity. Political scientists generally employ quantitative methods to pursue generalizations through large attitudinal surveys (Holbrook, 2011, pp. 148–150). There are few political studies—nonexperimental—that used methodologies that, despite reducing internal validity, increased external validity. Nonetheless, this type of study requires larger and significant samples that only world-based organizations could afford. The Gallup World Poll applied in 140 countries, or the World Values Survey (usually applied in around 60 countries) are good examples of large-scale political attitudinal studies that count with data for a considerably greater external validity.

Ecological validity

Another important limitation to this study is ecological validity—a subdimension of external validity. It refers to the limits of the experiment to explain phenomena in the actual daily life of others. Historically, it has been a contested element of psychological, behavioral, and attitudinal research. Three dimensions are important to mention. First, the test environment

avoids distractions, confusion, and fatigue. The laboratory characteristics and dynamics are not close to the settings of the real world. The more the participant is aware of participating in an experiment, the lower ecological validity. Secondly, the stimuli also limit ecologic validity while questioning how likely it is for people to find similar stimuli in real life. In this study, the stimuli could be found in real life while consuming VR content, in contrast with other abstract stimuli experimental attitudinal research—i.e., this aspect of external validity might not be low. The third element of ecological validity is a behavioral response that refers to how the responses are related to the construct being assessed. For example, it would be more realistic in a driving simulation if the person drives with a steering wheel rather than driving with a computer mouse. In this study, VR and screen groups were taken into a very real situation they may encounter while consuming VR content or watching videos—i.e., this aspect might not be low too in this experiment. Ecological validity is a highly debated concept in experimental research regarding the concept and its measurement (Barker, 2014).

Sample´s size

The sample size is another important element to explore as justification. Most VR attitudinal research includes small samples. In general, most studies include a sample of 25-50 participants per group condition, depending on the research objectives. The largest VR attitudinal study available might be Tussyadiah et al., with a sample number of 724 participants in the United Kingdom regarding tourism destination attitudes. However, they did not compare VR with other media (no control group) (2018, p. 140). The present study follows Bujic et al.'s sample estimation. They employed 31 participants in the VR group and 29 in the video group. Although the sample number was justified with the G*Power v. 2.1.9.4

calculation, larger samples are broadly beneficial. A larger sample offers greater data granularity, more accurate mean values, and easier identification of outliers. In general, they reduce the margin of error (Zamboni, 2018).

Technology and society stance

There are three important theoretical concepts to understand while dealing with technology and society research. First, technological determinism refers to the belief that technical forces determine social and cultural changes. Second, social construction claims that social and cultural forces determine technological change. Third, technological momentum argues that social development influences and are influenced by technology (Johnson & Wetmore, 2008).

While trying to understand the publicized nature of VR, we can notice that many authors might sound like advocates of technological determinism. Readers could notice this intention even with the publication´s names, for example, with the article of Loon et al. *Virtual reality perspective-taking increases cognitive empathy for specific others* (2018) or *The enemy's gaze: Immersive virtual environments enhance peace-promoting attitudes and emotions in violent intergroup conflicts* (Hasson et al., 2019). This deterministic practice might be difficult to defend at the experimental stage of VR attitudinal studies. Apart from that, this academic stance has been criticized over time (Wyatt, 2008, p. 165).

I lead to the technological momentum stance. On the one hand, technology affects the user experience by creating a stronger "presence" due to sensorial illusions—prior technologies do not have the immersive capabilities to generate such phenomena. With the

evolution of the VR affordances—resulted in enhanced virtual experience— the effects of people might change in the future. On the other hand, people do have a role in the technology, which is why experiment researchers control a large number of variables—gender, age, political ideology, use of the technology, level of education, specific knowledge, among others. They know people´s psycho-social features could affect the result of the interaction between VR and a participant. Some researchers are more cautious with their analysis while using titles like *Exploring the Effect of Cooperation in Reducing Implicit Racial Bias and Its Relationship With Dispositional Empathy and Political Attitudes* (Patané et al., 2020) or *The effects of Virtual Reality (VR) on charitable giving: The role of empathy, guilt, responsibility, and social exclusion* (Kandaurova & Lee, 2019). The keyword is "explored," which refers to the nature of the research phase of VR attitudinal studies. Provocative claims that pretend to praise VR experiences as the "ultimate empathy machine" (Milk, 2015) might not be accurate at this scientific moment.

Finally, in general, most VR attitudinal research does not express much concern about the sociological stances of technology. They usually describe the nature of VR, the experimental method, the measurements, and the statistical results. VR attitudinal researchers could be clearer of their technological stance in the future.

Chapter 5: Conclusion

The first aim of this study was to examine the potential of VR content as a method to elicit positive attitudinal change towards sustainable development (SD) compared to traditional 2D video. First, the results of this research indicate that VR does not always elicit positive attitudinal changes in SD attitudes. From the four categories included in the SD attitudes measurement—environment, economy, society, and education—only one dimension—economy—showed favorable attitudinal changes. Furthermore, VR content did not suggest a greater attitudinal change than traditional 2D video. Such findings indicate that VR and videos might have similar capacities to change people's attitudes towards SD.

Additionally, while analyzing the intervening effect of sustainable development knowledge and political ideology, we confirmed that both variables are moderating variables of SD attitudes. The more liberal a person is, the most likely to elicit greater attitudes towards SD. At the same time, the more knowledge about sustainable development people owns, the greater impact on SD attitudes. On the one hand, these findings urge SD attitudes research to include political ideology as a relevant variable in their analyses. Secondly, the relevant impact of knowledge on SD attitudes suggests a window of opportunity for all stakeholders that want to change people's attitudes towards SD through the power of SD literacy.

The second aim of this study was to analyze the power of VR to change people's attitudes towards donating to SD causes in comparison with traditional video. In contrast with the SD attitudes' results, the variable donation attitudes towards SD showed favorable results. The findings suggest that VR can change people´s donation attitudes toward SD

causes. Additionally, attitudinal changes produced by VR experiences are significantly greater than the changes generated by the video content. With such contrasting findings, the study concludes that VR shows partial results to prove effectiveness in changing peoples' attitudes.

The present study helped fill the gap to start a discussion of the capabilities of VR towards SD attitudes with quantitative experimental approaches. Before this effort, Muntean et al. project was only one qualitative study with such aim (2019, p. 3). Moreover, this study fills the gap to scientifically prove that VR could potentially be more effective than traditional media donating towards SD causes. Before these findings, there was only anecdotal evidence from the United Nations (2015).

There are many practical implications of these findings, particularly to the people interested in achieving two goals: eliciting positive changes in people's attitudes towards sustainable development and increasing favorable donations attitudes towards the causes of sustainable development. Potential stakeholders that might benefit from this study´s results are EDS scholars, international governmental organizations, charities, NGOs, governments—at all different levels—and the private sector—especially private companies that manage foundations, journalistic outlets, and visual artists.

There are potential limitations in research that could also be observed in previous VR attitudinal research. The first is regarding the characteristics of the employed stimuli: repetition, length, embodiment, content interactivity, and quality of the content narrative. The second challenge for this study is the sample: the sample size and the political ideology of

the experimental groups might have an impact to gain external validity of the results—with might be usual in experimental design.

Further research

The present study contributes to the nascent multidisciplinary field of VR attitudinal studies. Five relevant insights resulted from this research to improve this academic field with further research: experimental design, the integration of political ideology as a relevant variable, new types of stimuli, and diverse sampling. First, this study suggests adopting a pre-post design to measure initial attitudinal levels of participants. With such a methodological approach, we could better understand attitudes. Studies will not only report on people´s attitudes at one point in time—as most literature does—, but they will have the capacity to claim for attitudinal changes. The amount of VR attitudinal studies that focus on attitudinal changes is minimal. More research efforts are needed to fill that gap and allow researchers to compare results. While selecting a pre-post experimental design, researchers have to be careful not to combine data gathered from very different collection environments. This research recommends avoiding collecting pretest data via online surveys and post-test data in person since this reduces internal validity. One exception might be if the researcher has strict identity clearance protocols and controls the participant during an online pre-test. This recommendation could improve data accuracy for further VR attitudinal research and offers better data to be compared in the future.

VR attitudinal researchers and EDS scholars should include political ideology in their considered variables to explore. There is repetitive evidence that political ideology might

impact people's attitudes. Yet, many VR attitudinal studies do not consider this variable. The suggestion will enrich the conversation about the political leaning of individuals in shaping their attitudes. More research may include political ideology as a control variable if future research collects more favorable data on the intervening role of political attitudes. More justified control of the variables represents more reliable data.

There are some open questions to be answered by further research regarding the stimuli characteristics. As this study´s results suggest, VR360 elicits the same levels of attitudinal change towards SD. Would it be the case with content that includes embodiment or greater levels of interactivity? Would the result be the same with stimuli repetition—with a longitudinal study—or a much longer stimulus—duration? Is there any other more effective way to measure narrative pertinence and quality of the audiovisual content to be used as stimuli?

Finally, more empirical research regarding the covered SD issues is needed. Similar research with more diverse and larger samples in Tussyadiah et al. (2018) could offer applicability claims to other socio-political contexts. For example, it would be interesting to see similar VR attitudinal research results on young Mexican adults of different Mexican cities and states. As mentioned before, socio-psychological characteristics might affect results; with empirical data, we could argue how different attitudinal changes in such population might be.

References

Adanin, K. (2020). Students' Attitudes and Intentions of Using Technology such as Virtual Reality for Learning about Climate Change and Protecting Endangered Environments [PhD Thesis]. Ohio University.

Ahmed, R. (2018). Immersive Virtual Reality Advertisement: Examining the Effects of Vividness and Interactivity on Consumers' Psychological Responses [University of Oklahoma]. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=652741A6D034EB60&site=ehost-live

Albada, K., Hansen, N., & Otten, S. (2021). Polarization in attitudes towards refugees and migrants in the Netherlands. European Journal of Social Psychology.

AlBasri, M. (2019). Learning Empathy Through Virtual Reality: A Mixed Methods Study [Harvard University]. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=ADD3B963CC7BCBF5&site=ehost-live

Alsop, T. (2021, February 8). Topic: Virtual reality (VR). Statista. https://www.statista.com/topics/2532/virtual-reality-vr/

Ambusaidi, A., & Al Washahi, M. (2016). Prospective Teachers' Perceptions about the Concept of Sustainable Development and Related Issues in Oman. Journal of

Education for Sustainable Development, 10(1), 3–19. https://doi.org/10.1177/0973408215625528

Anderson, J., & Rainie, L. (2012, February 29). Main findings: Teens, technology, and human potential in 2020. Pew Research Center: Internet, Science & Tech. https://www.pewresearch.org/internet/2012/02/29/main-findings-teens-technology-and-human-potential-in-2020/

Anna Lindh Foundation. (2021). CEAR - Comisión Española de Ayuda al Refugiado. https://www.annalindhfoundation.org/members/cear-comision-espanola-de-ayuda-al-refugiado

Archer, K., & Berdahl, L. (2015). Explorations: Conducting empirical research in Canadian political science (3rd ed.). Oxford University Press.

Atkeson, L. R., & Rapoport, R. B. (2003). The More Things Change the More They Stay the Same: Examining Gender Differences in Political Attitude Expression, 1952-2000. The Public Opinion Quarterly, 67(4), 495–521.

Atkins, D. A. (2020). Investigating Cognitive and Persuasive Effects of 360-degree Virtual Reality Community News Narratives on Memory Performance, Presence, Perception of Credibility, and Attitude Change [PhD]. Ohio University.

Ball, C. (2019). Nurturing Nature in Virtual Reality: A Study of Public Service Experiences and Their Effects on Environmental Attitudes and Behavioral Intentions [Ph.D., Michigan State University].

https://www.proquest.com/pqdtglobal/docview/2211490901/abstract/9C9E309FB4F0488APQ/10

Banakou, D., Beacco, A., Neyret, S., Blasco-Oliver, M., Seinfeld, S., & Slater, M. (2020). Virtual body ownership and its consequences for implicit racial bias are dependent on social context. Royal Society Open Science, 7(12). https://doi.org/10.1098/rsos.201848

Banakou, D., Groten, R., & Slater, M. (2013). Illusory ownership of a virtual child body causes overestimation of object sizes and implicit attitude changes. Proceedings of the National Academy of Sciences, 110(31), 12846–12851.

Banakou, D., & Slater, M. (2014). Body ownership causes illusory self-attribution of speaking and influences subsequent real speaking. Proceedings of the National Academy of Sciences, 111(49), 17678–17683.

Barker, A. A. (2014). Ecological validity. Britannica. https://www.britannica.com/science/ecological-validity

Biasutti, M., & Frate, S. (2017). A validity and reliability study of the Attitudes toward Sustainable Development scale. Environmental Education Research, 23(2), 214–230. https://doi.org/10.1080/13504622.2016.1146660

Biasutti, M., & Surian, A. (2013). The Students' Survey of Education for Sustainable Development Competencies: A Comparison Among Faculties. Discourse and

Communication for Sustainable Education, 3(1), Article 1. https://cyberleninka.org/article/n/589157

Biocca, F., Burgoon, J., Harms, C., & Stoner, M. (2001). Criteria And Scope Conditions For A Theory And Measure Of Social Presence. Undefined. https://www.semanticscholar.org/paper/Criteria-And-Scope-Conditions-For-A-Theory-And-Of-Biocca-Burgoon/32286162dc71dd8a81cedcd2ce38c00ef478f4f5

Biocca, F., & Levy, M. R. (2013). Communication in the age of virtual reality. Routledge.

Bishin, B. G. (2004). The Validity and Accuracy of Commonly Used Ideology Measures: A Consumer's Guide. American Review of Politics, 25, 201–220. https://doi.org/10.15763/issn.2374-7781.2004.25.0.201-220

Blackburn, S. (1999). Gender violence and the Indonesian political transition. Asian Studies Review, 23(4), 433–448.

Bohner, G., Wanke, M., & Michaela Wanke. (2002). Attitudes and Attitude Change. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/mcgill/detail.action?docID=1656137

Bol, D. (2019). Putting Politics in the Lab: A Review of Lab Experiments in Political Science. Government and Opposition, 54(1), 167–190. https://doi.org/10.1017/gov.2018.14

Borrelli, D., & Greer, B. T. (2021). The Next Step: The California Cybersecurity Institute's Anti-Trafficking Virtual Reality Immersion Training. Anti-Trafficking Review, 17, 154–160. https://doi.org/10.14197/atr.2012211711

Bowman, N. D., Ahn, S. J., & Mercer Kollar, L. M. (2020). The Paradox of Interactive Media: The Potential for Video Games and Virtual Reality as Tools for Violence Prevention. Frontiers in Communication, 5. https://doi.org/10.3389/fcomm.2020.580965

Boyle, L., Cordahi, G., Grabenstein, K., Madi, M., Miller, E., Silberman, P., & Hamilton, B. A. (2014). Effectiveness of Safety and Public Service Announcement Messages on Dynamic Message Signs. United States. Federal Highway Administration.

Bras, H. L. (2019). After the demographic explosion. Politique Etrangere, Spring Issue(1), 107–120.

Brautović, M., John, R., & Potrebica, M. (2017). Immersiveness of News: How Croatian Students Experienced 360-Video News. In L. T. De Paolis, P. Bourdot, & A. Mongelli (Eds.), Augmented Reality, Virtual Reality, and Computer Graphics (pp. 263–269). Springer International Publishing. https://doi.org/10.1007/978-3-319-60922-5_20

Breves, P., & Heber, V. (2020). Into the Wild: The Effects of 360° Immersive Nature Videos on Feelings of Commitment to the Environment. Environmental Communication, 14(3), 332–346. https://doi.org/10.1080/17524032.2019.1665566

Brown-Iannuzzi, J. L., Lundberg, K. B., & McKee, S. (2017). The politics of socioeconomic status: How socioeconomic status may influence political attitudes and

engagement. Current Opinion in Psychology, 18, 11–14. https://doi.org/10.1016/j.copsyc.2017.06.018

Brun, H., Bugge, R. A. B., Suther, L. K. R., Birkeland, S., Kumar, R., Pelanis, E., & Elle, O. J. (2019). Mixed reality holograms for heart surgery planning: First user experience in congenital heart disease. European Heart Journal-Cardiovascular Imaging, 20(8), 883–888.

Bujic, M., & Hamari, J. (2020). Satisfaction and willingness to consume immersive journalism: Experiment of differences between VR, 360 video, and article. Proceedings of the 23rd International Conference on Academic Mindtrek, 120–125. https://doi.org/10.1145/3377290.3377310

Bujić, M., Salminen, M., & Hamari, J. (2021). Effects of Immersive Media on Emotion and Memory: An Experiment Comparing Article, 360-video, and Virtual Reality. OSF Preprints. https://doi.org/10.31219/osf.io/rtmcw

Bujić, M., Salminen, M., Macey, J., & Hamari, J. (2020). "Empathy machine": How virtual reality affects human rights attitudes. Internet Research, 30(5), 1407–1425. https://doi.org/10.1108/INTR-07-2019-0306

Bujić, M., Xi, N., & Hamari, J. (2021). Emotional Response to Extended Realities: The Effects of Augmented and Virtual Technologies in a Shopping Context. Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2021.077

Castillo, K. (2019, January 27). Olvidados por el Gobierno de Guerrero, indígenas Na Savi son desplazados en extrema pobreza. Sin Embargo MX. https://www.sinembargo.mx/26-01-2019/3524425

Christov-Moore, L., Simpson, E. A., Coudé, G., Grigaityte, K., Iacoboni, M., & Ferrari, P. F. (2014). Empathy: Gender effects in brain and behavior. Neuroscience and Biobehavioral Reviews, 46 Pt 4, 604–627. https://doi.org/10.1016/j.neubiorev.2014.09.001

Coghlan, A., & Carter, L. (2020). Serious games as interpretive tools in complex natural tourist attractions. Journal of Hospitality and Tourism Management, 42, 258–265. https://doi.org/10.1016/j.jhtm.2020.01.010

Comisión Especial para el seguimiento a la implementación de la Agenda 2030, Senado de la República. (2021). Informe Nacional Voluntario 2021 Agenda 2030 en México. https://www.gob.mx/cms/uploads/attachment/file/654375/INFORME_AGENDA_2030_-_SENADO_INV_2021.pdf

Conn, C., Lanier, J., Minsky, M., Fisher, S., & Druin, A. (1989). Virtual environments and interactivity: Windows to the future. ACM SIGGRAPH 89 Panel Proceedings, 7–18.

Craig, C. M., Brooks, M. E., & Bichard, S. (2021). Prosocial consumer socialization: How socialization agents impact prosocial attitudes and behavior. Atlantic Journal of Communication, 29(3), 136–150. https://doi.org/10.1080/15456870.2020.1751627

Cummings, J. J., & Bailenson, J. N. (2016). How immersive is enough? A meta-analysis of the effect of immersive technology on user presence. Media Psychology, 19(2), 272–309.

Curry, G. (2019). Human Rights, the SDGs and the 2030 Agenda for Sustainable Development. OHCHR. https://www.ohchr.org/Documents/HRBodies/UPR/SDGs_2030_Agenda.pdf

Dabla-Norris, M. E., Kochhar, M. K., Suphaphiphat, M. N., Ricka, M. F., & Tsounta, M. E. (2015). Causes and Consequences of Income Inequality: A Global Perspective. International Monetary Fund.

Daghir, J. (2017). Total Immersion: Virtual Reality's Path to Mass Adoption. Syracuse University Honors Program Capstone Projects. https://surface.syr.edu/honors_capstone/1068

Damer, B., & Hinrichs, R. (2014, February 1). The Virtuality and Reality of Avatar Cyberspace. The Oxford Handbook of Virtuality. https://doi.org/10.1093/oxfordhb/9780199826162.013.032

Datallo, A., Humer, I., Tahai, M., Sueda, S., Pietroszek, K., & Eckhardt, C. (2018). Interactive large structure n-body gravity simulation for immersive learning in virtual reality. ILRN 2018 Montana, 35.

David O. Dowling. (2020). The gamification of digital journalism: Innovation in journalistic storytelling. Routledge.

de Borst, A. W., Sanchez-Vives, M. V., Slater, M., & de Gelder, B. (2020). First-Person Virtual Embodiment Modulates the Cortical Network that Encodes the Bodily Self and Its Surrounding Space during the Experience of Domestic Violence. ENeuro, 7(3). https://doi.org/10.1523/ENEURO.0263-19.2019

De Coninck, D. (2020). Migrant categorizations and European public opinion: Diverging attitudes towards immigrants and refugees. Journal of Ethnic and Migration Studies, 46(9), 1667–1686.

Dembinski, M., Gromes, T., & Werner, T. (2019). Humanitarian Military Interventions: Conceptual Controversies and Their Consequences for Comparative Research. International Peacekeeping, 26(5), 605–629. https://doi.org/10.1080/13533312.2019.1659733

Dempster, H., & Hargrave, K. (2017). Understanding public attitudes towards refugees and migrants. London: Overseas Development Institute & Chatham House.

Dickert, S., Västfjäll, D., Kleber, J., & Slovic, P. (2012). Valuations of human lives: Normative expectations and psychological mechanisms of (ir) rationality. Synthese, 189(1), 95–105.

Dimitrov, R. S. (2016). The Paris Agreement on Climate Change: Behind Closed Doors. Global Environmental Politics, 16(3), 1–11. https://doi.org/10.1162/GLEP_a_00361

Dimock, M., Kiley, J., Keeter, S., & Doherty, C. (2014). Political Polarization in the American Public: How Increasing Ideological Uniformity and Partisan Antipathy Affects

Politics, Compromise and Everydaylife. https://www.pewresearch.org/politics/2014/06/12/appendix-a-the-ideological-consistency-scale/

Durnell, L. A. (2018). Emotional Reaction of Experiencing Crisis in Virtual Reality (VR)/360° [Ph.D., Fielding Graduate University]. In ProQuest Dissertations and Theses. https://www.proquest.com/docview/2023807745/abstract/6F5A449B3BCE4911PQ/1

Dwoskin, E., Zakrzewski, C., & Miroff, N. (2021, September 24). How Facebook's 'metaverse' became a political strategy in Washington. Washington Post. https://www.washingtonpost.com/technology/2021/09/24/facebook-washington-strategy-metaverse/

Dziekan, V. (2018). The virtuous politics of Alejandro Inarritu's Carne y Arena. Artlink, 38(4), 36–43. https://doi.org/10.3316/informit.022663397866558

Edison, S. W., & Geissler, G. L. (2003). Measuring attitudes towards general technology: Antecedents, hypotheses and scale development. Journal of Targeting, Measurement and Analysis for Marketing, 12(2), 137–156. https://doi.org/10.1057/palgrave.jt.5740104

EFE Barcelona. (2018, February 22). Rehabilitan a maltratadores con realidad virtual que les hace sentirse víctimas. www.efe.com.

https://www.efe.com/efe/espana/sociedad/rehabilitan-a-maltratadores-con-realidad-virtual-que-les-hace-sentirse-victimas/10004-3532029

Elmezeny, A., Edenhofer, N., & Wimmer, J. (2018). Immersive Storytelling in 360-Degree Videos: An Analysis of Interplay Between Narrative and Technical Immersion. Journal of Virtual Worlds, 11(1), 15.

Emler, N., Renwick, S., & Malone, B. (1983). The relationship between moral reasoning and political orientation. Journal of Personality and Social Psychology, 45(5), 1073.

Enos, R. D. (2014). Causal effect of intergroup contact on exclusionary attitudes. Proceedings of the National Academy of Sciences, 111(10), 3699–3704. https://doi.org/10.1073/pnas.1317670111

Escherich, M., & Moar, J. (2020, January 12). Virtual Reality Markets: Platform Trends, Market Analysis & Forecasts 2020-2025. https://www.juniperresearch.com/researchstore/innovation-disruption/virtual-reality-research-report/Subscription/platform-trends-market-analysis-forecasts

European Commission. (2021, February 3). Catching up with VRespect.Me: Fighting domestic violence through an innovative VR solution. CORDIS | European Commission. https://cordis.europa.eu/article/id/428895-catching-up-with-vrespect-me-fighting-domestic-violence-through-an-innovative-vr-solution

Farwell, L., & Weiner, B. (2000). Bleeding hearts and the heartless: Popular perceptions of liberal and conservative ideologies. Personality and Social Psychology Bulletin, 26(7), 845–852.

Fauville, G., Queiroz, A. C. M., & Bailenson, J. N. (2020). Virtual reality as a promising tool to promote climate change awareness. In J. Kim & H. Song (Eds.), Technology and Health (pp. 91–108). Academic Press. https://doi.org/10.1016/B978-0-12-816958-2.00005-8

Feltham, J. (2019, September 17). BBC's VR Work To Continue As VR Hub Stops Commissioning, Production. https://uploadvr.com/bbc-vr-hub-shuts-down/

Fernandez, A. A., Mora, S. R., & Damerell, R. A. (2021). Work-in-Progress–— Photogrammetry within Virtual Reality. 2021 7th International Conference of the Immersive Learning Research Network (ILRN), 1–2. https://doi.org/10.23919/iLRN52045.2021.9459384

Forgas, J. P., Cooper, J., & Crano, W. D. (2010). The psychology of attitudes and attitude change (Vol. 1–1 online resource (xii, 302 pages) : illustrations). Psychology Press. http://site.ebrary.com/id/10452337

Fox, J., Arena, D., & Bailenson, J. N. (2009a). Virtual reality: A survival guide for the social scientist. Journal of Media Psychology: Theories, Methods, and Applications, 21(3), 95. https://doi.org/10.1027/1864-1105.21.3.95

Fox, J., Arena, D., & Bailenson, J. N. (2009b). Virtual Reality. Journal of Media Psychology, 21(3), 95–113. https://doi.org/10.1027/1864-1105.21.3.95

García-Orosa, B., & Pérez-Seijo, S. (2020). The Use of 360° Video by International Humanitarian Aid Organizations to Spread Social Messages and Increase Engagement. VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, 31(6), 1311–1329. https://doi.org/10.1007/s11266-020-00280-z

Ghanim, D. (2009). Gender and violence in the Middle East. ABC-CLIO.

Giuseppe Riva, & Waterworth, J. A. (2014, February 1). Being Present in a Virtual World. The Oxford Handbook of Virtuality. https://doi.org/10.1093/oxfordhb/9780199826162.013.015

Godulla, A., Planer, R., Wolf, C., Lück, A., & Vaaßen, F. (2021). An Immersive Journey through Flawed Technology: Users' Perceptions of VR in Journalism. Journalism and Media, 2(3), 454–468.

Gómez Cruz, E. (2017). Immersive Reflexivity: Using 360° Cameras in Ethnographic Fieldwork. In E. Gómez Cruz, S. Sumartojo, & S. Pink (Eds.), Refiguring Techniques in Digital Visual Research (pp. 25–38). Springer International Publishing. https://doi.org/10.1007/978-3-319-61222-5_3

Gómez-Tagle, S., Gaona, H. T., López, J. A., Ramírez, J., & Jiménez, O. D. (2012). Cultura política de los jóvenes en México. El Colegio de México. http://www.culturapoliticajovenes.colmex.mx/

González, K. R. (2018). La educación positivista en México: La disputa por la construcción de la nación. Voces y silencios. Revista Latinoamericana de Educación. https://doi.org/10.18175/vys8.2.2017.10

Gonzalez-Franco, M., & Lanier, J. (2017). Model of Illusions and Virtual Reality. Frontiers in Psychology, 8. https://doi.org/10.3389/fpsyg.2017.01125

Gonzalez-Franco, M., & Peck, T. C. (2018). Avatar Embodiment. Towards a Standardized Questionnaire. Frontiers in Robotics and AI, 5. https://doi.org/10.3389/frobt.2018.00074

Gonzalez-Liencres, C., Zapata, L. E., Iruretagoyena, G., Seinfeld, S., Perez-Mendez, L., Arroyo-Palacios, J., Borland, D., Slater, M., & Sanchez-Vives, M. V. (2020). Being the Victim of Intimate Partner Violence in Virtual Reality: First- Versus Third-Person Perspective. Frontiers in Psychology, 11. https://doi.org/10.3389/fpsyg.2020.00820

Goo, H. W., Park, S. J., & Yoo, S.-J. (2020). Advanced Medical Use of Three-Dimensional Imaging in Congenital Heart Disease: Augmented Reality, Mixed Reality, Virtual Reality, and Three-Dimensional Printing. Korean Journal of Radiology, 21(2), 133–145. https://doi.org/10.3348/kjr.2019.0625

Gouldthorpe, J. L., & Israel, G. D. (2013). Capturing Change: Comparing Pretest-Posttest and Retrospective Evaluation Methods. EDIS, 2013(1). https://doi.org/10.32473/edis-wc135-2013

Griffee, D. (2001). Questionnaire Translation and Questionnaire Validation: Are They the Same?

Gröppel-Wegener, A., & Kidd, J. (2019). Introduction: The Seductive Power of Immersion. In Critical Encounters with Immersive Storytelling. Routledge.

Guterstam, A., Petkova, V. I., & Ehrsson, H. H. (2011). The illusion of owning a third arm. PloS One, 6(2), e17208.

Hambleton, R. K., & Kanjee, A. (1996). Increasing the validity of cross-cultural assessments: Use of improved methods for test adaptations. European Journal of Psychological Assessment, 11(3), 147. https://doi.org/10.1027/1015-5759.11.3.147

Harris, B. J. (2015, December 10). How The United Nations Is Using Virtual Reality To Tackle Real-World Problems. Fast Company. https://www.fastcompany.com/3051672/how-the-united-nations-is-using-virtual-reality-to-tackle-real-world-problems

Hasson, Y., Schori-Eyal, N., Landau, D., Hasler, B. S., Levy, J., Friedman, D., & Halperin, E. (2019). The enemy's gaze: Immersive virtual environments enhance peace promoting attitudes and emotions in violent intergroup conflicts. PloS One, 14(9), e0222342.

Heim, M. R. (2014). The Paradox of Virtuality. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199826162.013.002

Hernández García, Ma. A., Muñoz Armenta, A., & Meixueiro Néjera, G. (2019). Cultura política en México el estado del arte y los desafíos de su estudio a nivel subnacional. Instituto Estatal Electoral y de Participación Ciudadana de Oaxaca.

Herranz de la Casa, J. M., Caerols Mateo, R., & Sidorenko Bautista, P. (2019). La realidad virtual y el vídeo 360º en la comunicación empresarial e institucional. Revista de Comunicación, 18(2), 177–199. https://doi.org/10.26441/RC18.2-2019-A9

Herrera, F., Bailenson, J., Weisz, E., Ogle, E., & Zaki, J. (2018). Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. PLOS ONE, 13(10), e0204494. https://doi.org/10.1371/journal.pone.0204494

Herrera-Quintero, L. F., Chavarriaga, J., Banse, K., Bermudez, D., & Proeller, G. (2019). Disruptive technologies in intelligent transportation systems. 2019 2nd Latin American Conference on Intelligent Transportation Systems (ITS LATAM), 1–6.

Heys, S. (2020). Conscientization for practice: The design and delivery of an immersive educational programme to sensitise maternity professionals to the potential for traumatic birth experiences amongst disadvantaged and vulnerable women [University of Central Lancashire]. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=DFA179232B746942&site=ehost-live

Holbrook, A. L. (2011). Attitude Change Experiments in Political Science. In J. N. Druckman, D. P. Green, J. H. Kuklinski, & A. Lupia (Eds.), Cambridge Handbook of Experimental

Political Science (pp. 141–154). Cambridge University Press. https://doi.org/10.1017/CBO9780511921452.010

INEGI & SEGOB. (2012). Encuesta Nacional sobre Cultura Política y Prácticas Ciudadanas (ENCUP). https://www.inegi.org.mx/programas/encup/2012/

Isart Gil, M. (2017). La retrotraducción como herramienta de comprobación de la equivalencia y de la adaptación intercultural en la traducción de instrumentos de valoración de la salud. UNIVERSITAT JAUME I.

Jarvis, L. (2019). Narrative as virtual reality 2: Revisiting immersion and interactivity in literature and electronic media. International Journal of Performance Arts and Digital Media, 15(2), 239–241. https://doi.org/10.1080/14794713.2019.1637100

Johnson, D. G., & Wetmore, J. M. (2008). Technology and Society: Building our Sociotechnical Future. MIT Press.

Jones, J. J., & Sommer, J. M. (2018). Is Virtual Reality Uniquely Effective in Eliciting Empathy? Stony Brook University. https://doi.org/10.31235/osf.io/bgc5n

Joshi, S. V., Stubbe, D., Li, S.-T. T., & Hilty, D. M. (2019). The Use of Technology by Youth: Implications for Psychiatric Educators. Academic Psychiatry, 43(1), 101–109. https://doi.org/10.1007/s40596-018-1007-2

Jung, Y., & Lee, K. M. (2004). Effects of Physical Embodiment on Social Presence of Social Robots. University of Southern California, 8.

Kandaurova, M., & Lee, S. H. (Mark). (2019). The effects of Virtual Reality (VR) on charitable giving: The role of empathy, guilt, responsibility, and social exclusion. Journal of Business Research, 100, 571–580. https://doi.org/10.1016/j.jbusres.2018.10.027

Kim, G. M. (2019). The Persuasion Processes in Virtual Reality in the Context of Technology Acceptance [Ph.D., Syracuse University]. https://www.proquest.com/pqdtglobal/docview/2241792160/abstract/9C9E309FB4F0488APQ/19

Krämer, N., Sobieraj, S., Feng, D., Trubina, E., & Marsella, S. (2018). Being Bullied in Virtual Environments: Experiences and Reactions of Male and Female Students to a Male or Female Oppressor. Frontiers in Psychology, 9. https://doi.org/10.3389/fpsyg.2018.00253

Kratzig, G. (2019, November 13). Speaking of Psychology: Using virtual reality to train law enforcement officers. Https://Www.Apa.Org. https://www.apa.org/research/action/speaking-of-psychology/train-law-enforcement

Lam, T. C. M., & Bengo, P. (2003). A Comparison of Three Retrospective Self-reporting Methods of Measuring Change in Instructional Practice. American Journal of Evaluation, 24(1), 65–80. https://doi.org/10.1177/109821400302400106

Lamb, H. (2020). Can VR help to make policing fairer? Engineering & Technology, 15(3), 44–49. https://doi.org/10.1049/et.2020.0304

Lanier, J. (1992). Virtual reality: The promise of the future. Interactive Learning International, 8(4), 275–279.

Lee, K. M. (2004). Presence, Explicated. Communication Theory, 14(1), 27–50. https://doi.org/10.1111/j.1468-2885.2004.tb00302.x

Longo, M. R., Schüür, F., Kammers, M. P., Tsakiris, M., & Haggard, P. (2008). What is embodiment? A psychometric approach. Cognition, 107(3), 978–998.

Loon, A. van, Bailenson, J., Zaki, J., Bostick, J., & Willer, R. (2018). Virtual reality perspective-taking increases cognitive empathy for specific others. PLOS ONE, 13(8), e0202442. https://doi.org/10.1371/journal.pone.0202442

Lv, Z. (2020). Virtual reality in the context of Internet of Things. Neural Computing and Applications, 32(13), 9593–9602. https://doi.org/10.1007/s00521-019-04472-7

Mabrook, R. (2021). Between Journalist Authorship and User Agency: Exploring the Concept of Objectivity in VR Journalism. Journalism Studies, 22(2), 209–224. https://doi.org/10.1080/1461670X.2020.1813619

Martin, J.-C. (2014, February 1). Emotions and Altered States of Awareness. The Oxford Handbook of Virtuality. https://doi.org/10.1093/oxfordhb/9780199826162.013.001

Masson-Delmotte, V., Zhai, P., Priani, A., Connors, S. L., Péan, C., & Berger, S. (2021). IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Mathysen, D., & Glorieux, I. (2021). Integrating virtual reality in qualitative research methods: Making a case for the VR-assisted interview. Methodological Innovations, 14(2), 20597991211030776. https://doi.org/10.1177/20597991211030778

Mavi Sánchez-Vives. (2019). Transforming lives with virtual reality—Frontiers Forum 2019—YouTube. https://www.youtube.com/watch?v=hUiA04kHngs&ab_channel=Frontiers

McEvoy, K. A. (2015). Through the Eyes of a Bystander: Understanding VR and Video Effectiveness on Bystander Empathy, Presence, Behavior, and Attitude in Bullying Situations. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=4EBE7260F4D13E72&site=ehost-live

Metzinger, T. K. (2018). Why Is Virtual Reality Interesting for Philosophers? Frontiers in Robotics and AI, 5. https://doi.org/10.3389/frobt.2018.00101

Michalos, A. C., Creech, H., McDonald, C., & Kahlke, P. M. H. (2011). Knowledge, Attitudes and Behaviours. Concerning Education for Sustainable Development: Two

Exploratory Studies. Social Indicators Research, 100(3), 391–413. https://doi.org/10.1007/s11205-010-9620-9

Michalos, A. C., Creech, H., Swayze, N., Maurine Kahlke, P., Buckler, C., & Rempel, K. (2012). Measuring Knowledge, Attitudes and Behaviours Concerning Sustainable Development among Tenth Grade Students in Manitoba. Social Indicators Research, 106(2), 213–238. https://doi.org/10.1007/s11205-011-9809-6

Migration Data Portal. (2021). Migration data and the sustainable development goals. Migration Data Portal. http://www.migrationdataportal.org/sdgs

Milk, C. (2015). How virtual reality can create the ultimate empathy machine. https://www.ted.com/talks/chris_milk_how_virtual_reality_can_create_the_ultimate_empathy_machine

Mimnaugh, K. J. (2018). Investigating how mindfulness promotes the restorative effects of nature exposure in virtual reality. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=93E57E8D9C292A31&site=ehost-live

Miola, A., & Schiltz, F. (2019). Measuring sustainable development goals performance: How to monitor policy action in the 2030 Agenda implementation? Ecological Economics, 164, 106373. https://doi.org/10.1016/j.ecolecon.2019.106373

Muntean, R., Park, M., Rubleva, Y., & Hennessy, K. (2019). Sustainable Production and Consumption in 360. 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 1400–1400. https://doi.org/10.1109/VR.2019.8797753

Navarrete, C. D., McDonald, M. M., Mott, M. L., & Asher, B. (2012). Virtual morality: Emotion and action in a simulated three-dimensional "trolley problem". Emotion, 12(2), 364.

Navarro-Carrillo, G., Valor-Segura, I., & Moya, M. (2018). Do you Trust Strangers, Close Acquaintances, and Members of Your Ingroup? Differences in Trust Based on Social Class in Spain. Social Indicators Research, 135(2), 585–597. https://doi.org/10.1007/s11205-016-1527-7

Nelson, K. M., Anggraini, E., & Schlüter, A. (2020). Virtual reality as a tool for environmental conservation and fundraising. PLOS ONE, 15(4), e0223631. https://doi.org/10.1371/journal.pone.0223631

Newton, C. (2021, July 22). Mark Zuckerberg is betting Facebook's future on the metaverse. The Verge. https://www.theverge.com/22588022/mark-zuckerberg-facebook-ceo-metaverse-interview

Nezami, F. N., Wächter, M. A., Maleki, N., Spaniol, P., Kühne, L. M., Haas, A., Pingel, J. M., Tiemann, L., Nienhaus, F., Keller, L., König, S., König, P., & Pipa, G. (2020). WestDrive X LoopAR: An open-access virtual reality project in Unity for evaluating

user interaction methods during TOR. ArXiv:2012.12041 [Cs]. http://arxiv.org/abs/2012.12041

Nousheen, A., Yousuf Zai, S. A., Waseem, M., & Khan, S. A. (2020). Education for sustainable development (ESD): Effects of sustainability education on pre-service teachers' attitude towards sustainable development (SD). Journal of Cleaner Production, 250, 119537. https://doi.org/10.1016/j.jclepro.2019.119537

Novet, J. (2021, March 31). Microsoft wins U.S. Army contract for augmented reality headsets, worth up to $21.9 billion over 10 years. CNBC. https://www.cnbc.com/2021/03/31/microsoft-wins-contract-to-make-modified-hololens-for-us-army.html

Nunes, T. A., & Lee, H. (2019). Humanitarian Documentary: A Comparison Study between VR and Non-VR Productions. Journal of Multimedia Information System, 6(4), 309–316.

Olson, K. E., O'Brien, M. A., Rogers, W. A., & Charness, N. (2011). Diffusion of Technology: Frequency of Use for Younger and Older Adults. Ageing International, 36(1), 123–145. https://doi.org/10.1007/s12126-010-9077-9

Olsson, D., Gericke, N., & Chang Rundgren, S.-N. (2015). The effect of implementation of education for sustainable development in Swedish compulsory schools – assessing pupils' sustainability consciousness. Environmental Education Research, 22, 1–27. https://doi.org/10.1080/13504622.2015.1005057

Oscars. (2017, November 12). Alejandro González Iñárritu Accepts a Special Oscar for Carne Y Arena. https://www.youtube.com/watch?v=jGI-nCuQuFY&ab_channel=Oscars

Ostrom, E. (2010). A Note for the First. Newsletter of the APSA Experimental Section, 1(1), 19.

Padrao, G., Gonzalez-Franco, M., Sanchez-Vives, M. V., Slater, M., & Rodriguez-Fornells, A. (2016). Violating body movement semantics: Neural signatures of self-generated and external-generated errors. Neuroimage, 124, 147–156.

Parish-Morris, J., Solórzano, R., Ravindran, V., Sazawal, V., Turnacioglu, S., Zitter, A., MILLER, J. S., & MCCLEERY, J. P. (2018). Immersive virtual reality to improve police interaction skills in adolescents and adults with autism spectrum disorder: Preliminary results of a phase I feasibility and safety trial. Annual Review of Cybertherapy and Telemedicine, 16, 50–56.

Parsons, T. D. (2019). Ethical Challenges in Digital Psychology and Cyberpsychology (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781108553384

Passig, D., Eden, S., & Heled, M. (2007). The impact of Virtual Reality on the awareness of teenagers to social and emotional experiences of immigrant classmates. Education and Information Technologies, 12(4), 267–280. https://doi.org/10.1007/s10639-007-9031-y

Passini, S. (2014). The effect of personal orientations toward intergroup relations on moral reasoning. Journal of Moral Education, 43(1), 89–103.

Patané, I., Lelgouarch, A., Banakou, D., Verdelet, G., Desoche, C., Koun, E., Salemme, R., Slater, M., & Farnè, A. (2020). Exploring the Effect of Cooperation in Reducing Implicit Racial Bias and Its Relationship With Dispositional Empathy and Political Attitudes. Frontiers in Psychology, 11. https://doi.org/10.3389/fpsyg.2020.510787

Peacock, A. (2020). I've seen the Future—The new 2021 VUZIX AR Glasses—Sneak Peek! https://www.youtube.com/watch?v=xOMx4HZvHYM

Penner, L. A., Dovidio, J. F., Piliavin, J. A., & Schroeder, D. A. (2005). Prosocial behavior: Multilevel perspectives. Annu. Rev. Psychol., 56, 365–392.

Piff, P. K., Kraus, M. W., Côté, S., Cheng, B. H., & Keltner, D. (2010). Having less, giving more: The influence of social class on prosocial behavior. Journal of Personality and Social Psychology, 99(5), 771. https://doi.org/10.1037/a0020092

Programa de las Naciones Unidas para el Desarrollo. (2015). Empleos en el PNUD - 56581-UNMC Virtual Reality and Video Specialist Consulta. https://jobs.undp.org/cj_view_job.cfm?cur_lang=sp&cur_job_id=56581

Programa de las Naciones Unidas para el Desarrollo. (2019). Solicitud de propuesta No. PNUD-ECU-SdP-ADQ-19-83957 Producción de experiencia virtual en video 360° para sensibilización ciudadana. Programa de las Naciones Unidas para el Desarrollo. https://procurement-notices.undp.org/view_file.cfm?doc_id=194715

Putze, S., Alexandrovsky, D., Putze, F., Höffner, S., Smeddinck, J. D., & Malaka, R. (2020). Breaking the experience: Effects of questionnaires in vr user studies. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–15.

Ratan, R., Cruz, M. S., & Vorderer, P. (2007). Multitasking, Presence & Self-Presence on the Wii. 12.

Rodenbaugh, M. (2020). Virtual Reality and News Audiences: Empathy or More? [M.S., Colorado State University]. https://www.proquest.com/pqdtglobal/docview/2452124248/abstract/9C9E309FB4F0488APQ/17

Rojas-Ospina, T., Valencia-Serrano, M., Rojas-Ospina, T., & Valencia-Serrano, M. (2019). Adaptación y Validación de un Cuestionario Sobre Estrategias de Autorregulación de la Motivación en Estudiantes Universitarios. Psykhe (Santiago), 28(1), 1–15. https://doi.org/10.7764/psykhe.28.1.1128

Roque Hernández, R. V., Mendiola Medrano, E. J., López Mendoza, A., & Herrera Izaguirre, J. A. (2019). Realidad virtual: Realidades, prospectivas y percepciones de estudiantes universitarios de Tecnologías de la Información. Dilemas Contemporáneos: Educación, Política y Valores, 6(3).

Rouse, R. (2021). Against the Instrumentalization of Empathy: Immersive Technologies and Social Change. In Augmented and Mixed Reality for Communities. CRC Press.

Sadin, É. (2021). La inteligencia artificial o el desafío del siglo: Anatomía de un antihumanismo radical. Caja Negra.

Schaub, M., Gereke, J., & Baldassarri, D. (2021). Strangers in Hostile Lands: Exposure to Refugees and Right-Wing Support in Germany's Eastern Regions. Comparative Political Studies, 54(3–4), 686–717.

Schwind, V., Knierim, P., Haas, N., & Henze, N. (2019). Using Presence Questionnaires in Virtual Reality. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, 1–12. https://doi.org/10.1145/3290605.3300590

Seinfeld, S., Zhan, M., Poyo-Solanas, M., Barsuola, G., Vaessen, M., Slater, M., Sanchez-Vives, M. V., & de Gelder, B. (2021). Being the victim of virtual abuse changes default mode network responses to emotional expressions. Cortex, 135, 268–284. https://doi.org/10.1016/j.cortex.2020.11.018

Sellers, V. (2020). Assessment of Affective Responses to Classroom, Outdoor, and Virtual Geology Field Experiences. All Dissertations. https://tigerprints.clemson.edu/all_dissertations/2640

Silverstein, J. (2021, June 4). The global impact of George Floyd: How Black Lives Matter protests shaped movements around the world. https://www.cbsnews.com/news/george-floyd-black-lives-matter-impact/

Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing Our Lives with Immersive Virtual Reality. Frontiers in Robotics and AI, 3. https://doi.org/10.3389/frobt.2016.00074

Speicher, M., Hall, B. D., & Nebeling, M. (2019). What is Mixed Reality? In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1–15). Association for Computing Machinery. https://doi.org/10.1145/3290605.3300767

Steed, A., Frlston, S., Lopez, M. M., Drummond, J., Pan, Y., & Swapp, D. (2016). An 'In the Wild' Experiment on Presence and Embodiment using Consumer Virtual Reality Equipment. IEEE Transactions on Visualization and Computer Graphics, 22(4), 1406–1414. https://doi.org/10.1109/TVCG.2016.2518135

Stein, J.-P. (2021). Conjuring up the departed in virtual reality: The good, the bad, and the potentially ugly. Psychology of Popular Media, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/ppm0000315

Stepanova, E. R., Quesnel, D., & Riecke, B. E. (2019). Understanding AWE: Can a virtual journey, inspired by the Overview Effect, lead to an increased sense of interconnectedness? Frontiers in Digital Humanities, 6, 9.

Sujay, L. (2019). Average session time of VR users in the U.S. 2019. Statista. https://www.statista.com/statistics/1098976/average-session-time-of-vr-users-by-user-type/

Taylor Owen, Fergus Pitt, Raney Aronson-Rath, & James Milward. (2015). Virtual Reality Journalism. Columbia Journalism Review. https://www.cjr.org/tow_center_reports/virtual_reality_journalism.php/

Teo, T., Lawrence, L., Lee, G. A., Billinghurst, M., & Adcock, M. (2019). Mixed Reality Remote Collaboration Combining 360 Video and 3D Reconstruction. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, 1–14. https://doi.org/10.1145/3290605.3300431

Tomislav, K. (2018). The concept of sustainable development: From its beginning to the contemporary issues. Zagreb International Review of Economics & Business, 21(1), 67–94.

Tussyadiah, I. P., Wang, D., Jung, T. H., & tom Dieck, M. C. (2018). Virtual reality, presence, and attitude change: Empirical evidence from tourism. Tourism Management, 66, 140–154.

UN Virtual Reality. (2021). Syrian Refugee Crisis. http://unvr.sdgactioncampaign.org/cloudsoversidra/

UNESCO. (2020). Education for sustainable development: A roadmap. https://unesdoc.unesco.org/ark:/48223/pf0000374802

UNHCR. (2021). UNHCR Jordan: Azraq Refugee Camp - Factsheet, June 2021 - Jordan. ReliefWeb. https://reliefweb.int/report/jordan/unhcr-jordan-azraq-refugee-camp-factsheet-june-2021

Van Damme, K., All, A., De Marez, L., & Van Leuven, S. (2019). 360° Video Journalism: Experimental Study on the Effect of Immersion on News Experience and Distant

Suffering. Journalism Studies, 20(14), 2053–2076. https://doi.org/10.1080/1461670X.2018.1561208

Vaterlaus, J. M., Jones, R. M., & Tulane, S. (2015). Perceived differences in knowledge about interactive technology between young adults and their parents. Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 9(4), Article 4. https://doi.org/10.5817/CP2015-4-3

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A Longitudinal Field Investigation of Gender Differences in Individual Technology Adoption Decision-Making Processes. Organizational Behavior and Human Decision Processes, 83(1), 33–60. https://doi.org/10.1006/obhd.2000.2896

Verkuyten, M., Mepham, K., & Kros, M. (2018). Public attitudes towards support for migrants: The importance of perceived voluntary and involuntary migration. Ethnic and Racial Studies, 41(5), 901–918.

Verma, A., Purohit, P., Thornton, T., & Lamsal, K. (2021). An examination of skill requirements for augmented reality and virtual reality job advertisements. Missouri Western State University, 19.

Voinea, C. F. (2016). Political attitudes: Computational and simulation modelling. John Wiley & Sons.

Waltermire, B. (2018). Virtual Reality and Its Impact on Travel Journalism Audiences: A Study of Presence, Credibility, and Destination Image That Can Influence Vr User

Attitudes About a Travel Destination. http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=04D680582005392D&site=ehost-live

Watson, Z. (2017). VR for News: The New Reality? (p. 48). Reuters Institute for the Study of Journalism.

Weaver, R. (2014). Contextual Influences on Political Behavior in Cities: Toward Urban Electoral Geography. Geography Compass, 8(12), 874–891. https://doi.org/10.1111/gec3.12186

Weber, M. (2009). The Theory Of Social And Economic Organization. Simon and Schuster.

Williams, K. C., & Morton, R. B. (Eds.). (2010). The Advent of Experimental Political Science. In Experimental Political Science and the Study of Causality: From Nature to the Lab (pp. 3–28). Cambridge University Press. https://doi.org/10.1017/CBO9780511762888.001

Woloschuk, W., Harasym, P. H., & Temple, W. (2004). Attitude change during medical school: A cohort study. Medical Education, 38(5), 522–534. https://doi.org/10.1046/j.1365-2929.2004.01820.x

Won, A. S., Bailenson, J., Lee, J., & Lanier, J. (2015). Homuncular flexibility in virtual reality. Journal of Computer-Mediated Communication, 20(3), 241–259.

Won, A. S., Bailenson, J. N., & Lanier, J. (2015). Homuncular flexibility: The human ability to inhabit nonhuman avatars. Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource, 1–16.

Wyatt, S. (2008). Technological determinism is dead; long live technological determinism. The Handbook of Science and Technology Studies, 3, 165–180.

Yoo, S.-C., & Drumwright, M. (2018). Nonprofit fundraising with virtual reality. Nonprofit Management and Leadership, 29(1), 11–27. https://doi.org/10.1002/nml.21315

Yu, R., Duer, Z., Ogle, T., Bowman, D. A., Tucker, T., Hicks, D., Choi, D., Bush, Z., Ngo, H., Nguyen, P., & Liu, X. (2018). Experiencing an Invisible World War I Battlefield Through Narrative-Driven Redirected Walking in Virtual Reality. 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 313–319. https://doi.org/10.1109/VR.2018.8448288

Zamboni, J. (2018). The Advantages of a Large Sample Size. Sciencing. https://sciencing.com/advantages-large-sample-size-7210190.html

Appendix A

Ideology consistency scale

Indication: Below, you will find a set of political claims related to political leanings. Please, read both statements and select the one that you consider valid. There are no correct or false answers. These are not trick questions. Please, answer as honestly as you can:

Pre-test item	Conservative Position*	Liberal position*
29	Government is almost always wasteful and inefficient.	Government often does a better job than people give it credit for.
30	Government regulation of business usually does more harm than good	Government regulation of business is necessary to protect the public interest.
31	Poor people have hard lives because government benefits don't go far enough to help them live decently.	Poor people today have it easy because they can get government benefits without doing anything in return.
32	The government today can't afford to do much more to help the needy.	The government should do more to help needy Mexicans, even if it means going deeper into debt.*
33	Ethnic minorities that can't get ahead in this country are mostly responsible for their own condition.	Ethnic discrimination is the main reason why many black people can't get ahead these days.
34	Immigrants today are a burden on our country because they take our jobs, housing and health care.	Immigrants today strengthen our country because of their hard work and talents.
35	The best way to ensure peace is through military strength.	Good diplomacy is the best way to ensure peace.
36	Most corporations make a fair and reasonable amount of profit.	Business corporations make too much profit.
37	Stricter environmental laws and regulations cost too many jobs and hurt the economy.	Stricter environmental laws and regulations are worth the cost.
38	Homosexuality should be discouraged by society.	Homosexuality should be accepted by society.

Note. The indication message was adapted from Rodenbaugh, M. (2020). Virtual Reality and News Audiences: Empathy or More? [M.S., Colorado State University. The scale was adapted from Dimock, M., Kiley, J., Keeter, S., & Doherty, C. (2014). Political Polarization in the American Public: Increasing Ideological Uniformity and Partisan Antipathy Affect Politics, Compromise, and Everyday Life. This scale is almost the same as the original measurement. It only required cultural adaptation for items 32 and 33. *Participants did not see the first raw of the table.

Appendix B

Attitudes toward Sustainable Development scale

Pre-test item	Post-test item	Item content	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
40	5	When people interfere with the environment, they often produce disastrous consequences.	1	2	3	4	5
41	6	Environmental protection and people's quality of life are directly linked.	1	2	3	4	5
42	7	Biodiversity should be protected at the expense of industrial agricultural production.	1	2	3	4	5
43	8	Building development is less important than environmental protection.	1	2	3	4	5
44	9	Environmental protection is more important than industrial growth.	1	2	3	4	5
45	10	Government economic policies should increase sustainable production even if it means spending more money.	1	2	3	4	5
46	11	People should sacrifice more to reduce economic differences between populations.	1	2	3	4	5
47	12	Government economic policies should increases fair trade.	1	2	3	4	5
48	13	Government economic policies should act if a country is wasting its natural resources.	1	2	3	4	5
49	14	Reducing poverty and hunger in the world is more important than increasing the economic well-being of the industrialized countries.	1	2	3	4	5
50	15	Each country can do a lot to keep the peace in the world.	1	2	3	4	5
51	16	The society should further promote equal opportunities for males and females.	1	2	3	4	5
52	17	The contact between cultures is stimulating and enriching.	1	2	3	4	5
53	18	The society should provide free basic health services.	1	2	3	4	5
54	19	The society should take responsibility for the welfare of individuals and families.	1	2	3	4	5
55	20	Teachers in college should use student centred teaching methods.	1	2	3	4	5
56	21	Teachers in college should promote future oriented thinking in addition to historical knowledge.	1	2	3	4	5
57	22	Teachers in college should promote interdisciplinarity between subjects.	1	2	3	4	5
58	23	Teachers in college should promote the connection between local and global issues.	1	2	3	4	5
59	24	Teachers in college should promote critical thinking rather than lecturing.	1	2	3	4	5

Note. Pre and post-test items´ numbers correspond to the variable number of this study´s database. The questionnaire´s items and scores guideline were taken from Biasutti, M., & Frate, S. (2017). A validity and reliability study of the Attitudes toward Sustainable Development scale. Environmental Education Research, 23(2), 214–230.

Appendix C

Index of Knowledge of SD

Pre-test item	Item content	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
60	Economic development is necessary for sustainable development (SD).	1	2	3	4	5
61	Improving people's opportunities for long and healthy lives contributes to SD.	1	2	3	4	5
62	Protecting the environment is necessary for SD	1	2	3	4	5
63	A culture of peace where people settle conflicts by discussion is necessary for SD.	1	2	3	4	5
64	Human actions are contributing to changes in our atmosphere and climate systems.	1	2	3	4	5
65	SD requires individuals to reduce all kinds of waste.	1	2	3	4	5
66	Good citizenship is necessary for SD.	1	2	3	4	5
67	SD is not dependent on gender equality*.	1	2	3	4	5
68	The elimination of poverty is necessary for SD.	1	2	3	4	5
69	SD requires access to good quality education for everyone.	1	2	3	4	5
70	SD requires businesses to behave responsibly to their employees, customers and suppliers.	1	2	3	4	5
71	Conservation of fresh water is necessary for SD.	1	2	3	4	5
72	'Maintaining biodiversity' means maintaining the number and variety of living organisms. This is necessary for SD.	1	2	3	4	5
73	Respect for cultural diversity is necessary for SD.	1	2	3	4	5
74	SD results in fair distribution of goods and services to all people around the world.	1	2	3	4	5
75	SD requires respect for human rights.	1	2	3	4	5
76	SD requires shifting to the use of renewable resources as much as possible.	1	2	3	4	5
77	SD requires people to learn new things throughout their lives.	1	2	3	4	5
78	SD requires people to reflect on what it means to improve the quality of life.	1	2	3	4	5
79	22. SD requires that people understand how the economy works.	1	2	3	4	5

Note. Pre-test numbers correspond to the variable number of this study´s database. The questionnaire items were taken from Michalos, A. C., Creech, H., Swayze, N., Maurine Kahlke, P., Buckler, C., & Rempel, K. (2012). Measuring Knowledge, Attitudes, and Behaviours Concerning Sustainable Development among Tenth Grade Students in Manitoba. Social Indicators Research, 106(2), 213–238. The scales ranges were in the opposite order than the original scale— the original authors used "strongly agree" (1) to "strongly disagree" (5). *Item 67 is reverse scored.

Appendix D

Measure donation attitudes toward SD causes

Pre-test item	Post-test item	How likely is that you donate to some of the following causes?	Very unlikely	Not likely	Likely	Very likely
123	75	Environmental protection.	1	2	3	4
124	76	Help to migrants	1	2	3	4
125	77	Gender equality	1	2	3	4
126	78	Education for all	1	2	3	4
127	79	Health for all	1	2	3	4
128	80	Labor rights	1	2	3	4
129	81	Economic poverty	1	2	3	4

Note. The list of causes is based on Comisión Especial para el seguimiento a la implementación de la Agenda 2030, Senado de la República. (2021). Informe Nacional Voluntario 2021 Agenda 2030 en México. The list of SD causes is not limited to seven areas. These causes were selected by the author for this study.

Appendix D

Stimulus measurement

	VIDEO NAME	Vídeo 360: la llegada a un campo de refugiados		¿Quiénes son los Cascos Blancos sirios? | Reportaje		La Canción del Lobo Feroz 360		La Estrella de la Mañana 360		[360 VIDEO VR] Mediterráneo: así es un rescate		Demo Vídeo 360 ACNUR		SeguirConVida Seguir con vida: de la guerra siria a las	
	EVALUATOR	A	B	A	B	A	B	A	B	A	B	A	B	A	B
ELEMENTS TO MEASURE	Spanish version (6)	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	YOUTUBE (6)	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Storytelling (0-3)	3	3	1	1	2	2	3	3	3	2	3	2	3	3
	Audio quality (0-3)	3	3	2	2	3	2	3	3	3	3	2	3	3	3
	Cinematography (0-3)	3	3	1	2	2	2	2	3	3	3	3	3	3	3
	Enviroment (0-3)	0	0	1	1	3	3	2	3	0	0	1	1	1	1
	Economy (0-3)	3	3	1	2	2	2	2	3	2	3	3	3	3	3
	Society (0-3)	3	3	2	3	2	3	2	2	3	3	3	3	3	3
	Education (0-3)	1	1	0	0	3	3	3	3	0	0	2	2	0	0
	Migration (0-3)	3	3	2	2	2	2	1	2	3	3	3	3	3	3
	UN/INTERNATIONAL ORGANIZATIONS (0-3)	3	3	0	0	2	2	2	2	2	3	3	3	2	2
	Charity stimultuing (0-3)	2	2	1	2	3	2	2	2	1	2	3	3	2	3
	SUM PER PERSON	36	36	23	27	36	35	34	38	32	34	38	38	35	36
	TOTAL		72		50		71		72		66		76		71

En la piel de un refugiado, la historia de Alain contada en	Las imágenes del 19-S en 360 grados	Fukushima (ES) | Video 360 VR | EL PAÍS Semanal	[360 VIDEO VR] República Centroafricana: en los	DREAMer teme final de DACA con Trump (VR/360)	No es justo que me deporten: mis hijos sirven en el ejército	Viviendo indocumentado y con grillete (VR/360)
A	B	A	B	A	B	A	B	A	B	A	B	A	B
6	6	6	6	4	4	6	6	6	6	6	6	6	6
6	6	6	6	6	6	6	6	6	6	6	6	6	6
3	3	1	1	3	3	2	2	2	2	1	2	1	3
3	3	2	2	3	3	2	3	3	3	2	3	1	3
2	2	2	3	3	3	1	2	2	2	2	3	1	3
2	2	1	2	3	3	1	1	0	0	0	0	0	0
3	3	1	2	2	3	2	2	1	1	2	2	2	3
3	3	2	3	2	2	3	3	2	3	3	3	3	3
3	2	1	2	0	0	0	0	1	3	2	2	1	1
3	3	0	0	2	3	3	3	3	3	3	3	3	3
2	1	1	2	1	2	3	3	0	2	0	1	0	1
2	2	2	3	2	3	2	1	0	1	0	0	0	0
38	36	25	32	31	35	31	32	26	32	27	31	24	32
	74		57		66		63		58		58		56

Note. Evaluator A refers to José Noé De Ita Zavala. Evaluator B refers to Lourdes Rodríguez. The results within the square represents the selected videos.

Appendix E

Experiment´s logbook

Participant	Political ideology	Group	Pre-test	Post-test
1	LIBERAL WOMEN	VR	July 12, 2021	August 4, 2021
2	LIBERAL WOMEN	VR	July 12, 2021	August 4, 2021
3	LIBERAL WOMEN	VR	July 12, 2021	August 5, 2021
4	LIBERAL WOMEN	SCREEN	July 14, 2021	August 4, 2021
5	MODERATE MEN	VR	July 14, 2021	August 4, 2021
6	MODERATE MEN	SCREEN	July 14, 2021	July 28, 2021
7	LIBERAL MEN	VR	July 14, 2021	August 4, 2021
8	LIBERAL WOMEN	SCREEN	July 14, 2021	July 28, 2021
9	LIBERAL WOMEN	SCREEN, mistake	July 14, 2021	August 5, 2021
10	MODERATE MEN	SCREEN	July 14, 2021	August 4, 2021
11	LIBERAL WOMEN	SCREEN	July 19, 2021	July 27, 2021
12	LIBERAL WOMEN	SCREEN	July 19, 2021	July 27, 2021
13	LIBERAL MEN	SCREEN	August 19, 2021	July 27, 2021
14	MODERATE MEN	VR	July 15, 2021	July 29, 2021
15	MODERATE MEN	SCREEN	July 15, 2021	July 28, 2021
16	LIBERAL WOMEN	VR	July 15, 2021	July 29, 2021
17	LIBERAL MEN	SCREEN	July 15, 2021	July 29, 2021
18	LIBERAL MEN	SCREEN	July 16, 2021	July 30, 2021
19	LIBERAL WOMEN	SCREEN	July 16, 2021	July 30, 2021
20	LIBERAL MEN	SCREEN	July 16, 2021	July 30, 2021
21	LIBERAL WOMEN	SCREEN	July 16, 2021	July 30, 2021
22	LIBERAL MEN	SCREEN	July 17, 2021	July 26, 2021
23	LIBERAL WOMEN	VR	July 19, 2021	August 3, 2021
24	LIBERAL MEN	SCREEN	July 19, 2021	August 3, 2021
25	MODERATE WOMEN	VR	July 20, 2021	July 31, 2021
26	LIBERAL MEN	VR	July 20, 2021	July 31, 2021
27	LIBERAL WOMEN	VR	July 20, 2021	July 31, 2021
28	MODERATE WOMEN	VR	July 20, 2021	August 2, 2021
29	LIBERAL MEN	VR	July 20, 2021	August 7, 2021
30	MODERATE WOMEN	SCREEN	July 20, 2021	August 21, 2021
31	LIBERAL MEN	SCREEN	July 21, 2021	August 3, 2021
32	MODERATE MEN	VR	July 20, 2021	August 4, 2021
33	LIBERAL MEN	VR	July 20, 2021	August 4, 2021
34		NA	July 20, 2021	
35	LIBERAL MEN	SCREEN	July 21, 2021	July 28, 2021
36	LIBERAL WOMEN	SCREEN	July 21, 2021	July 28, 2021
37	LIBERAL MEN	VR	July 22, 2021	July 29, 2021
38	LIBERAL WOMEN	SCREEN	July 22, 2021	July 29, 2021
39		NA	July 22, 2021	
40	LIBERAL MEN	SCREEN	July 22, 2021	July 29, 2021
41	LIBERAL WOMEN	SCREEN	July 23, 2021	July 30, 2021
42	MODERATE MEN	VR	July 23, 2021	July 30, 2021
43	LIBERAL MEN	VR	July 23, 2021	July 30, 2021
44	MODERATE WOMEN	SCREEN	July 23, 2021	August 6, 2021
45	LIBERAL MEN	VR	July 23, 2021	August 6, 2021
46	LIBERAL WOMEN	SCREEN	July 23, 2021	August 5, 2021
47	LIBERAL WOMEN	SCREEN	July 24, 2021	July 31, 2021
48	LIBERAL WOMEN	SCREEN	July 24, 2021	August 7, 2021
49	MODERATE MEN	SCREEN	July 24, 2021	August 9, 2021
50	LIBERAL WOMEN	VR	July 31, 2021	August 7, 2021
51	LIBERAL WOMEN	VR	July 26, 2021	August 2, 2021
52	MODERATE MEN	SCREEN	July 26, 2021	August 2, 2021
53	LIBERAL MEN	VR	July 26, 2021	August 3, 2021
54	MODERATE MEN	SCREEN	July 26, 2021	August 3, 2021
55	MODERATE MEN	SCREEN	July 26, 2021	August 7, 2021
56	LIBERAL WOMEN	VR	July 26, 2021	August 7, 2021
57	MODERATE MEN	VR	July 27, 2021	August 3, 2021
58	MODERATE MEN	VR	July 27, 2021	August 7, 2021
59	LIBERAL WOMEN	SCREEN	July 28, 2021	August 11, 2021
60	LIBERAL MEN	VR	July 28, 2021	August 11, 2021
61		NA	July 23, 2021	
62	LIBERAL MEN	VR	August 1, 2021	August 10, 2021

Note. NA refers to participants who did not return to the post-test; hence, they were eliminated.

Appendix F

Consent form (Spanish only)

FORMATO DE CONSENTIMIENTO

Título de la investigación: Tecnologías inmersivas y aptitudes políticas sobre el desarrollo sostenible/Immersive techonologies and political attitudes towards sustainable development (pendiente a cambio)

Investigador: José Noé De Ita Zavala

Asesor de tesis: Ronald Guy Emerson

Institución: Universidad de las Américas Puebla

Has sido invitado a participar en esta investigación. Para que puedas decidir si deseas participar o no en este proyecto, debes de conocer la naturaleza del estudio. Este formato describe el propósito, procedimiento, privacidad, beneficios y riesgos de la investigación. La investigación sigue los principios éticos de la declaración de Helsinki.

Descripción del proyecto

Este proyecto se realiza con el propósito de conocer los efectos de consumir periodismo de realidad virtual en aptitudes políticas, en específico, sus efectos en las aptitudes respecto al desarrollo sostenible.

Procedimiento

Se te citará en dos ocasiones de manera presencial. La primera fase consta de una evaluación (a partir de cuestionarios) que se llevará a cabo entre el 12 y 24 de julio de 2021. El tiempo estimado de la primera participación es de 25 minutos. En la segunda cita entrarás en contacto con periodismo de realidad virtual. Habrá dos grupos de participantes. El primero utilizará lentes de realidad virtual y el segundo verá el contenido en un monitor de computadora. Tú podrías ser parte de cualquiera de los dos grupos a partir de un sorteo aleatorio. Al finalizar la observación responderás un cuestionario. El tiempo estimado de la segunda participación es de 30 minutos.

Riesgos e incomodidades

Utilizar lentes de realidad virtual podría, en algunos casos, generar mareos. En cualquier momento, si experimentas tales incomodidades, puedes suspender tu participación.

Beneficios

La investigación es relevante porque ayudará a comprender el rol que podrá ocupar el contenido realidad virtual para la construcción de aptitudes.

Confidencialidad de información

Toda la información recolectada en este estudio es confidencial. Tus respuestas jamás estarán ligadas a tu nombre, sólo necesitamos un número de participante.

Uso de datos para futuras investigaciones

Los datos recabados podrán utilizarse en futuras investigaciones sin la necesidad de una firma de consentimiento adicional, siempre manteniendo la confidencialidad de los participantes.

Compensación

Las personas que participen en el pre-test recibirán como agradecimiento acceso a un *coffee break*, así como un paquete de aperitivos. Los participantes que completen el post-test recibirán acceso a un *coffe break* y un *kit* de dulces típicos poblanos.

Datos de contacto

Si tienes alguna pregunta referente a la investigación, puedes contactar a José Noé De Ita Zavala al correo noadzavala@gmai.com o llamando al +52 2221741338.

Al firmar, se acepta que:

- Has leído este formato de consentimiento y se te ha dado la oportunidad de resolver tus dudas.
- Se te han explicado los riesgos de la participación.
- Eres una persona mayor de edad.
- No tienes una condición médica física o mental de gravedad (como epilepsia, esquizofrenia, enfermedades cardiacas, etc.) que prohíba el consumo de realidad virtual.
- Tu participación es voluntaria.
- Si presentas malestares, puedes pausar o abandonar el estudio al momento que lo desees sin penalización alguna.
- Se te otorgará una copia de éste formato al final de tu participación.

Nombre: _____

Firma: _____

Fecha: _____