# TravelGalleria: Supporting Remembrance and Reflection of Travel Experiences through Digital Storytelling in Virtual Reality

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## Abstract

Travel is a powerful yet fleeting experience that can shape personal perspectives and support self-reflection. To recapture the essence of travel, we explored the use of VR as a medium for immersive re-experiencing with an emphasis on storytelling. We developed TravelGalleria, a VR authoring tool that allows users to curate personalized digital galleries. TravelGalleria encourages creative expression, enabling users to use audio narration, annotations, spatially arranged photos, and more to recount their travel stories. A probing user study with TravelGalleria (n = 20) showed promising trends toward emotional resonance and introspective learning. Our findings illustrate how our tool supports users in remembering, reliving, and deriving new insights regarding past experiences, as they were able to reconnect with emotions and themes central to their travels. We discuss these findings in the context of meaningful digital experiences and storytelling in reflective digital practices, highlighting design suggestions and open areas for future research.

## CCS Concepts

• **Human-centered computing** → **Empirical studies in HCI**.

## Keywords

travel, virtual reality, digital storytelling, reflection

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## 1 Introduction

Among people's lived experiences, **travel** stands out as a significant activity that individuals often document and revisit [72, 107]. Leaving a familiar environment behind to immerse in a new setting (with a potentially new culture or language) can open one's eyes to the differences in the world and promote thinking from new perspectives. Travel experiences are meaningful — they involve the construction of a new self-identity and heighten one's self-perception; travel has the potential to facilitate personal growth and development [48, 72, 107]. Reflection on travel can be enabled through various approaches, such as taking pictures, writing journals, or telling stories [7, 24, 101].

**Digital storytelling**, in particular, has increasingly emerged as a powerful practice where participants develop narratives and digital experiences using various pieces of multimedia artifacts [80, 82, 110]. Its success lies in the flexibility and accessibility of digital media, as well as the overall characteristic of active engagement. Digital storytelling allows anyone to become the creative narrator of their story [110], and the vividness of digital images enhances their immersion [110]. Digital storytelling has been actively employed as a developmental tool in the fields of education [81, 85], tourism [51], research [67], and more.

Tying into the vividness of digital experiences, **virtual reality (VR)** is a medium that offers a high level of immersion and presence within an illusory setting [89, 93]. Consequently, VR can affect people's responses and perceptions in ways beyond other digital channels [93]. A plethora of research has leveraged VR in building experiences for games, tourism, learning, and more [14, 18, 36, 38, 68, 87, 112]. While the research community has heavily explored VR for engaging in completed, built experiences, it has been less explored as a medium to facilitate active creation — in curating an immersive virtual space and fostering a narrative story from scratch [3]. In our work, VR helps simulate this immersive, personalized space that might otherwise be inaccessible to users — VR provides a 'simulacrum' of broader storytelling environments, supporting the ludic creation of travel narratives in an artistic, user-generative manner.

The combination of these aforementioned concepts — the importance of reflection on travel, the use of digital storytelling for reflection, and the potential for VR to tell stories — lays the groundwork for the present research on understanding how people tell their travel stories in immersive VR environments. Our study focusses on addressing the following research questions:

- **RQ1**: How can immersive VR and embodied VR tools uniquely help people develop a travel narrative?
- **RQ2**: How does creating digital stories in VR influence one's perceptions of and reflections on past travel experiences?
- **RQ3**: How can insights drawn from RQ1 and RQ2 inform important design considerations for storytelling and travel reflection tools?

To address these research questions, we developed a system to support digital storytelling in VR. This system, called **TravelGalleria**, is a VR authoring tool that follows a gallery metaphor. TravelGalleria transforms a user's travel images into interactable


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elements in VR. Along with a suite of other features such as audio narration, text panels, and annotations, users can develop a full-fledged VR *experience*; one they can immersively explore while playing with interactive elements to tell the story of their travels. We used TravelGalleria in an exploratory probe to investigate how people use our system to narrate their travels. Through creating their travel gallery, participants immersively reminisced on their documented memories and reflected upon new insights into their relationships with travel. We outlined the importance of user-centric curation during reflection, examined the use of VR as a reflective medium, and discussed how our work fits within existing methods of travel documentation and reflection.

## 2 Related Works

To contextualize our study, we first explore what makes travel meaningful and how people interact with their travel documents. We then consider digital storytelling and how this process is mediated through digital affordances. Finally, we consider VR as a medium and its potential suitability for reflection and meaning-making. To preface, reflection in HCI contexts can be a slightly nebulous term [6], but we interpret it as focussing on the breakdown of situations, inquiry of past processes, and transformation of experience into learning [5].

### 2.1 Travel Experiences and Reflection

People tell stories and form narratives around all experiences throughout their lives, but we uniquely chose to focus on travel for several reasons. Firstly, travel is an activity that has the potential to promote aspects of self-discovery and introspection [107]. Gill and Packer discuss how the motivations for travel can promote meaningful self-reflection, and how travel artifacts such as photographs can be a salient reminder or reflection of the past [72]. Fayos-Solá et al. outline how travel appeals to both the eros — the appetite for enjoyment, and the epistemophilia — the desire for learning and education; they also discuss how travel can build meaningful experiences [29]. In particular, Kang outlines how meaningful travel relates to the interconnected relationship between the travel experience and daily life — this is mediated by the traveller's feelings and emotions in the moment [48].

Furthermore, travel is an experience that people tend to document, especially digitally through photos and videos [24, 28, 56, 74]. Research has shown how such documents can be a means of sharing one's meaningful life in a 'public diary' [24], but also of conveying personal stories to oneself [7]. Tying towards this latter introspection is the practice of travel journalling. Keeping a journalled account of one's travels not only allows one to recount and recreate the physical qualities and sensory immersion within the landscape, but also reconnect with and reflect upon one's self-identity [104]. Beyond written accounts, travel journals can use illustrations or pictures to capture details [2, 78], constructing an immersive narrative or 'story' regarding the trip [100].

Some prior works have focussed on using technology for travel reflections, e.g. the work of Wan et al. [101] and Karaturhan et al. [50]. Such systems are also available in present technologies, e.g. Apple's Memories feature[1]. However, none of them have used virtual reality as the core medium for active creation and curation, which we focus on in our study. All in all, we consider travel to be an ideal experience to study — it breaks the usual status quo of identity and setting, it is meaningful within one's life, and it is often well-documented through visual means.

[1]https://support.apple.com/en-ca/118279

### 2.2 Digital Storytelling

From a pedagogical perspective, digital storytelling is an artistic practice involving the development of a video story using multimedia digital artifacts and narratives [22, 32, 45, 82]. However, more broadly, digital storytelling could simply be taken more literally as using digital technology for narrative expression [67, 80, 110]; allowing any average person to become a creative storyteller. Xu et al. outline the power of digital storytelling in its flexibility (versatility in media technologies to create a non-linear story), universality (accessibility to nearly anyone), and interactivity (active participation of the user) [110]. The aspect of digitality is important, as in virtual worlds, images and stories can be presented more vividly, making them more similar to that of the real world [110].

Digital storytelling has been actively applied in different fields. In education, it can make students more attentive and provide a unique expression of ideas, thoughts, and life events while facilitating learning [81, 85, 110], in cultural tourism, it can help re-create lost experiences [51], and in research pedagogy, it can support the meaningful curation and sharing of data artifacts [67]. From an eudaimonic perspective, building personal stories allows people to structurally describe challenging events, imbuing a power and meaning towards their experiences [16, 83, 90]. Hakanurmi describes how narratives constitute people's personal identity and that formulating narratives gives human life structure and meaning [40]; Morgan suggests that the process of doing so involves abstracting the real world into narrative elements [66]. Similarly, Lewis highlights the imperative nature of storytelling in human understanding [55]; stories become active vehicles for meaning-making, allowing people to make sense of their lived experiences [16, 55]. We take inspiration from these learnings in our work, encouraging users to narrate their travel stories using digital units of lived experience, such as photos and voice recordings. Our work extends on prior research to convey the importance of storytelling within research, especially within the paradigm of third-wave HCI [8], which emphasizes HCI practices that are humanistic, value-based, and meaning-making approaches.

Although VR has been studied as a medium for conveying stories (e.g. through games or similar experiences) [14, 18, 36, 68, 87], it has been less studied as a medium for actively creating them — an essential part of digital storytelling. Some prior works, such as Wang et al.'s VR journalling application, has examined VR's potential for self-regulation and awareness [102]. Our research extends on this foundation by allowing users to be active creators of their own travel stories.

### 2.3 Storytelling, Reflection, and Curatorial Practices in Immersive VR

Virtual reality (VR) enables users to immerse themselves in a virtual world, with embodiment and presence as core features of the medium — creating the sensation of existing within the virtual

setting [53, 89]. Extensive research has been conducted on these affordances and how they influence VR applications [4, 88], and researchers have taken advantage of these characteristics to apply virtual reality towards a variety of domains, including pain relief [65], therapeutic systems [108], or entertainment mediums [73]. Presence often ties further into immersion — based on the sensory fidelity that the system provides [9], users feel as though they are in the virtual world. Overall, VR offers an illusory setting that influences the user's response and perception derived from a belief of being present [93]. Such immersion can also aid in recall, as highlighted by the memory palace metaphor [54].

Based on its affordances, VR can be a fitting medium for immersive storytelling. Bucher considers how the presence (relating to the player-as-a-camera perspective) in VR affects how immersive stories are developed and delivered [12]. Bucher also highlights how the development of immersive narratives in VR mimics a dialogue or a dance rather than being a forced experience, with the viewer having a clearly defined role in the space [12]. Along these lines, research has considered the use of VR storytelling concepts in journalism for immersive first-person delivery of news [23], in games to improve physical activity engagement [58], or in education to facilitate interactive and engaging experiences [43]. In museum and digital heritage environments, research has studied the value of storytelling in VR to communicate and engage effectively with visitors [34, 52, 64, 75]. Gifreu-Castells, in particular, emphasized the importance of understanding objectives, themes, technology, and space in curating for VR exhibits [34] — core aspects we consider in our design of TravelGalleria.

Our work encourages users to actively participate using embodied VR tools to generate their travel narrative. This harks towards Vallance and Towndrow's concept of 'storyliving' — highlighting the participant's role in the VR experience [98]. As physical and virtual spaces overlap, Saker highlighted how VR can immersively *simulate* a physical world [86]; yet Han highlighted how VR can create unique generative representations of space [41] that convey meaning beyond real-world analogues [42]. The abstraction of space also suggests a particular sequence and temporal flow as users navigate through the virtual environment [1]. This influences pacing and progression, which can guide a general narrative structure [96, 103] and influence how stories are constructed.

In our work, VR simulates an immersive, diegetic space similar to the 'democratic surround' [39, 97] — immersive multimedia exhibits that induce learning through personal perspectives. Similar to such explorations within tangible space (e.g. Shiva's Rangoli [37]), VR has seen promising use for reflective, insightful experiences. For instance, VR's stimulation of multiple senses and its realism in simulation can support mindful practices [30]; VR's potential for perspective-taking can help cultivate reflective skills [27, 94]. Reflective interventions specifically designed around VR include Wagener et al.'s MoodShaper [99] and Rasch et al.'s Mind Mansion [79], which leverage VR to address negative experiences, as well as Shen et al.'s LegacySphere [92], which uses VR to facilitate intergenerational storytelling. Jiang and Ahmadpour highlight how VR-specific design strategies can support reflection, drawing upon people's readiness for reflection (shifting their mindset), immersive estrangement (distancing themself from the virtual world), observation and re-examination (reflecting critically upon the world), and repatterning of knowledge (transforming familiar personal elements) [47]. As our work aims to immersively offer a space for people to re-explore and re-examine experiences that are familiar and likely meaningful to them in a new way, we appropriate elements mainly from the latter design strategy. This further ties into MacIntyre et al's idea of 'aura' — in that spaces are imbued with meaning in part due to their personal significance and connection with the user [59].

All in all, story generation in VR has been explored in Ostrin et al. [71] and Bahng et al. [3]. Bahng et al., in particular, focussed on participants creating VR representations of personal experiences to express feelings and represent inner worlds [3]. Building on VR's potential for storytelling, how can curatorial principles from digital storytelling inform the design and assessment of a system in which people can design their own narrative experiences?

## 3 TravelGalleria — System Design

To investigate our research questions, we designed TravelGalleria, a VR tool that allows a user to author and experience an immersive narrative. We briefly discuss the metaphors that influenced its design as well as some key features.

### 3.1 Design Metaphors

The concept of 'digital storytelling' can sometimes espouse a free, unstructured approach beginning on a blank canvas. However, a light amount of guidance can be helpful in otherwise largely unstructured activities, for example, guiding questions in journalling [17, 25]. As such, we provided this guidance through familiar metaphors for users who may not know how to even begin.

The first metaphor, the **mind map**, aimed to address the question of organization and coherency. We wanted users to have a way to initially organize their travel documents, which may be largely scattered and random, into more coherent groupings. Mind maps were a helpful tool for this task — they help cluster different perspectives regarding a central subject through deliberate engagement and consideration [26, 105]. We implemented a mind map process in VR to help users initially structure their travel experiences within theme groupings, centred around the foundational subject of travel (see Figure 1a).

The second metaphor, the **gallery**, aimed to address a potential issue of spatial structure. Without any structure, users may be lost in terms of what to do; the familiarity of a gallery serves as a basic structural template. The gallery is a useful metaphor because it still affords a high level of customization and interaction drawn from the activity of *curation* — in which users must decide what to put in a gallery, how to arrange them, etc [91]. VR galleries have been explored in literature [19, 95, 113, 115], but the act of actively creating one and curating its content is less examined [76].

Our gallery metaphor also borrows from concepts from **walking simulator games**. To preface, games in general are a powerful medium for encouraging learning about past experiences and personal identity [21, 33, 44, 46, 114]. Walking simulator games, in particular, emphasize exploration, storytelling, and environmental interaction; they are often lauded for their aesthetics and artistry as well as their penchant for reflection and emotional expression

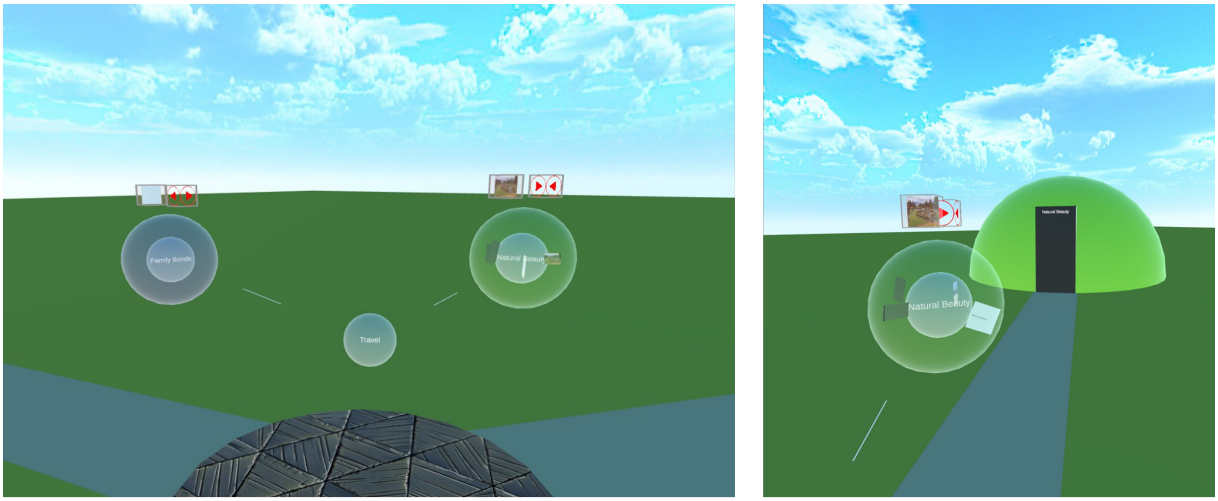


**Figure 1: Our VR implementation of the mind map metaphor. Subimage (a) shows user-created thematic spheres centred around a central theme sphere of travel. Users can assign a background and audio to the theme, as well as change its colour and text. Users add documents to the theme by dragging and dropping them into the sphere, where they orbit inside. Subimage (b) shows how each theme sphere corresponds to a dome-shaped gallery collection, which users can walk into to experience that collection — see Figure 2.**

[15, 31]. Design elements inspired by walking simulators, i.e. interactable 'memories' and audio narration, were appropriated to encourage the development of story-based narratives regarding the travel experience.

Overall, our metaphors form the basis of the requirements of the TravelGalleria system. With digital storytelling as a foundation, we wanted to take advantage of this activity's potential for **personal customization** and **expressiveness** through multiple forms of media. However, our implementation of familiar metaphors in the mind map and gallery aims to provide users with a level of **supportive guidance** in their storytelling journey as well, forming a semi-structured paradigm for creation.

## 3.2 System Design and Features

In this section, we briefly describe the core features of the TravelGalleria system.

*3.2.1 Themes Map to Collections.* Our simple mind map analogy allows users to create themes, each corresponding to a collection of curated content, as in Figure 2. This mind map connects thematic spheres to the central overarching concept of travel. Each thematic sphere represents an individual collection of the gallery, depicted as a dome with a door (see Figure 1b). The spatial arrangement of the mind map directly correlates to that of the gallery — the more distant a theme sphere is from the central theme for example, the more distant that corresponding collection is, and the angle between collections matches the angle between theme spheres. As such, the mind map quite literally forms the map of the gallery when projected to 2D.

To organize their documents under these themes and have them initially appear in the associated collection, users can drag and drop their photos and videos into these thematic spheres; this causes them to orbit within the sphere. Additionally, users can set the background of a collection as one of their input images, which we display as a panoramic view. Users also have the option to add audio to their themes to explain why they chose the specific theme and why it is meaningful. This audio plays upon entering the specific collection, similar to trigger-based audio narration in walking simulator games.

*3.2.2 Interactive Travel Documents.* Users' travel documents are transformed into interactable elements in virtual reality — users can grab, move, resize them, etc. following a usual suite of VR interactions. We also have the option for people to record and associate an audio clip with each document element to expand on context or tell the story of the document (akin to an audio guide, drawing from the gallery metaphor).

*3.2.3 Multimedia and Personalization Features.* We incorporated various decorative features to leverage the multimedia nature of virtual reality and offer additional ludic creativity in customizability and aesthetics. To mimic text panels in museums, we added interactable text that the user can either type in using a keyboard or use speech-to-text (using whisper.unity[2]). Users can also record and create 'audio cubes' that are simply floating cubes that replay the user's spoken audio when pressed. These interactable features (text panels, audio cubes) can be seen in Figure 2. Users can additionally use a VR pen to create annotations, either freely in space or directly onto their photos or videos (Figure 3a). Finally, users can augment

[2]https://github.com/Macoron/whisper.unity

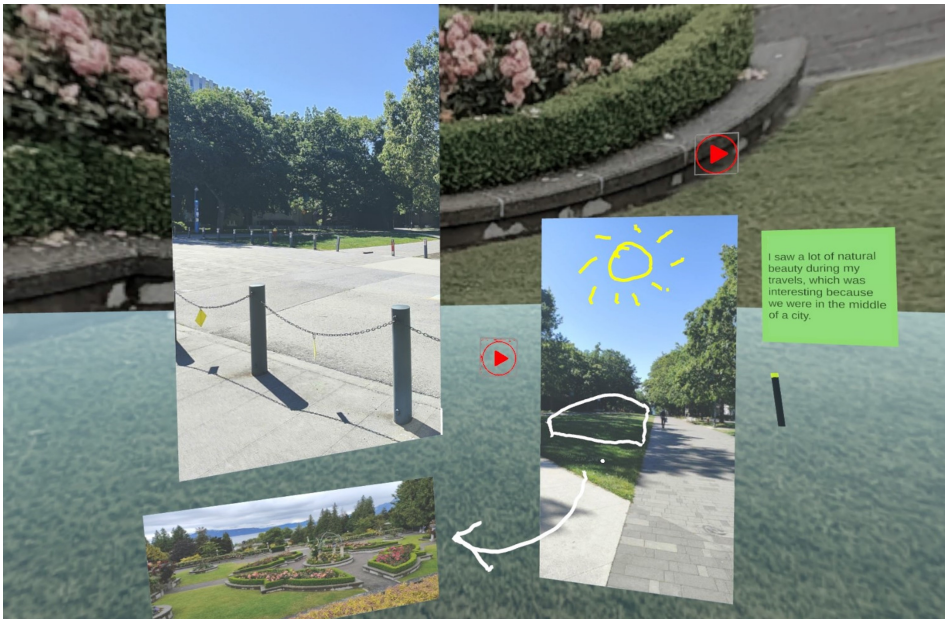


**Figure 2: Inside a collection, users can freely manipulate the documents, additional decorations, and multimedia to curate the gallery.**

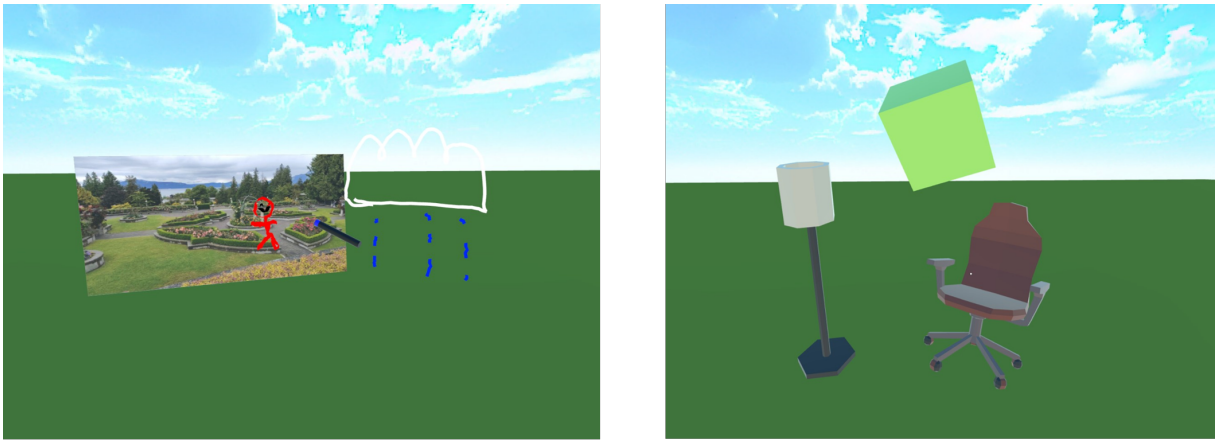


**Figure 3: Some examples of decorative features available to the user — (a) annotations (both mapped onto the travel document or in free space) and (b) furniture and shapes.**

the aesthetics of their collection with a small library of shapes and furniture[3] (Figure 3b).

## 3.3 Hardware and Software

TravelGalleria was developed using Unity Version 2021.3.33f1 and runs completely locally. In terms of hardware, we used a Meta Quest 2 connected to a Windows computer using Meta Quest Link. We tested the system on two computers, one with an NVIDIA RTX 3080 graphics card and one with an NVIDIA GTX 1070 graphics card.

[3]https://assetstore.unity.com/packages/3d/props/furniture/low-poly-simple-furniture-free-240197

# 4 User Study

We performed a user study using TravelGalleria, which served as an exploratory probe into the potential of VR for travel reflection. Participants used the system to create their gallery based on their travel documents and answered questions to assess how the experience affected their reflections and perspectives.

## 4.1 Participants

Participants were recruited through a mix of convenience sampling and a posting made on our institute's paid studies list. The eligibility criteria for our study were to be 18 or older and to have documented travel experiences in the form of digital photos and videos that they would be willing to bring in to share for the study. We allowed users to bring documents from several trips because we wanted them to tell the story of their overall travel experiences and their impact on their lives, rather than focus on a specific trip or location. We were able to recruit a sample of 20 participants (age: mean 27.2, min 20, max 44; gender: 11M / 9F), which we evaluated to be an adequate number based on our subjective evaluation of information power [61] as well as prior local standards [13]. Participants were asked about their travel frequency — 7 participants reported travelling about once per year, 10 reported travelling a few times per year, 1 participant indicated travelling about once every few years, 1 participant reported travelling about once per month, and 1 reported travelling a few times per month. For VR use, 2 participants never used VR, 15 had used it once or a few times in the past, and 3 indicated VR use at a frequency of about once per week. Before the study, we contacted participants to provide a brief introduction and asked them to bring the travel documents they would like to use in the study. We also asked participants to read, review, and sign a study consent form, which outlined the ethics, risks, and data usage of the study; prior approval was provided by the institute's ethics review board.

## 4.2 Study Protocol

Upon arrival, the lead researcher provided each participant with an initial introduction to the study and the system. The researcher walked the users through the system features, how to use different menus, etc. After this initial tutorial, the participants were given the bulk of the session time to create their gallery; the researchers were largely hands-off during this time. After creating the gallery, we asked the participant if they could create a snapshot of their created gallery for future analysis, which they could do through an in-system menu.

In the remainder of the session, participants were asked to fill out a demographic survey as well as a study survey with Likert-scale questions, and then participate in a short semi-structured interview about their experience with the system. The demographic survey queried the participant's age, gender, frequency of VR usage, and frequency of travel. The Likert-scale questions were a mix of general, researcher-designed questions tied to the initial research questions, as well as the R2T2 scale [57] (see Table 1 for a summarized table of metrics and the supplemental material for full results). The R2T2 scale focusses on understanding how pieces of technology support one's thinking about oneself, consisting of three subscales regarding metrics of reflection, rumination, and self-focussed thinking. The interview questions largely expanded on our questionnaire questions, digging into specifics regarding each participant's thoughts about the system, their creation process, and their perception of travel memories and reflections. Audio recordings of the interview were collected with participant consent. All in all, each user study session took approximately 90 minutes in total, and participants were compensated $24 CAD for their participation.

## 4.3 Data Analysis

As our data collection artifacts were largely framed around our research questions, our data analysis follows suit. Our findings are presented in a way that addresses our first two research questions, with quantitative evidence from the questionnaire data and qualitative support from the interview data. As the interview data was already largely derived from specific research questions, the primary researcher analyzed this data through a deductive thematic analysis focussing on experiential, semantic content [11]. This process began with an initial semantic coding of the data; the code labels were then grouped hierarchically into categories (see supplemental material) that formed the developed themes that addressed our research questions. The primary researcher conducted the analysis but with discussion with the other author in the research team (noting that this can be a limitation when it comes to coder bias).

# 5 Results and Findings

We present the results of our user study. Section 5.1 focusses on the experience of using TravelGalleria, highlighting how our VR system and the provided immersive tools helped users in creating their travel stories (addressing **RQ1**). This section ties primarily towards the design and functionality of TravelGalleria. In Sections 5.2 and 5.3, we consider how the active creation process of a travel gallery affected participants' perceptions and memories of their past travels, as well as supported new reflections and introspective insights (addressing **RQ2**). These findings are more system-agnostic, situating TravelGalleria within a broader conceptualization of travel reflection in immersive environments.

## 5.1 The Experience of Creation

Most participants enjoyed using TravelGalleria to tell their travel stories, reflected both in the quantitative results (Q1: mean = 4.20; Q2: mean = 4.20) and the qualitative interviews. Participants also found the system easy to learn and use (Q3: mean = 4.05). In the following sections, we delve deeper into the specific details of TravelGalleria's design.

*5.1.1 Design Metaphors and Semi-Structured Paradigm.* Almost all participants were positively receptive to the semi-structured paradigm of having a base metaphor with guidance to build out their experience. The initial task of grouping documents into themed collections of travel was well-received as a helpful way to organize one's thoughts (Q6: mean = 4.05), and as it offered people a place to begin — *"it gives you a place to begin with in terms of reflecting"* (P2). Participants explored this grouping task in different ways. As examples, P11 discussed how their categories arose from geographic features — *"There's one category of pictures which are the activities and travels to places in the mountains or in the forest, and then another category of things that are based around water ...then the third category was like urban environments"* and P2 discussed how their categories were more tied to reasons they enjoy travel — *"I realized that those 3 themes were kind of key elements of why I enjoy travel"*. This latter quote highlights how this initial active grouping exercise helped facilitate introspection, which we expand upon in subsequent sections. Compared to a completely unstructured approach where the users might start with absolutely nothing, P10

**Table 1: Summary Statistics of the questionnaire questions. The mean (standard deviation in brackets) for each question is presented. The Likert scale questions were presented on a scale of 1 = strongly disagree to 5 = strongly agree.**

| Question ID | Question | Mean (Stdev) |
|---|---|---|
| Q1 | I enjoyed using the system to create a gallery | 4.20 (0.62) |
| Q2 | The experience was engaging and fun | 4.20 (0.70) |
| Q3 | The system was easy to learn and use | 4.05 (0.69) |
| Q4 | The act of creation helped me reflect on my travel experiences | 4.15 (0.67) |
| Q5 | I gained new insights about my travels through creating the gallery | 3.25 (0.85) |
| Q6 | The ability to place my documents in initial themes helped me organize my thoughts | 4.05 (0.76) |
| Q7 | The ability to organize objects spatially helped me tell my travel story | 4.20 (0.62) |
| Q8 | The breadth of additional elements available in the VR gallery (i.e. furniture, shapes, pen) enhanced my narrative creation | 4.00 (0.79) |
| Q9 | The experience helped me recall details and emotions from my travels | 4.15 (0.93) |
| Q10 | My perceptions of my past travels were affected during the creation process | 3.25 (1.21) |
| Q11 | I would like to share this VR travel gallery with my friends or family | 4.15 (0.99) |
| Q12 | Sharing my VR travel gallery would help me connect with others over my travel experiences | 3.95 (1.10) |
| REF1 | Using this technology made me conscious of my behaviours | 3.65 (0.99) |
| REF2 | This technology helps me to be able to reflect more easily on my actions | 3.85 (0.88) |
| REF3 | This technology supports reflecting on my behaviours as an ongoing activity | 3.65 (0.81) |
| RUM1 | This technology can put me in a negative thought cycle | 1.75 (1.02) |
| RUM2 | This technology makes me more likely to ruminate about a past situation | 3.45 (1.23) |
| RUM3 | Using this technology can make me ruminate or dwell over things that happened for a long time afterward | 2.85 (0.93) |
| THK1 | This technology makes me feel that it is important to me to understand what my feelings mean | 3.40 (1.05) |
| THK2 | This technology supports me in usually knowing why I feel the way I do | 3.20 (1.06) |
| THK3 | This technology makes me feel that it is important to me to be able to understand how my thoughts arise | 3.35 (1.18) |

mentioned *"if you build everything from scratch, sometimes you spend much time thinking... you can easily get absorbed into some details and lose the big picture"*.

Even though TravelGalleria guides users in creating their gallery, its semi-structured paradigm still adopts a high degree of active creation. Participants contrasted this against fully automated, algorithmic approaches to reviewing travel, such as Apple's Memories feature, finding active curation to be more engaging and meaningful. P2 states that algorithmic-generated content spoon-feeds them, whereas TravelGalleria supported *"going through and picking out the experiences that you enjoyed and picking up the memories that are meaningful to me"*, P11 mentions that *"I don't like the system trying to read me"*, and P12 suggests that *"there's no meaning behind what the algorithm comes up with"*. In contrast, P18 states that in our system *"you are the one making meaning of the photo versus the algorithm"*. This supports the results of Q4 (mean = 4.15) which shows active creation is important in encouraging reflection (we expand on reflection in Section 5.3). In TravelGalleria, active creation was facilitated by the interactivity of the VR medium.

Although our semi-structured approach was largely appreciated by most users, alternatives were presented as well. P3 wanted a more rigid, templated approach that could be algorithmically generated — *"I would prefer not to create it myself... me personally, I don't like to like to consciously create a memory like this"*. Others expressed a preference for a system freer in creative expression, e.g. *"there should be a sandbox version"* (P13), as the guiding metaphor *"may limit someone's preference"* (P5).

*5.1.2 Creating a Travel Story using VR.* Using TravelGalleria, users manipulated their travel documents (photos and videos) to curate their gallery collections. P1 stated that *"photos are the main media of telling the story"*, and participants mentioned the importance of looking back at their old documents to remember and reflect, e.g. *"it would help me reflect on my travels just because it forced me to look*

*at old photos"* (P8). The idea of exploring at different perspectives, sizes, and spatial possibilities was uniquely afforded by VR. People generated unique spatial perspectives of their travels that felt more interactive and immersive — *"Covering my full field of view... I think that it makes the images feel a lot more personable. It really helps me remember what I was actually going through during those times"* (P2) and *"the bigger the size of the photos was pretty nice... it feels more immersive that you're actually there"* (P15). Using a photo as the panoramic background of the room allowed P20 to feel like they were immersed *"in the background"*. Users contrasted the medium of VR against other mediums of explored photos, outlining how immersion in VR positively promoted engagement — *"if I was curating online or something that gave me similar tools but on the mouse, I don't think it has been engaging as [TravelGalleria] was"* (P8), remembrance — *"I can sort of see them together, not just like swipe through them on a phone screen. It really helps me relive what that experience was like"* (P2), and interactivity — *"I actually found it really fun, like playing around with all these features... very, very interactive as opposed to iPhone"* (P13).

Participants experimented with the multimedia storytelling features provided by TravelGalleria — audio narration, annotations, text, and so on — to augment their existing documents. TravelGalleria's audio feature, in particular, was a useful tool for people to narrate their stories beyond visuals — *"When I'm describing what happened, it helped me to remember things and it helped me to reflect on my feelings and in certain scenarios I can get a new perspective of seeing that moment"* (P1), and *"if you add an image and then you add a voice-over then you can actually explain to the viewer what the image means to you"* (P13). These ludic multimedia features also allowed participants to add ambience and personal flavour to galleries, e.g. P13 talks about how they liked the scribbling *"because it gives me freedom to add things"*, liked the text *"because like I like poetry, so I can add small snippets of poetry"*, and would want to expand the audio to *"add audioscapes... for example, that picture of the flower with the droplets, it would be nice to add drizzling water"*. P10 indicated that the furniture selection allowed them to create a relaxing ambience and P8 discussed how colour influenced their gallery — *"I appreciated being able to map colours to concepts... when I'm in the environments and when I think of the memories that I have from the pictures that I aligned with those colours"*. Overall, participants appreciated the breadth of features available in TravelGalleria, which helped in enhancing narrative creation (Q8: mean = 4.00).

Moving to a broader view of storytelling in VR, one of the idiosyncratic affordances of VR as a medium is its unique representation of spatial semantics. We found that the spatial arrangement of elements possible in VR was imperative and helpful in telling participant stories (Q7: mean = 4.20). As a few examples of the different ways of using space in VR, P5 described a temporal arrangement of documents in their collection — *"I grouped it sequentially in time"*, P8 grouped documents by visual colour — *"I focus more on just like these photos have similar colours"*, and P3 created a collection that focussed on guided movement within the collection — *"I'm gonna just do it... as if someone is walking through those experiences, you know? Going from the train and then going inside the sea and then having some food on the table"*. P12 and P15 expand on how space itself in the virtual world can be a dimension of a story — P12 stated that *"I wanted... my spatial arrangement to tell a bit of a story, even if a person might not get the story"*, and P15 mentions that *"making something really big versus really small... that can, in an abstract term, convey a story about important things"*.

## 5.2 Perception, Memories, and Remembrance

Whereas the prior findings were more specific either towards our system or the VR medium, the remainder of the findings are related to the system-agonistic *act* of storytelling. Building a gallery of travel documents allowed participants to relive their past experiences, and users recalled details and emotions from their travels (Q9: mean = 4.15). P12 mentions that they were able to *"think back on their travel experiences"* and distill the important themes and ideas — *"I noticed that most of the time a lot of my memories are associated with having fun"*, continuing by stating that *"every time I was like playing around with the photo or whatever, I was thinking about the context of what, how that photo came to be, what situation I was in, and it just made me feel kind of really happy"*. This aspect of recalling memories and emotions was echoed by almost every other participant, e.g. *"when I'm looking at this picture again and I try to organize it in this room, I kind of retrieved the emotion when I first saw it"* (P10), *"that was actually a memory I had completely forgotten about it, and it was like it made me think back to how I felt. And it was like a very fond memory and pleasant to remember"* (P11), and *"it was honestly a kind of a powerful experience for me because I have had like some memory issues over the past little while... reliving those memories and experiences and sort of reminding myself how much I enjoyed them"* (P2). P15 mentioned that remembrance of the picture combined with the immersion of the VR system almost stimulated a physiological effect — *"it kind of took me back to the day because it was pretty hot. So I felt hot while looking at the photo as if I was there"*. Overall, TravelGalleria was successful at promoting remembrance and emotional resonance with prior travel memories. Ludic storytelling elements also helped encourage remembrance, such as audio *"[it] makes you reflect on how you're feeling when that happens, having that audio aspect"* (P18) or annotations *"[using] the pen to highlight the parts of the images that remind you of something interesting or trigger a fun memory"* (P1).

Most participants indicated positive feelings when looking back, but we found that the feelings upon remembrance were not always the same as the feelings during the instance of travel. P16 and P9 mentioned that remembrance through the lens of nostalgia is different than feelings at the moment — *"if you have fun or you're happy in the moment, then you just feel happy. But if you just look back on that, it's more like nostalgia. It's like you just remember feeling happy"* (P9) and *"it feels good to remember... there's some aspect of the remembering that feels good differently than actually experiencing that thing"* (P16). To highlight this difference between past and present, P1 and P11 were able to reinterpret their potentially more negative memories in a more positive light during the study. P1 mentions that during their trip, they were stressed about work, but they were able to *"distill the happy memories from that time. So actually in this case, reliving is a happier experience"*, and P11 mentions an outdoors trip where they were tired, cold, and scared, but *"looking back, it's different... that was scary, but it was fun. We had good laughs. We pushed ourselves"*. Although these provide

distinct examples of re-interpretation, the impact of TravelGalleria on *changing* one's perception of past travels was still more neutral throughout the studies (Q10: mean = 3.25).

### 5.3 Reflection for New Insights

Whereas almost all participants described the potential for TravelGalleria for reliving and remembrance, we differentiate this from reflection, which focusses on eudaimonic learning and self-knowledge. TravelGalleria as a tool to support reflection was scored more neutral (Q5: mean = 3.25). However, several participants were able to foster a deeper understanding regarding travel experiences and self-identity. P1, who brought pictures from a previous conference, felt that the creation process helped *"provide future guidance for similar events... I want to be more active and confident at those conferences to know people. I feel like I was just too shy at that conference that time"*. P2 and P5 suggested that creation heightened appreciation regarding certain aspects of life, as P2 stated *"it sort of highlights like the common themes amongst all of my travel experiences. It sort of reminds me like why I enjoyed all this travel so much"* and P5 stated that *"I also feel like reminded like, oh, I have nice moments before. Because sometimes if you are back from your travel to a normal life, you kind of feel like, oh, this is my normal life... You can try to remind yourself like yeah, I have nice moments and I will have nice moments later too. The boring daily life is slightly more acceptable"*. P6 provided a different example of introspective thinking, expressing guilt when looking back because of climate tied to international travel. All of these prior examples outline ways in which building an immersive experience and reliving one's travel story facilitated deeper takeaways from self-inquiry regarding one's personal relationship with travel.

We examined the reflection subscale of the R2T2 scale, as reflection was imperative in our initial research questions [57]. Due to the relative recency of the scale, interpretation of the values through comparison or absolute summation is not the most informative at present. However, considering this subscale's individual questions, all three leaned towards agreement (REF1: mean = 3.65, REF2: mean = 3.85, REF3: mean = 3.65). Thus, the results suggest that the active creation through TravelGalleria was conducive to facilitating some level of reflective engagement during the creation process. On the other hand, rumination did not appear to be a major factor. Although participants indicated neutral responses in terms of dwelling on their memories while making the gallery (RUM2: mean = 3.45, RUM3: mean = 2.85), this was not something that would put them into a negative thought cycle (RUM1: mean = 1.75). Participants almost always viewed travel as a positive and joyful experience, and as highlighted prior, even negative moments during travel could be remembered fondly. The responses to the self-focussed thinking subscale were relatively neutral-leaning-positive (THK1: mean = 3.40, THK2: mean = 3.20, THK3: mean = 3.35). This suggests that the creation process did not strongly encourage self-inquiry on feelings and emotions. Overall, the more neutral (though still tending positive) responses, especially regarding the reflection subscale, may be because of the limited time of the study (several participants indicated that time was a limiting factor; especially if they were new to VR and needed to acclimatize to the controls), but it is still promising considering the positive results *despite* the study's brevity.

## 6 Discussion

In this section, we highlight how our findings fit within past research and theory, and outline their significance and implications in various research domains, including reflective technology and travel documentation (addressing **RQ3**).

### 6.1 The Importance of the Individual in Reflective Technology

We highlighted the importance of active storytelling in remembrance and reflection of meaningful travel experiences. Active participation in creating travel narratives was key in curating and building a travel gallery, and this allowed users to select and organize their documents in a personal, authentic manner. The development of narratives is imperative in reflective meaning-making as stories form a hermeneutic interpretation of life events [16, 66, 111]. Morgan outlined how the method of creating narratives involves casting actors in roles, constructing a narrative genre, and drawing metaphors [66]. Our interpretative perspective is that the user of TravelGalleria becomes the main character of their story, and multimedia elements within the environments help construct the genre (e.g. setting the ambience) and draw metaphors (e.g. through spatial grouping or theming). Our decision to provide an active form of creation was inspired by the reflective exercise of *self-inquiry* [6], in our case, into travel motivations and behaviours.

One form of active creative expression that we have highlighted is that of digital storytelling — deliberately using multimedia technology artistically to recount a vivid life story [110]. Artistic self-expression is a powerful reflective activity [35, 49], and our implementation allows users to meaningfully construct their personal travel stories (appropriating the concept of meaningful curation from Mosconi et al.'s work [67]). Viewing digital storytelling as a pedagogical practice, our results highlight that freedom in individual curation and the process' facilitation of individual creative expression show positive results regarding remembrance and reliving of previous memories, supporting prior work. The emphasis on the user's active creation translates the process of storytelling in VR towards an initial form of 'storyliving' [98], which further extends meaning-making processes as the virtual environment becomes personalized through deliberate intention. Such exercises can facilitate reflective and engaging learning through storytelling, which can potentially be important parts of education and teaching [43]. Incorporating autobiographical elements into VR storytelling could be important in reflective learning, both on one's own experience and taking the perspective of others [10].

All in all, we highlight that **having the human as the fundamental agent of control for creation is important when it comes to technology supporting reflection and meaning-making**. This agrees with prior work — Lewis highlights how individual, personal stories are central to human meaning, existence, and understanding, yet are lacking as a concept within academic research [55]. The human is the central figure in meaning-making processes, and this harks back towards third-wave HCI, which represented a shifting attitude from developing tools for productivity

into developing experiences that embrace personal holistic livelihood and convey individualistic meaning [8]. This paradigm of HCI is particularly important at present considering an increasing number of creative domains are abstracting away the human (e.g. art or writing); we argue that having the human in the loop for reflective technologies is crucial. Furthermore, **meaning-making systems should support a person's autonomy**; people should decide for themselves what concepts derive meaning for them. In our research, the human protagonist is simply mediated by the digital system (TravelGalleria) to tell their personal story, similar to Bahng et al.'s exploration [3]; the emphasis on human-focussed active creation allows users to remember, reflect, and find meaning in their overarching experience in ways that an algorithmically-generated analogue may fail to support.

However, some participants still expressed a preference for automatic generation. TravelGalleria is designed to support reflection, yet the motivation to reflect needs to come from the users themselves. Reflection also takes time and effort, and TravelGalleria specifically provides a step-by-step process which could potentially make the task seem burdensome (tying towards a similar consequence in Karaturhan et al. [50]). Future extensions could thus consider balancing the level of user effort with the reflective value of travel reflections. One possible effort could be through AI-assisted co-creation [69], where nuanced AI guidance complements human meaning-making [109].

## 6.2 VR as a Medium to Support Storytelling

The immersive and interactive nature of VR supported personal remembrance and reflection. Furthermore, the 'spatial semantics' of VR was a key element that aided in people's immersive storytelling experiences; one which starkly contrasts most participants' experiences with simply viewing their travel photos on their phones or computers. An interactive, immersive world allowed users during our study to reshape their documents and view them from different perspectives, aiding remembrance and recall. Using both travel documents and our suite of embodied VR tools, users represented their travel themes and associated emotions uniquely in VR space. Some users were able to tie their themes back towards the eudaimonic outcome of understanding themselves; representing reflection beyond recall [6]. As such, TravelGalleria mainly intersects Jiang and Ahmadpour's reflective design guideline of 'repatterning of knowledge' [47] — users personalize the relevant setting (their gallery collections) and use individualized artifacts (their documents) to remember and re-interpret their memories. This forms an initial foray into the reflective process based on their outlined framework; future research could more deeply explore other outlined designed strategies such as 'readiness for reflection' or 'immersive estrangement' to further enhance the level of reflection for our system [47].

When discussing the motivating rationale for VR as a reflective and meaning-making tool, many past works have focussed on its ability for perspective-taking drawn from its immersion and realism [20, 27, 30, 94]. However, beyond simply the immersive aspect of 'being there', other VR characteristics also support reflection. MacIntyre et al. proposed the idea of 'aura' for virtual places and objects [59], which derives from their personal significance to a user. In TravelGalleria, users' active construction imbues the space with their own stories, experiences, and artistic flavour. Users can represent documents in more personalized spatial configurations, such as enlarging specific pictures, moving close to them, etc. Following MacIntyre et al.'s definition, we posit that VR extends 'aura' because the individual connects their interpretation of virtual space to an understanding of the outside world. Overall, the aura of a world enhances the memorability of an experience [59] and ties into concepts of embodiment, space, and place — abstractions that are extended and transformed in VR.

Altogether, our findings support prior work on VR's role in facilitating storytelling and reflection through its unique affordances of presence and immersion. However, our work also further suggests that **the very concept of spatial organization in virtual space can be a dimension of a digital narrative** — liberty in spatial arrangement adds another axis of freedom for storytelling activities, providing another way for a user to impart a personal aspect of themselves into the experience. Our system has an open space within each collection, but also an implied space guided by the metaphor of a gallery; future explorations could provide new spatial paradigms, e.g. informed by work on Han et al.'s work on architectural narratives [41, 42], to see how potentially dynamic space can tie into narrative formation.

Space also implies a temporal conceptualization, another narrative concept [1], as it guides motion through the virtual world. Space can be to adjust pacing and order to generate a narrative structure (e.g. a dramatic arc [96, 103]); applied to our work, space allows participants to logically order their travel stories (e.g. in Section 5.1.2, P3 arranged items to create a temporal ordering for their gallery). Thus, VR's immersion and interactivity enable both unique spatial and temporal dynamics, reinforcing VR as a medium to support and enhance reflection. In particular, immersion supports the sense of 'being there' [86, 93], extending on the memory palace metaphor [54].

Returning to VR as a 'simulacrum' of a broader, spatially constructed storytelling medium — salient findings in Sections 5.2 and 5.3 are not necessarily tied specifically to the medium of VR. For instance, the physical 'Shiva's Rangoli' installation allowed participants to interact tangibly in a diegetic exhibit, similarly focussing on meaning-making and storytelling [37]. In line with our work, participants influenced and partially constructed the narrative in an 'other' world. As Saker notes, VR ultimately simulates something physical [86]. Thus, rather than tying specifically towards the VR medium, our findings regarding remembrance and reflection may relate more broadly to immersion in a user-created diegetic space [37]. However, such spaces can be prohibitive in terms of logistics, cost, and effort — while spatial dynamics are important in reflective practices, the requisite physical space or desired real-world spatial placement of documents may not always be feasible. In this sense, VR **democratizes storytelling space**, providing users with the tools and environment to freely create their own immersive stories [3]. Extending on Turner's 'democratic surround' [39, 97], TravelGalleria offers an immersive space that encourages active curation, exploration, and independent reflection. VR transcends spatial constraints, allowing users to engage meaningfully in an accessible, unbounded environment.

### 6.3 Travel Documentation for Reflection and Sharing

TravelGalleria was successful at promoting remembrance of past travels and showed promise in fostering reflection through self-inquiry. In particular, this self-inquiry was often between the times during one's travel (which forms a small microcosm of space and time) and times during one's regular daily life outside of travel. The contrast aligns with Packer's description of travel as an experience in which one experiences a new setting under a temporarily constructed identity [72]. Although documenting travel is common, the aspect of revisiting them for active reflective purposes is more rare. We initially aimed to capture the important aspects of travel through an analogue to travel journalling [2, 104]; our system mimics the multimedia storytelling of classical travel journals in a digital manner. Similar to travel journals, users were able to recount and relive the sensory and narrative aspects of the trip; some users were also able to even reflect upon their positionality regarding travel. As such, we found that our VR system provided a novel way to give prominence to the eudaimonic outcomes of travel [72, 107], especially as several participants echoed the fact that revisiting their travel memories for reflection was not often a conscious thing that they did. In addition, **the interactivity of photos and images in VR further enhanced the vividness of one's recounted story, and digital multimedia forms such as audio and annotations augmented the creativity and personalization of the documented travel**. Playful engagement through interactive elements in VR in immersive space can enhance purpose [79, 99], deepening the motivation of personal travel reflection. Despite these advantages of VR, one limitation compared to other documentation mediums is its convenience during travel. Whereas journals can be transported easily, VR systems cannot; as such, our work only facilitates storytelling after the travel is completed. Future work could explore other ways of immersively documenting and reflecting on travel while on the go.

Although travel documentation can facilitate individual self-reflection, sharing with others is also a core motivator [24, 56] and one that is readily supported through existing documenting mediums. Social sharing was discussed in the study but not actively explored given the practical limitations. Participants noted that they would like to share their built galleries with friends or family (Q11: mean = 4.15). Sharing stories and perspectives have been explored in different domains to help facilitate connection with others [70, 92]; thus, we could consider sharing people's created travel galleries with others and studying the relationships that sprout from such practices, extending on Q12. From a more bi-directional approach, the gallery could support synchronous collaborative storytelling between users in a single VR world (more akin to social VR [60, 92]), or perhaps asynchronous 'visiting' to co-create meaning (drawing inspiration from games research [63, 84, 106]). Furthermore, travel can often be a shared experience with friends or partners. Whereas our work focussed on *individual* reflection, collaborative reflection combines multiple perspectives to draw insights [77]. Applied to TravelGalleria, multiple participants could co-create a shared experience by using the storytelling units both distinctly and symbiotically. For example, a user could narrate their perspective over a photo taken by someone else, which could extend to a back-and-forth conversation. This draws upon the ideas of probing, sharing, and supporting perspectives [77] through reciprocal, spontaneous communication [62]. All in all, **future explorations could focus on designing for the social aspect of travel sharing**.

## 7 Limitations and Extensions

The nature of our recruitment methods meant that the demographics for our user study leaned young. People of different ages (e.g. older adults) could potentially offer different perspectives about their travel and different levels of meaning and self-interpretation, given perhaps different reasons or objectives for travel (e.g. leisure, entertainment, learning, etc.) — an important consideration for future extension. Furthermore, our work was largely focused on the broader storytelling aspect of curation rather than focusing on specific design decisions. Future work could consider improving and evaluating aspects of usability, enhancing interactivity and personalization in different ways (e.g. through AI-driven content), or incorporating more sensory inputs such as haptics.

Our study also focussed on immediate reflections on travel in a single short session. Some participants speculated that they would reflect more deeply had they had more time and experience with the system (and with VR in general). Longitudinal studies could be employed to better understand how people's reflections and perceptions about their travel change over time, and how they might want to update their galleries in TravelGalleria to reflect such changes — this would also allow participants to focus more on the experience of re-living their travels, as our study focussed primarily on authoring and storytelling. Finally, comparison studies could be employed to more directly compare TravelGalleria against other forms of travel storytelling, as our insights relied primarily on contrasting their actual experience with the TravelGalleria system to their recounted experiences of reviewing their photos and videos. In terms of comparison, our sample of participants also rarely actively curated their photos post-trip, e.g. in creating albums or scrapbooks. These could represent different mediums to facilitate reflection that could be explored in the future.

## 8 Conclusion

We proposed research questions about how immersive VR can support digital storytelling for travel reflection. To address these questions, we developed TravelGalleria, a VR authoring tool that allows users to curate a digital gallery of their travel documents. TravelGalleria maps themes of travel into collections of a gallery, and users can use their travel documents alongside additional multimedia interactive elements to organize, narrate, and personalize their travel stories. Using TravelGalleria, we performed a probing user study with 20 participants. We found that the immersive and interactive characteristics of VR supported reflection and remembrance. Participants recalled memories vividly, and in some cases, re-interpreted or reflected upon their broader impact within their lives. Finally, we contextualized our findings with prior research into reflective experiences in VR, storytelling in research, and travel documentation. Our results highlight how VR shows promise for authoring one's travels through mixed multimedia and

for experiencing one's story to relive and reflect on one's travel story.

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