Mixed Reality Storytelling for Social Engagement with Older Adults

by

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Abstract

Aging is a natural process that brings social and physical challenges among adults, due to which they have to make shifts in habits and routines. Adults belonging to an older age group lose touch with people which provides an opportunity for researchers to think and implement novel ways to engage the population with their loved ones. The advent of technology within the Mixed Reality (MR) space aims to facilitate diverse groups of people to engage in immersive and interactive ways, opening possibilities to address the predicament of aging in an isolated environment. Utilizing participatory design in a virtual setting, inclusive design frameworks and design thinking practices, the contributions of this research are to present the broad concepts of storytelling, social engagement and Mixed Reality existing in the literature, and then take inspiration to co-design a Mixed Reality storytelling system with older adults and their friends & family for the purpose of cultivating meaningful social connections through sharing stories.

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Dedication

To,

My mother Mussarat Azhar, & father Azhar Abdullah, whose affection and love have given me inestimable support, patience, and tolerance all these years,

My uncle Muhammad Nasrullah & my cousin and friend Asad Ghaus for making my dreams come true,

My Grandmother, whose stories have been a source of inspiration for me,

And to all those who made this achievement possible: love and unlimited gratitude.

The future of Mixed Reality Storytelling for aging adults

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Chapter 1: Introduction

1.1 Research Motivation

Overview

Humans are social beings with a strong need for community and interaction. And this need becomes even more predominant in the later stages of our lives. People experience social and physical changes with time, such as retirement from the workforce, losing a loved one, uncertainties about the future, relocating to assisted living facilities, and facing physical or cognitive decline. These experiences can lead to barriers in communication and social networks in the community, eliciting negative outcomes such as feelings of loneliness. This poses a challenge to active aging. The term 'active aging' is defined by the World Health Organization (WHO) as "the process of optimizing opportunities for health, participation, and security in order to enhance quality of life as people age" (World Health Organization, 2002). As a policy framework, active aging allows people to realize their potential for physical, social, and mental well-being and to participate in society. With the advancements in immersive technologies,

upcoming tools will allow designing for various services for older adults to assist active aging including social care. The motivation behind this work is to support the social functioning of older adults with ongoing research in prospective technologies; within the mixed reality space that allows the elderly population to engage with other members of society in an all-inclusive and age-friendly environment.

1.1.1 Importance

With an increase in life expectancy, there are more older adults worldwide than before and according to the report by the World Health Organization, the proportion of older adults is expected to increase by twice the size between the years 2015 and 2050 (World Health Organization, 2018). The quality of life of an individual is increasingly influenced by connections with other people. There are physical limitations associated with aging, hence the level of physical social engagement drops significantly with advancing years which can lead to social isolation. A health report by Statistics Canada estimates that as many as 525,000 (12%) people aged above 65 feel socially isolated and over a million (1,018,000 [24%]) of older Canadians report low community involvement (Gilmour & Ramage-Morin, 2020). Health risks associated with social isolation and loneliness affect “successful aging” of older adults are confirmed in published works of Cornwell & Waite (2009), Coyle et al. (2012) and Taylor and Taylor et al. (2018). Here, successful aging is a theoretical model coined by Rowe & Kahn (1997) that supports aging. It is composed of three components which are described as - the avoidance of

disease and disability, maintenance of high physical and cognitive function, and sustained engagement in social and productive activities. Table 1.1 shows how social isolation directly or indirectly affects all components of successful aging.

Successful Aging (Rowe & Kahn, 1997)	**Impact of Social Isolation**
Minimize risk of disease & disability	Social isolation leads to increased risk of cognitive dysfunction like Alzheimer's and dementia (Wilson et al., 2007).
Maintain physical and cognitive function	Social Isolation and loneliness can deter physical and cognitive stimulation by inducing depression. Depression is associated with lower rates of exercise and worse nutrition (Taylor and Lynch et.al, 2004) (O'Hara, 2006).
Active engagement with life	Social isolation leading to loneliness prevents individuals from engaging in conversation with people and having a positive outlook on life (Kelly et al., 2017).

Table 1.1: Effects of Social Isolation on Successful Aging

On a macro level, changes in global trends such as globalization, urbanization, migration, and social norms also contribute towards social exclusion (Michel, 2020). Taking social norms as a factor, generations today are more likely to live separately or relocate to health care homes and rehabilitation facilities compared to previous generations and as a result, experience shrinking social networks. Currently, as the world fights against the Covid-19 pandemic, the Center for Disease Control and Prevention (CDC) authorized

people to follow safety protocol and guidelines to socially distance and protect others, opening new challenges for older adults (Older Adults and COVID-19 CDC, 2021). Not only that older adults are exposed to far greater health risks; considering the group has compromised immunity, but also face social challenges given they are less engaged than before (Bailey et al., 2021). The lack of face-to-face interaction during the pandemic has led to the emergence of incorporating novel ways in enabling older adults to virtually interact and socialize with their friends and families.

An assessment on life satisfaction amongst older adults living in Canada reports that older people with strong personal and community relationships have higher levels of life satisfaction (Uppal & Barayandema, 2018). As an intervention to support social engagement amongst older adults, storytelling can provide opportunities to make connections, share cultural knowledge and build relationships (Lili et al., 2018; Vutborg et al., 2010; Hausknecht et.al, 2019).

Statistical data from 2012 on tech-savvy seniors of Canada reports that 63% of the 1532 participating older adults use technology to stay socially active (Backgrounder - Revera Report on Tech-Savvy Seniors, 2012) and the use of interactive technology, such as 3D virtual environments has the potential to provide far greater levels of engagement (Khosraviet al., 2016).

Through the supporting evidence provided earlier, the circumstances necessitate researching novel tools and techniques that can be used to facilitate storytelling amongst older adults. Advances within the Mixed reality space such as the development of ARkit [1] , ARCore [2] and Mixed Reality Toolkit [3] bring exciting prospects of how research-driven technology can offer engaging forms of storytelling, designed inclusively to address the wide range of social and emotional needs of older adults. When developing technology-based solutions, Mannheim et al. (2019) highlights the importance of involving older adults in the research and design process for ensuring their inclusion in the digital society. My Major Research Project (MRP) recognizes this need for co-design and embarks upon an inclusive research throughout the design process.

Relevance to Stakeholders

Research with the goal to improve the quality of life for older adults has a positive social impact on all stakeholders and creates various economic and social benefits. For example, experts believe researching the well-being of older adults will manage health care costs of the aging population – especially if the mental and physical decline can be prevented or delayed until the very end of life (Keating et al., 2005). Additionally, delayed physical and cognitive functioning will also allow older adults to stay in the

[1] https://www.arkit.io
[2] https://developer.microsoft.com/en-us/mixed-reality
[3] https://developers.google.com/ar

workforce for a longer period, postpone retirement and enable the community to have greater political representation (Galasso, 2008). As a result, society will experience a decrease in age-related gap.

As the life satisfaction of older adults living in assisted living facilities is linked to a decreased occupational burnout for healthcare workers in assisted living facilities, research towards improving social well-being of the elderly will therefore result in greater job satisfaction amongst the healthcare staff (Katherine Penn MPA, 2003).

Another relevant factor to note here is that storytelling and technology adoption can bridge the intergenerational age between the older adults and their younger family members. Each passing generation is exposed to large cultural, technological, and political changes but having a strong social connection with family members is vital to stay pragmatic in situations that have historical relationships. Lessening this intergenerational gap can benefit all family members including grandchildren, parents, and grandparents. The benefit can be seen with an increase in knowledge within their grandchildren who are able to connect with grandparents through listening to their life narratives (Li and Hu et al., 2020).

1.1.2 Current Work

As established before, communication technologies are highly effective in bridging the gap between various online communities and more recent trends showcase storytelling as a popular method to encourage social participation. Social engagement is virtually more engaging when it is immersive as its multi-dimensional model gives users a feeling of being present in the moment. Immersive technologies present an opportunity to create realistic experiences to keep older adults socially active while in the safety and comfort of their rooms (Lee, Kim, and Hwang, 2019).

Virtual and Mixed Reality is advancing at breakneck speeds where storytelling is one of its major use cases. Virtual Reality (VR) enables immersing the user in a virtual environment to achieve a goal whereas Mixed Reality (MR) utilizes a mix of both virtual and real environments (Milgram, Paul, and Fumio Kishino 1994). Specifically talking about storytelling for older adults, long term care homes like Revera [4] uses VR headsets, that involves playing interactive videos for the residents in the nursing homes which has played a significant role in helping the residents overcome feelings of isolation and loneliness. Viarama [5] is a software company in Scotland, working on building older adult's childhood memories into virtual reality experiences as memoirs.

[4] https://reveraliving.com/en
[5] https://viarama.co.uk/

In terms of social Augmented Reality (AR) experiences, the mobile AR game 'Pokemon Go' [6] , developed by Niantic, has gained groundbreaking popularity. The game engages its players socially by incentivizing them with rewards by unlocking 3D fictional creatures when they visit geotagged locations by other players. Developments in AR software and hardware has empowered game developers to make cognitive and social care games such as ARise [7], the adventure game for pediatric patients, and AR dragon [8] which is a virtual pet simulator.

In the collaborative space, shared social VR spaces and excellent examples of the use of 3D Avatars include Decentraland [9] and the upcoming Facebook Horizon [10] soon. "Hubs" by Mozilla [11], a web-based platform for VR has gained popularity amongst students and professionals looking to give presentations and attend meetings in a 3D space during the current Covid-19 pandemic while they work from home.

In the digital space, storytelling has also been vastly explored for social connectedness (Hausknecht et al., 2019). Age-Well [12] is a Canadian network at the forefront of researching and developing technologies and services for healthy aging. It has actively

[6] https://pokemongolive.com/
[7] https://arise.spellboundar.com/
[8] https://www.playsidestudios.com/ar-dragon
[9] https://decentraland.org/
[10] https://www.oculus.com/facebook-horizon/
[11] https://hubs.mozilla.com.
[12] https://agewell-nce.ca/

contributed towards storytelling and collaborative workshops that involve community participation. In their recent Nak'azdli *Lha'hutit'en Project*, elementary students recorded stories of the elderly as ‘legacies’ to preserve cultural wisdom and showcased them at a community event (Freeman, 2020).

The discussed current work demonstrates the potential of ongoing research on storytelling and immersive technologies and its application in the areas of entertainment and social spaces.

1.2 Research Summary

Problem Statement

With increasing age, comes a growing need for social interaction. In a technology-driven world, immersive technologies like Mixed Reality are fast being developed for the purpose of facilitating socially engaging storytelling activities. Older adults can be adopters of this innovation if they are involved throughout the design process that recognizes their diverse needs.

Research Questions

This research aims to investigate how Storytelling in Mixed Reality can be designed inclusively with older adults to enhance social engagement? The research questions of the MRP are as follows:

1. How do we design Storytelling to increase social engagement for older adults?
2. How do we make Mixed reality experiences inclusive for older adults?
3. How do we combine storytelling and Mixed Reality to make it an engaging social experience for older adults and others?
4. How do we test and evaluate Mixed Reality Storytelling for its impact on improving the quality of social engagement for older adults?

Hypothesis, Goal & Objectives

The table below explains the hypothesis, goals and objectives of this study.

Hypothesis	It is hypothesized that Mixed Reality can provide older adults with an immersive platform that compliments stories.
Goal	This exploratory study aims to showcase a novel Mixed Reality based socially engaging system that incorporates storytelling for older adults.
Objectives	1. To research existing frameworks of storytelling and social engagement in the context of older adults and state-of-the-art Mixed Reality through an extensive literature review. 2. To address inclusive design by adopting user-centered co-design approaches as a methodology. 3. To prototype storytelling in Mixed Reality as a proof of concept based on the synthesis of primary data collected. 4. To evaluate the final design with qualitative and quantifiable metrics and compare results with published research.

Table 1.2: Research Summary Goals of the MRP

1.3 Research Scope & Audience

It is important to note that "older age" is a broad term, and no typical criteria can define the needs of the older population. People can experience changes in physical and mental capacities at variable ages. Having said that, this research will address existing design gaps in social forms of storytelling in Mixed Reality.

After a comprehensive analysis of literature on "storytelling for older adults", the MRP considers only conversational elements of storytelling which involve creating and sharing narratives between individuals. With respect to Mixed Reality, the design of the prototype is explored as a touch-based system on a mobile display and does not address Mixed Reality interactions involving gesture recognition and spatial awareness. As it is a user-centered research, it heavily relies on feedback from its users. Therefore, the conclusions made from primary data are subjective to its participant pool.

About the audience of this research, the study has attempted to target an age-diverse user group. And the research is focused on tech enthusiasts who are motivated to make online friends, and older adults looking to connect and reminisce with family, friends, and the online community.

1.4 Research Contributions

The project has contributed towards producing valuable learning outcomes which include:

- A scan of literature on gerontechnology, frameworks on storytelling, related work on Mixed Reality and the knowledge gap.
- A mixed methods research methodology to address age-diversity in co-design by defining protocols of data collection centered around inclusive design guidelines. In doing so, this project also reflects on the challenges experienced in the process, as well as the tools and resources that were required to conduct a virtual research.
- A detailed explanation of the process and design decisions of the proposed system: MR Story Mail, developed based on primary and secondary data collected.

- Insights from participating older adults and their friends and families, on sharing stories with mobile-based Mixed Reality. It does so by analyzing the qualitative feedback provided by the participants.
- A discussion on future work of this MRP that proposes new ways of thinking about using age-friendly Mixed Reality environments which can be a motivation for future researchers and developers.

1.5 Chapter Overview

This chapter gave an introduction of the MRP including its importance, existing work, research summary as well as its scope and contribution.

Chapter 2 begins with a literature review that explores concepts of social engagement, gerontechnology, storytelling and mixed reality as they relate to this project. It starts off by researching definitions and taxonomies of social engagement and gerontechnology. The review then narrows down its focus on researching storytelling as a participatory social activity and discusses its implementation in the technological space. The discussion then ties those approaches to the synergies that exist between Mixed Reality and storytelling, which are defined and then explored in a scan of relevant literature.

The chapter then finally summarizes how the explored frameworks and techniques will be used in the design and evaluation of the project.

Chapter 3 explains the four phases of the MRP's design methodology constructed by utilizing mixed methods of inquiry with a state-of-art design framework. Following which it explores how the inclusive design guidelines are applicable to the project and finally expands upon the data collection methods.

Proceeding forward, chapter 4 of this work discusses the design and development of the Mixed Reality based storytelling system: MR Story Mail, in the four phases of the design process.

Chapter 5 presents the results of the findings generated from the evaluation of the final design. The results are analyzed to reflect on the research questions and to highlight the successes.

Finally, chapter 6 concludes this MRP by discussing the limitations of the study including the small participant size and its impact, highlights future work and futuristic technological advancements to keep track of and revisits its goals and contributions in the conclusion.

Chapter 2: Literature Review

To gain a better understanding of existing research on the major concepts of the MRP, the keywords “gerontechnology” “social engagement for older adults”, “Digital storytelling”, “AR/VR Storytelling” and “Mixed Reality” are used to search for scholarly articles, books, and journals. This chapter explores these key concepts which are divided into four main sections. Section 1 investigates social engagement and how it supports successful aging. Section 2 is about inquiring gerontechnology, age diversity and older technology users. Section 3 consists of research on storytelling with a focus on social engagement and its technological frameworks. Section 4 defines Mixed Reality and inspects the synergies between Mixed Reality and storytelling in related research. Lastly, section 5 acknowledges a knowledge gap and summarizes how the findings of the literature review can be carried forward in this project.

2.1 Social Engagement

This section explores social engagement in the context of successful aging. By doing this, the research will be able to define the level of social engagement evaluated in the project and how it can be designed to support successful aging.

2.1.1 Social Engagement - A Taxonomy

There exists various definitions of 'social engagement' in the literature which are also interchangeably used with 'social participation'. The survey paper *Inventory and analysis of definitions of social participation found in the aging literature* by Mélanie Levasseur (2010) investigates these definitions involving older adults. Some of these definitions describe social engagement as "actions that connect individuals to others and that relate to care or development" (McBride, 2006) and "maintenance of many social connections and a high level of participation in social activities" (Bassuk et al., 1999). The survey conceptualizes a taxonomy of social participation with six levels of activities based on levels of involvement of individuals with others and the goals of the activities. Table 2.1 below, shows the taxonomy which will aid in evaluating social engagement offered by the final design of this project.

Level	Type of Social Activity	Description
1	Doing an activity in preparation for connecting with others	Solitary activities that involve all daily activities that an individual normally does alone in preparation for other activities that will connect them with others.
2	Being with others (alone but with people around)	This level includes community activities that are done alone e.g.: walking in the neighborhood, purchasing a ticket online.
3	Interacting with others (social contact) without doing a specific activity with them	In this level the individual is in social contact with others, in person or through the internet, but does not do a specific activity with them
4	Doing an activity with others (collaborating to reach the same	This is when the individual collaborates with others to perform an activity, reach a common goal
5	Helping Others	These involve activities where an individual helps others and the person or group of persons being helped can be identified.
6	Contributing to society	This interaction occurs within society. At this level, the individual contributes more broadly to society, for example by being part of political parties or organizations.

Table 2.1: Taxonomy of Social Engagement, as in (Levasseur et al., 2010)

2.1.2 Successful Aging and Social Engagement

With the advancement in science and education, elderly health care has begun to research social and psychological aging to support the multidimensional needs of older adults. Different theories exist on successful aging that describe the characteristics of social and biomedical requirements of older adults (Rowe and Kahn, 2015; Duay and

Bryan, 2006; Gallistl, 2018). Research on the *Immersive experience model of the elderly welfare centers supporting successful aging* (Lee & Park, 2020) has combined these theories of successful aging and characterized it in five classifications that focus on disease prevention, physical and cognitive functioning, psychological factors, social relations, and productive activities including learning and participation in educational and creative activities. Taking inspiration from this research, Table 3 shows how this project proposes to support successful aging indirectly in disease prevention and physical and cognitive functions and directly benefits psychological characteristics, productive activities, and social learning.

Successful Aging	**Definition**	**Key Takeaways**
Disease prevention	Avoidance of disease and awareness of one's health condition	Design should have social emotional benefits which is linked to the prevention of cognitive dysfunction (Wilson et al., 2007).
Physical and cognitive function	High physical and mental functions	Design can support physical and cognitive functioning by having modalities and through the creation of diverse, highly flexible input and output systems.
Psychological characteristics	Emotional stability, attachment to experiences and memories, absence of depression and loneliness, high degree of self-respect and satisfaction with life	Design should develop a positive storytelling experience and address any negative emotional risks associated with social exchange and storytelling.

Successful Aging	Definition	Key Takeaways
Productive activities	Continuing educational and self-development, motivation for life, social activities, and an active attitude to learning	Design should involve learning by enabling exploration of novel elements.
Social interaction	Close relationships with others, forming social bonds, adaptability to the environment, and social support	Design should support and encourage active participation of users of the system

Table 2.2 : Successful aging as a Welfare Model (Lee & Park, 2020) and key takeaways

2.2 Gerontechnology

Technology has streamlined many day-to-day activities and new technology has the potential to provide interventions to assist older adults in keeping healthy for longer periods (Remmers, 2010). Gerontechnology refers to the use of technology amongst older adults and its effectiveness in sustaining their quality of life. Gerontechnology that support the social lives of older adults, such as Information Communication Technologies (ICTs) have been extensively researched and linked to decreasing loneliness and social isolation (Chen et al., 2016; Czaja et al., 2018), while also improving well-being (Czaja et al., 2018; Ihm & Hsieh, 2015). Immersive tools can be layered with communication technologies to enhance and support work and hobbies (Bjering et al., 2014) .

2.2.1 ICT User Typology

To understand the technology acceptance of older adults, author of the book *Breaking the Digital Divide*, Johanna Birkland (2019) theorized an ICT User Typology to help identify the needs of the diverse older population that will allow tailoring and building devices to meet the lifestyle preferences of the target users. This will assist in the creation of user personas to categorize the characteristics of the targeted audience in order to design an adaptable and flexible design. Table 2.3 explains these characteristics and key takeaways for this research.

User Type	**Is Drawn To**	**Design Takeaways**
Enthusiasts	Fun, play, newness, experimentation	Emphasizing fun by gamifying the experience (Alsawaier, 2018) and the novel design of the Mixed Reality experience (Lindgren et al., 2016).
Practicalists	Functionality, practicality, usefulness	Understanding user needs through user studies. (Kosara et al., 2003)
Socializers	Connection, community, relationships, socialization, Engagement	Design should have social networking and follow a social media model. (Ngai et al., 2015)
Traditionalists	Nostalgia, technology and media of their youth	Enhancing design to support User-Interface (UI) based on natural interaction (Hsiao et al., 2017).

User Type	Is Drawn To	Design Takeaways
Guardians	Security, control, relationships, unobtrusiveness	Design should be user- sensitive, transparent with inclusivity in privacy features. (Wang, 2018; van Rest et al, 2012; Newell et al., 2011)

Table 2.3: ICT Typology, as per Birkland (2019) and MRP key takeaways

2.2.2 Designing Technologies for Age Diversity

ICTs for older adults include the use of the internet, smart devices and computers, research has shown the diverse range of differences in attitudes to adoption of technology amongst groups based on gender, age, technical literacy, financial and cultural factors (Stenberg et al., 2014). It is advised by the same research to look at older age groups in smaller bunches, e.g., five-year intervals, and not as one big group when designing for them. Choosing not to use technology is completely valid and does not define a person's self-worth in the society. Having said that, Stenberg et al. (2014) highlights that the challenge is to encourage older adults in trying out new gadgets.

Encouraging technology utilization through incentives that spark older adult's interests is highlighted as a possible solution. Keeping this in mind, the study on *Potential of augmented reality and virtual reality technologies to promote wellbeing in older adults* also noted that: Older adults will be engaged and become more active when they feel

they are involved with a specific activity or human relationship while using the system. Additionally, collaborative experience will encourage them to solve difficult problems together and reduce their fear of using the system. Such experiences will play an important role in changing the stereotype that they find it difficult to understand instructions for using modern technologies (Lee & Kim et al., 2019).

Older adults strongly report that technology use is often difficult because their needs are not considered in design (Stenberg et al., 2014). From this perspective, a desire for simplified interfaces is found to be particularly important to older adults using online social technologies (Rama, 2001). Multimodular designs for considering future design goals for social networks, research has demonstrated that older adult value "deeper, well thought out, carefully crafted social communications" and modalities that "enable depth of thought, reflection, and personalization" (Alkhamisi et al., 2013; Lee & Kim et al., 2019). Another study noted that older users find touch and gesture recognition interfaces easier to use (Hsiao et al., 2017). Consequently, using multimodal systems when making adaptive user interfaces in designing technological solutions for older adults is an effective way to address different user limitations and to account for age diversity.

2.3 Storytelling

Humans have innately resorted to the art of storytelling since the beginnings of their existence. Hinchman and Hinchman (1997) defines stories as narratives that connect events meaningfully for a target audience to present insights about the world and/or people's experiences of it.

Stories can take several forms and multiple mediums have been used for its delivery. Digitally, it can be combined with multimedia like visuals, text, and sounds. In the interest of older adults' well-being, digital storytelling has been recognized as an effective intervention to promote; social engagement and reminiscence, to preserve oral traditions and to facilitate connectedness between older adults and young people (Lili & Rincon et al, 2018). Sharing stories evokes empathy and emotion and is linked to positive changes in the confidence, sense of purpose and fellowship (Lili & Rincon et al, 2018). Conversational storytelling has been established as one of the socially engaging experiences and the next section explores in detail as to what it entails (Mandelbaum, 1989).

2.3.1 Conversational Storytelling

Communication through conversational storytelling offers improvisation, personalization, flexibility in choosing topics, co-narration, encourages engagement and participation of all audience, experiential learning, room for discussion, fulfils

psychological needs of being heard and listened to, attention for older adults. Research has noted that being able to share experiences and communicate through conversational storytelling enables older adults to relive past experiences that make them happy, connect to families that are living apart, and pass down their cultural knowledge to their grandchildren which positively affects their social emotional educational learning (Poulios, 2005). As roles can also be interchangeable in conversational storytelling, families or children connecting with their older adults through conversational narratives get attention and learn family legacies from their grandparents which promotes intergenerational bonding (Thompson et al., 2009). Storytellers get the opportunity to talk about themselves in a positive way which boosts self-esteem (Poulios, 2005).

To build upon this, conversational storytelling can be combined with interpersonal activities to become an interactive experience (Mandelbaum, 1989) . Research has established that people who engage in more interpersonal activities like communicating with family members or friends show greater reduction in depression severity and increase in behavioral activation (Solomonov et al., 2019). This is because it involves active participation in the activity which fosters connections.

Neal.R Norrick the author of *Conversational Storytelling* (2007), says that stories are distinguished from narratives because they involve a personal relevance, context and

always include evaluation by the storyteller. William Labov, a professor of Linguistics at the University of Pennsylvania, defined a structural analysis of narratives that can be used to tell oral stories. However, Labov only considers stories told by one person (Labov, 1997). In a social setting, stories can be shared by many narrators. Therefore, an alternative theory of Goodwin's Story Structure (2015) is considered which is primarily built over Labov's. This theory claims stories consist of six techniques in order to build up a narrative. They are as follows:

1. **Preface:** A story preface is an indication that the storyteller is going to tell a story for people who have an interest. It basically answers the question "What was this about?"
2. **Story Solicit:** This is an indication from the listeners that they are listening. This response could be verbal or gestural and nonverbal. This point also emphasizes the importance of having story listeners as their responses greatly influence how the storyteller narrates. So, it not only supports the ability to focus, but also ensures the storyteller that their audience is engaged which helps build self-confidence.
3. **Preliminary to the Story:** This category refers to the setting of the scene. The storyteller provides a critical background to the story and answers questions like who? where? how? etc.

4. **Story Action:** This is the main body of the narrative - the main plot that makes up the story.
5. **Story Climax:** This is the conclusion of the narrative and uses words that signal the end of the story like “that was it” “that is how it ended”.
6. **Story Appreciation:** This point is about the audience communicating to the speaker their response to the story.

2.3.2 Storytelling Design Framework

In designing a storytelling system for this project, the goal is to facilitate it with Mixed Reality. Chu et al. (2016) provides a design framework for storytelling, illustrated in Figure 2.1, that can be used with supporting technologies designed for older adults.

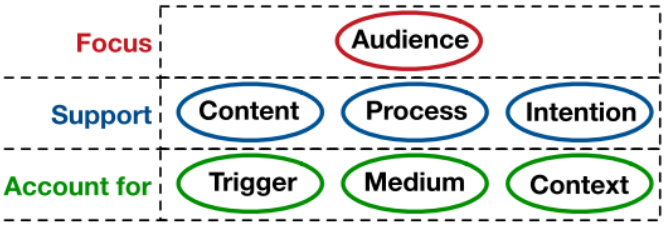


Figure 2.1: Storytelling as Motivational Framework (Chu et al., 2016)

The factors that should be considered in this framework are explained as follows.

Audience: The design of storytelling should cater to a variable audience personality as it can impact the storyteller's degree of self-esteem. Older adults face the challenge of no audience, the audience being remote, or having the same audience all the time.

Content: Content creation is important in storytelling whether it is based on a true story or a fictional one. For older adults, the challenge is either having too little or too much to tell.

Process: Story involves a myriad of processes from retrieval of details, structuring, summarization, mental organization, and tracking, that are typically done automatically or unconsciously. Older adults will find some processes more challenging than others depending on the context.

Context: Contextual setting for storytelling is an important factor to consider as older adults prefer to combine it with other activities, or associate with certain times and places.

Medium: Older adults use only a limited number of communication media such as phone, email etc. for the purpose of storytelling according to their personal preferences.

Story trigger: This relates to how storytelling is catalyzed such as the story being instantaneous or pre-planned.

Storytelling intention: Intention behind storytelling is not always evident. Even so, older adults can tell stories for various purposes, among which creating or maintaining relationships as well as conveying lessons or messages are two key ones.

2.3.3 Benefits and Costs of Storytelling

The study on *Understanding Storytelling as a Cognitive framework* (Chu et al., 2016) carried out a quantitative analysis to understand the perceived benefits and costs of storytelling in older adults. The findings for each were categorized into three groups, which are elaborated below.

Perceived Benefits of Storytelling

1. **Social/Emotional:** It is seen as a fun and relaxing activity for leisure and entertainment. It allows older adults to share their life or prior experiences with others thereby enabling a human connection. Therefore, it instills a feeling of being listened to which boosts self-esteem.
2. **Cognitive:** It is cognitively stimulating for older adults as it entails creativity, planning, finding connections between different ideas and extrapolation of

events for making it meaningful to their audience.

3. **Practical:** Practically, it is flexible as it can happen anywhere even simultaneously with other activities.

Perceived Costs of Storytelling

1. **Social/Emotional:** Storytelling can result in decreased self-esteem if its audience appears forced. Lack of confidence in the storyteller can lead them to stick to listening instead. Moreover, narrations on certain themes/topics such as reminisce, bad experiences, or when past and present memories are compared can foster feelings of sadness.
2. **Cognitive:** It can often be hard to avoid telling stories that have already been shared which can result in repetition. At times, moderated storytelling is needed for older adults who require help in keeping track of the story state during the process of telling.
3. **Practical:** The research reports that many older adults have dedicated places or times where they like storytelling to take place. Storytelling with people who are remote requires that the listeners are available either via email or phone, but the findings noted that because much of the older adults' storytelling occur face-to-face, some have difficulty engaging in remote methods.

2.4 Mixed Reality & Storytelling

Stories can be told in many forms such as through games, films, music, photographs, art, and social media. Immersive technologies such as Mixed Reality can be used to merge the digital and the real world through computer graphics and offer a three-dimensional storytelling experience. The section dives in detail of what is mixed reality and how it has been used in storytelling.

What is Mixed Reality?

The concept of Mixed Reality (MR) is described as a fusion of the real and virtual worlds that can be viewed from a screen display (Milgram & Kishino, 1994). When defining Mixed Reality, Milgram (1994) introduced the concept of a "virtuality continuum", illustrated in Figure 2.2. He describes the continuum as “where real environments are shown at one end of the continuum, and virtual environments, at the opposite extremum”, then further defines Mixed Reality environment as “one in which real world and virtual world objects are presented together within a single display, that is, anywhere between the extrema of the virtuality continuum."

In this continuum, Augmented Reality (AR) lies towards the real end of the continuum and provides virtual experiences to users, by layering digital information on the real world. On the virtual side of the continuum, Virtual Reality (VR) allows users to be fully immersed in the virtual environment, isolated from real-world circumstances. Mixed

Reality is a hybrid of AR and VR that puts track-able and intractable digital objects in the user's environment.

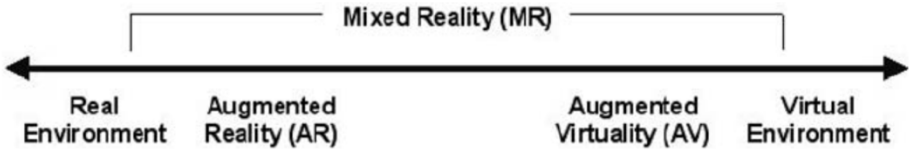


Figure 2.2: The Reality-Virtuality continuum (Milgram et al., 1994)

The type of mixed reality displays available in the market can be classified using the dimensions of extent of world knowledge, reproduction fidelity and extent of presence metaphor, proposed by Milgram (1994). Monitor based displays such as mobile phones and tablets provide a hand-held Mixed Reality experience. They have a very low extent of world knowledge, moderate reproduction fidelity, and small extent of presence, meaning that they are relatively non-immersive than the head-mounted displays. Head-worn Mixed Reality displays such as the Microsoft HoloLens 2 [13] (Figure 2.3, left) in contrast provides a much better Mixed Reality experience as it falls greater on each of the dimensions than the mobile-based Mixed Reality (Figure 2.3, right).

[13] https://www.microsoft.com/en-gb/education/mixed-reality

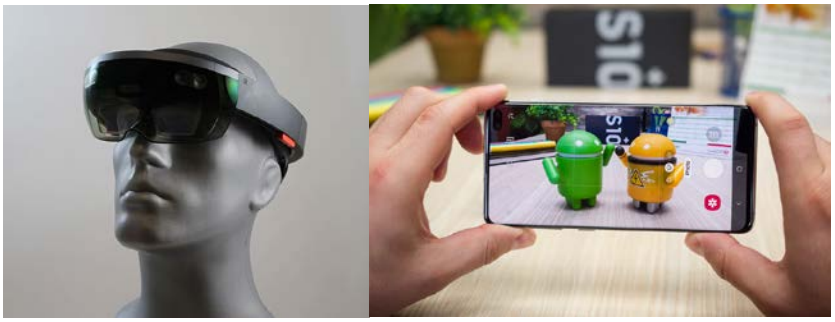


Figure 2.3: Microsoft HoloLens 2 (left) (Microsoft HoloLens 2, 2020), Mobile Mixed Reality Display (right) (Pokemon Go by Niantic Labs).

Mixed Reality Supporting Storytelling - Related Work

Little work on storytelling in the context of Mixed Reality supporting the social needs of older adults was found in the literature. Although relevant work on the various ways how storytelling is combined in immersive environments of AR, VR and MR is presented below.

Augmented reality has been vastly studied with storytelling. Examples of such work consist of using Mobile-based AR apps (MARs) for digitally enhancing children's physical story books (Aurelia et al., 2014), AR-based learning to immerse students (Abas et al., 2019; Geetha et al., 2021), tactile interfaces to make collaborative interactive storytelling in games (Zhou and Cheok et al., 2004; Shen & Mazalek, 2010), AR-based tourism (Nóbrega et al., 2018; Shih et al., 2019; Azuma, 2015).

Virtual Reality is very popular with tourism applications, games, documentaries, and films. One such work uses interactive digital storytelling for enabling visitors to explore virtual exhibits guided by a digital story (Sylaiou et al., 2020). Another work uses a mix of immersive technologies including Mixed Reality to combine it with gamified storytelling in virtual museums (Papagiannakis et al., 2018). One of the most interesting works on storytelling in Mixed Reality, uses handicrafts as tangible interaction tools to create and tell stories with HoloLens (Song et al., 2019).

2.5 Summary & Knowledge Gap

The project aims to embark upon creating a Mixed Reality platform supporting the storytelling of older adults for the purpose of socially engaging them. From the scan of relevant work to the best of my knowledge, it was evident that even though immersive technologies have been extensively researched with storytelling, such a system has not been co-designed with older adults and highlights a knowledge gap in existing research.

Having reviewed the various definitions of social engagement in this section, this research will carry forward the definition of McBride (2006) and thereby define it as the action of connecting individuals for care and development. As Mixed Reality can provide a feeling of submersion in the virtual environment, older adults can be enabled to experience immersive social engagement experiences that surpass physical or mobility

limitations. As the research is performed virtually, it is only feasible to use commonly available mobile-based Mixed Reality as opposed to the expensive head-mounted displays. This also falls in line with Birkland (2019), highlighting that out of the challenges of technology adoption in older adults, one is the financially out of reach devices.

The research will use the framework of storytelling provided by Chu et al. (2016), to design it as socially stimulating in Mixed Reality. ICT User typology as proposed by Birkland (2019) will enable the construction of personas for various user types that will target specific characteristics of technology users.

From a design methodology perspective, most works in the literature aim for designing with particular age groups and rarely consider age diversity as discussed in *AgeCI: HCI and age diversity* (Silva et al., 2014). As storytelling is not bound by age, the design cannot be segregated just for older adults, the research methodology therefore should address age diversity by also considering perspective from other stakeholders: the friends and families of older adults.

The evaluation of benefits and costs framework of storytelling provided by (Chu et al., 2016) will be used to compare the findings of my research and understand its shortcomings.

Chapter 3: Methodology

The MRP intends to co-design and evaluate a Mixed Reality storytelling system on its engagement and ease of use. To achieve this objective, the methodologies that complement are Research Through Design (RtD) (Zimmerman et al., 2007) and User Centered Design (UCD). In the field of Human Computer Interaction (HCI), RtD is a practice-based research defined as a model that allows researchers to study the world and build designs intended to affect change.

To map out the contribution of this study, the design is examined through four critical lenses:

1. Documenting the process.
2. Demonstrating the toolkit or novelty of the design.
3. Validating the relevance of this work, and finally.
4. Prove the tool's extensibility and usability as a basis for new research.

The project also practices UCD by involving direct stakeholders in the project end-to-end. An iterative approach as per UCD, achieved through usability tests and feedback loops reinforces findings of the research and adds an extra layer of validation to it.

The following sections cover the design framework, inclusive process and tools and data collection used in this research which will complement the adopted methodology.

3.1 Research Design Framework

To visualize the discussed methodology, a “double diamond” design framework is used (Council, 2015). The model is a roadmap for design thinking that provides a clear and comprehensive visual description of the design process. It allows for a deep introspection of the problem ‘divergent thinking’ and then taking a focused action ‘convergent thinking’ to resolve it. It is broken down into four stages termed as *discover*, *define*, *develop,* and *deliver*.

The research and creation journey of the MRP were divided accordingly with the given stages into four phases: user stories for narrative creation, synthesis, prototyping, and evaluation, all explained in detail in the next chapter. Figure 3.1 illustrates these stages as they combine design theory and practice to fit the double diamond framework while using methods from Rtd and UCD.

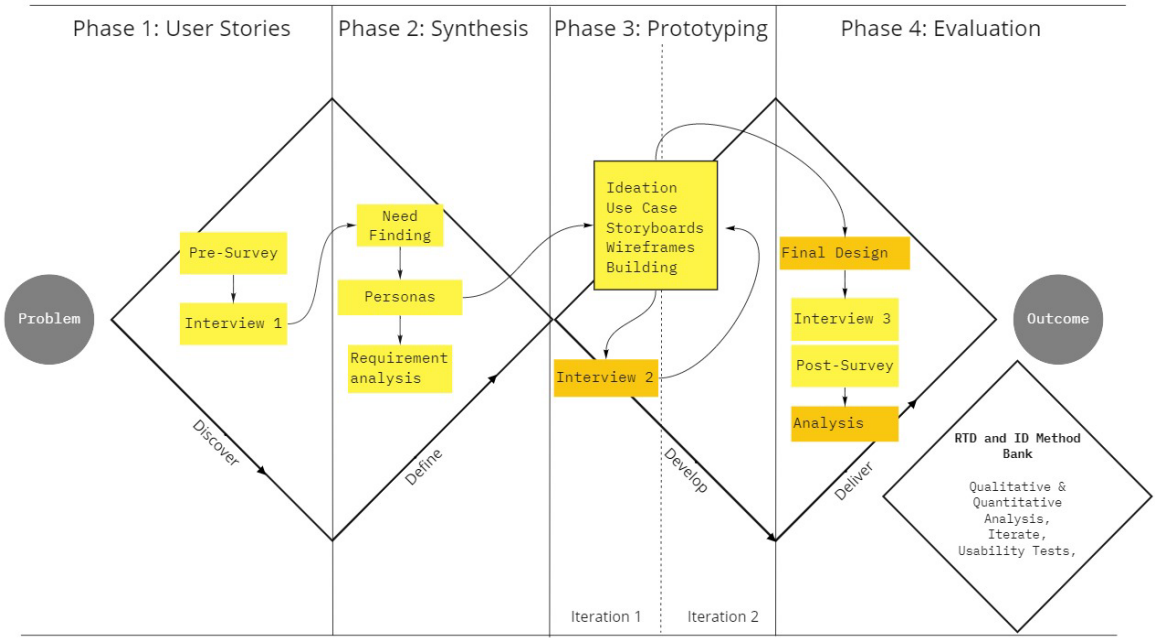


Figure 3.1: MRP research stages in the double diamond model

The four phases are as follows:

1) User Stories & Narrative Capturing

The first phase; that is, user stories are crucial to understanding the habits and pain points of target users as they relate to the contextual inquiry of this project. It is achieved through a semi-structured interview session with participants. The aim of this format of interview is to explore challenges with communication and gain insights on the significance of interpersonal activities for the audience. The information gathered is then used to synthesize it with literature-based concepts in the next phase.

2) Synthesis

The second stage is synthesis which consists of analyzing primary data gathered from the interviews and combining it with secondary research data that includes concepts from literature, to create user personas. Additionally, using it to define a design intent narrative for the problem and define a list of requirements that will drive the design and architecture of the tool.

3) Develop- Prototyping

The prototyping phase is where the organization and development of the Mixed Reality storytelling tool occurs. The results of the synthesis stage inform the design, where the system goes through multiple iterations to move from ideation to a functional prototype. Once a lo-fi prototype is ready, the participants are called up for a second round of interviews to test usability of the early-stage design.

4) Deliver- Evaluating

In the final phase, the prototype is evaluated from the findings of the final interviews with the users. This interview requires testing a late-stage prototype incorporating feedback from the usability studies, followed by a discussion to reflect on the user experience of the system. Quantitative data is captured through the analysis of pre and post surveys.

3.2 Inclusive Design in the Process:

Considering the scope and limitations of this MRP, Inclusive design guidelines are used at best to design with a predefined set of age-diverse people. Inclusivity in the research process is practiced by working with the three *Inclusive Design Dimensions* (Treviranus, 2018) as follows:

1: Recognize diversity and uniqueness

Under the first dimension, this MRP keeps the diversity and uniqueness of each individual in mind by using qualitative interviews as inquiry methods. This allows us to understand how users think about the world, subjectively understanding what actions they perform and behavior they exhibit. The findings of the interviews are coded into personas, to make sure different individual needs and goals are recognized during the design process while at the same time avoiding any form of segregation.

Personalization through Inclusive design and allowing flexible configurations lead to interoperability within the system. Inclusive design recognizes the importance of self-determination and self-knowledge, which enables users to adapt the system to their needs and achieve the goal of effective storytelling.

2: Inclusive process and tools

The research process is kept inclusive by involving the users in the design process right from the start of the research. The final design was co-designed using various frameworks such as usability tests with open feedback and virtuous tornado activities (Treviranus, 2018) to highlight the equal researcher-participant power dynamics in the process. The research screening forms proceeding recruitment asks for participants preferred video conferencing tools and ICT devices to integrate a solution that supports the accessibility of design and development tools.

3: Broader beneficial impact

To support broader research, open source for the project is made public so the community can access and build upon the current framework. Additionally, detailed documentation is done to achieve transparency of the tool and keep a log of any changes made.

3. 3 Methodology of Data Collection through Participatory Design

This section goes into detail about the process of collecting the data from live participants for inquiry after getting approval by the Research Ethics Board[14] (Appendix

[14] https://www.ocadu.ca/research/research-ethics-board

A). For this project, participants and available literature were the sources of data that support this research.

Participant Recruitment and Screening:

Participation was required to be in pairs of one older adult (OA) and one general adult (GA). The interviews were divided into two phases where the first two interviews co-designed the system, and the final interview involved the same participants in addition to new ones. The reason for adding new groups in the final evaluation was to test the versatility of the design as an experiment.

The participants for the study were approached by word of mouth, poster (Appendix B) and online social media. Interested candidates were required to go through an initial screening by filling an online form (See Appendix D - Screening Questionnaire), where they had to meet the following eligibility criteria:

1- Older Adults to be over 65 years of age and a friend and family as General Adult to be over 18 years of age.

2- Had a laptop, tablet, or smartphone.

3- Did not have cognitive decline like Dementia (such as that caused by Alzheimer's) or risks such as Post Traumatic Stress Disorder (PTSD) for participants' emotional and physical safety.

The candidates who passed the eligibility criteria were emailed details of the study along with the informed consent (Appendix C), and a pre-survey (Appendix D - Pre-Survey).

Survey Design:

There were two online surveys (Appendix D - Pre and Post Survey) required to be completed by the participants at the beginning and end of the research. The survey design was inspired by the study *Impact of virtual reality (VR) experience on older adults' well-being* (Lin & Lee et al., 2018). It asks about demographics, metrics about participant's perceived wellbeing, and how familiar they are with digital technologies. The purpose is to get an idea about participant personality and their overall feelings to assess their social engagement. With a combination of postsurvey, it can make comparisons between the co-design group and the new group to assess the kind of users who react more positively towards the system.

Interview Session:

Participants were approached via contact information they provided, which allowed the researcher to schedule interviews using Zoom[15] video conferencing as the preferred platform of participants. The interview was scheduled for 1-hour with the following agenda: Participants were provided an explanation of the project followed by an introduction of the researcher. Then a verbal consent was obtained to video record the

[15] https://zoom.us/

session for the purpose of transcribing it later, with a supporting slideshow that was shared for visual aid purposes.

The first interview (Appendix D - User Stories Session 1) was carried out to understand the communication habits and technology use of the participants. Essential insights were captured on the pain points and goals that were further used to generate user personas.

After the initial need finding interview, mid-fi prototypes consisting of wireframes and an AR demo were developed. The second interview (Appendix D - Usability Session 2) was then carried out in a co-design fashion and usability testing was done with participants using the prototypes. The prototype was shared via a weblink and participants were asked to do screen share while interacting with the system which allowed the researcher to note down observations. Then a second iteration was done, and the needs and requirements were revised and assessed based on further brainstorming, storyboarding and wireframes developed in the process. This version of data was used to implement the final MR prototype.

The final prototype was tested in the last interview (Appendix D - Final Evaluation Session 3) which asked participants open-ended evaluative questions. Right after which all participants were required to fill the post survey. The surveys were evaluated

quantitatively, and qualitative feedback was noted from the interviews which is documented in the findings section.

Risks & Confidentiality

For this MRP, any foreseeable risks associated with participation were identified and informed to the participants in the consent form. These included physical and psychological risks associated with answering any interview questions, visual fatigue from computer screen time or frustration from understanding the software. To minimize these risks, the participants were informed that they are welcomed to take as many breaks as needed and may choose not to answer any research question or even stop the session at any point in time. They were also offered any instructional videos and textual instructions wherever required and asking questions was encouraged throughout the process.

Additionally, all information provided is kept confidential and grouped with responses from other participants. However, with participant consent, some of the video/photographic data is used to illustrate findings.

Now that we have captured the essential data required and converted them into useful information, this leads us to talk about the design aspect of the software and the implementation that follows.

Chapter 4: Design

This chapter walks through the four phases of the design process. The first section explains the user stories and narrative capturing process. The results of the user story drive the design and the project through different iterations to move from ideation to a functional prototype. The second stage is about the synthesis of data from phase 1 and redefining user requirements. The third stage involves developing the design which also includes findings from the usability test that employs a co-design activity, iterating through a revised design based on its findings. Finally, the fourth phase is about the evaluation on the built design.

4.1 Phase 1 - User Stories and Narrative

A preliminary interview was carried out as part of the user story phase to understand the communication habits and technology preferences of the participants. The interview questions were divided in themes and participants were informed that the format of the interview was conversational in nature rather than a strict question & answering session. This allowed the researcher to conduct productive interviews with better

quality insights. The participants in each group belonged to the same household and attended the session together.

There were two groups of paired participants who interviewed[16]. Among the participants, P1A; the older adult (OA), was interviewed whose relationship was of a father to participant P1B, the general adult (GA). P2A was the older adult and grandmother of P2B, the general adult (GA). Appendix D details the questions that were asked during the interviews. The interview findings were coded into different themes (See Appendix E for each of the participant's detailed responses). Table 4.1 shows a summary of the findings from this interview.

Themes & Findings	**Older Adults (2)**	**General Adults (2)**
Routine Insights	They showed interest in trying out new activities	They were unenthusiastic about changing routines due to busy schedules
Activities & Hobbies	Playing board games, read books, talk to friends, and share ideas.	Playing sports, painting, watching films
Social Networks - family, friends, online	Had social networks from volunteering, work colleagues, family and friends.	Constantly connected with colleagues, friends, and families.
What is valued in communication and its styles	Sharing stories and having others participate in them by responding. Do not like to share very personal feelings.	Asking about the day daily. Communication style depends on the context of the application in use

[16] Due to recruitment challenges during Covid-19. This is addressed in Chapter 6 under limitations.

Themes & Findings	Older Adults (2)	General Adults (2)
Tech Use likes & dislikes	Disliked constant app updates. Showed interest and comfort with using mobile applications but experienced onboarding troubles with some apps. Showed reliance on technology for keeping up to date with friends and families. Did not like public platforms of sharing.	Use social media apps very frequently but have observed an adoption cycle and stop using it after a while. Dislike frequent updates and the negative outcomes of using technology such as addiction and distractions.
Communication & Tech Challenges	Syncing with time zones when communicating with people overseas. Internet connection issues were identified as a major issue.	Difference in time zones when communicating with people overseas. Unavailability of people when wants to share urgent messages
Likes to do when upset, lonely or sad	They liked to write poetry, read books, keep fit or find physical activity to do.	Sleep, eat or do something productive

Table 4.1: List of coded findings from Interview 1

Furthermore, participants were asked an open-ended question about what an ideal interactive system they would use to keep in touch with other people. The following highlight some of the verbatims captured:

- "Sharing screens or information it all depends. When I face technical problems, I would like somebody to show me visually so by a video." – OA.
- "Highlights of the story gathered automatically and told to someone automatically at the end of the day" - GA.

- "I would like to have book clubs where I could share whatever I have read." – OA.

It was noticed that there are already digital solutions that exist for their current problems[17]. Being able to translate these ideas in Mixed Reality poses an interesting challenge in terms of research and design considering work is already underway in this space.

Summary

To summarize, the remarks and answers highlighted important insights on the pain points and needs of the participants. After close analysis, the interview results were used to generate ideas and inspire design decisions. The asynchronization of communication, for example, in the system was important to account for variable time zones. The user stories also showed how active participation of friends and family is considered of high value when it comes to sharing stories, which also validates the MRP's literature findings. Additionally, a detailed analysis of current technology is a valid segway into discussing how to synthesize data from this section to identify user goals and requirements in a format that will drive the design forward.

[17] Video/Audio messaging/calling such as on WhatsApp, Snapchat, Facebook.

4.2 Phase 2 - Synthesis

In this section, primary data acquired from the user story phase and the interviews is synthesized to create qualitative analysis for this study. The literature surveys explored in chapter 2, acts as secondary data to assist in creating quantitative analysis. Consequently, the design intent is determined by constructing a conceptual understanding of questions such as:

1) Who is the project being designed for?
2) What does it want to achieve?
3) Constraints and limitations,
4) Tools, skills required and,
5) Timeline of the research, followed by a list of must-haves of the system.

Primary Findings:

From the user story interview, it is found that the group of older adults like to spend their time socializing with people. The younger participants are time-sensitive in that

regard. Moreover, it was a common trend to see participants frequently communicating with people in different time zones.

Technology-wise, all participants were frequent smartphone users. They also had positive attitudes towards adopting new technology, but older adults expressed concern with applications that require a large learning curve and listed only a few software applications that were part of their daily routine. Frequent visual updates of software were constantly recognized as a nuisance by most participants. Younger adults expressed concerns regarding the negative side of technology, such as “addiction” and “distraction” that disrupts their daily duties. They additionally noted that software applications should have a single goal instead of a one-size-fits-all which adds to the confusion.

In the context of storytelling, older adults liked to read text heavy stories and in the stories that they shared with others, they expected active responses. Older adults valued meaning in their social relationships. This means that it is essential that the experience offers explicit value to them or they will not use the technology. In interpersonal activities they liked reading with others, being active on group chats, playing board games and maintaining fitness.

Secondary Findings:

Being unable to get access to primary quantitative data due to the small participant pool, an analysis of quantitative-based studies over the literature was done and its findings explored in this section. The purpose of doing this was to ensure that the design outcome of the project is flexible and applies to users outside the research as well. Chu et al. (2016) found from their quantitative study that the stories that the older adults share are usually in the form of reflections, explanations, a specific message that they want to convey to others, jokes, icebreakers, gossip, or lectures. One such study shows that pictures, concise questions, and unfamiliar stories work best to stimulate personal stories, especially if they are personal to authors (Alexandrakis et al., 2019). *A comparison of narratives told by younger and older adults* note that gender and age play important roles in affecting one's subjective experience (Beaudreau et al., 2005). Their results indicate that people within the younger age bracket prefer stories with a mixed amount of novelty and consistent topics while people in the older bracket, prefer more variation in topics. Reminiscing narratives have also been repeatedly found as a go-to preference when it comes to older adults sharing stories (Scott & DeBrew, 2009; Chu et al., 2016; Mager, 2019).

However, the system should be accountable for the topics provided for storytelling especially in reminiscing stories as there is the risk of triggering negative emotions. (Chu et al., 2016).

Design Intention

Prior to developing the system, a design intent is defined in Table 4.2 below as a summary of the target audience, performance objectives, constraints and requirements based on the analysis in the section above.

Concept	
Who (The Audience)	1- Older Adults over 65 2- Friends and family of older adults
What (user's objective)	The user's objective is to feel connected and socially engaged after using the system from the MRP.
What (system's mission)	For the tool that this project will develop, the mission is to use mobile Mixed Reality to make an engaging system for older adults that allows them to share their stories with friends and families.
Constraints and Limitations	
Hardware	The project needs to be developed on easily available platforms like a smartphone, tablet or laptops. It also needs to be online, have multiplayer connectivity and work over android and IOS operating systems.
Technological	It should follow all WCAG and digital accessibility guidelines for a friendly and inclusive user experience. It should also provide easy onboarding to improve technology adoption and to reduce the resources required for user training. This involves participants' ability to use technology as most new assistive devices require the use of smartphones or tablet devices. It should improve user safety by prioritizing privacy.

Concept	
Behavioral	Generalizing the behaviors and goals for older adults is extremely difficult. Because of this variance, the diffusion and adaptation of the product is also constrained on how the users feel about using the system and how they have perceived similar systems in the past.
Timeline	The project received a research ethics board approval on 5th of January and had needed to be completed

Table 4.2: Conceptual Design Intention

User Personas

Personas are behavioral models; they represent a set of people for whom we are solving the problem for. Personas assist us in clarifying the broad and diverse range of user needs and preferences. Inspired by the user typology (Birkland, Johanna LH, 2019), explored in Chapter 2, four user personas (shown in Figure 4.1), were made through the data captured from the interviews taken which are broken down into personality-related characteristics with age bracket, background, likes, goals, and pain points described for each.

USER 1 - Older Adult (65 -70 years)	
User Type	Guardian
Background	• Recently retired and lives with spouse at home • Connects with his/her children overseas almost every day • Often connects with friends and colleagues from prior workplace, some of are them also retired • Stays home mostly because of the current pandemic • Physically and cognitively healthy
Likes	• Watches TV for news and interesting documentaries • Every now and then, likes to try new things in daily routine • Reading and solving puzzles • Sending jokes and memes to friends • Using facebook to keep up do date with social network and likes shorter posts depending on the information being retrieved
Goals	• Talk about eventful activities with others and learn about theirs • Being able to share only with those they feel comfortable with - privacy is important
Pain Points	• Feels a disconnection & frustration when connecting with friends overseas because of timezones • Does not when their posts get unwanted comments • Will like to explore a new app but if it does not catch initial engagement, they will not use it

USER 2 - Older Adult (70-75 years)	
User Type	Traditionalist
Background	• Lives with spouse at their home where grandchildren come for vacations • Famous author of books and has a vast social network related to it. • Often participates in community work and goes to book reading clubs • Regularly receives pictures of young grand children who are overseas. The children are too young to effectively talk on phone and misses their presence • Has some mobility issues and cannot sit or stand for long periods • Not a savvy tech user
Likes	• Keen about learning • Enjoys poetry and reading books • Meeting, talking to new people and making connections • Uses WhatsApp easily to keep up do date with friends and shares pictures and videos on it.
Goals	• Connect with grandchildren in a fun way that they participate in • Need to see the value of social engagement in app to use it • Making friends online
Pain Points	• Doesn't like frequent updates of interfaces on apps. Requires initial assistance with using apps • Requires others to listen and participate in conversations otherwise will lose interest

USER 3 - General Adult (25-40 years)	
User Type	Practicalist
Background	• Working professional and is too busy to explore apps, activities but is open to the idea • Connects with close family through text & calls • Lives with family and older adults
Likes	• Short visual messages • Maintaining physical health • Watching TV, sharing shopping items via picture texts to friends & families • Likes to keep their life private to family & close friends • Productivity focused and dislikes social media apps for being addictive • Connects to friends weekly via games video calls and daily with family via calls
Goals	Connect with family online hassle-free through a fun activity
Pain Points	• When people are unavailable to, they would rather not share • Does not like public sharing

USER 4 - General Adult (18-25 years)	
User Type	Socializer
Background	• Attends school from home because of pandemic • Connects with friends remotely every day • Lives with grandparents and often assists them with tech • Very savvy with tech and understands app use quickly
Likes	• To use all social apps and try new ones and support from friends influence decisions • Does not have too much time with school to try new things in daily routine • Heavy Instagram & Snapchat Use to keep up to date with news, friends • Likes to paint and show it on social media platforms
Goals	Wants to connect with friends and work collegues
Pain Points	Does not like frequent and significant interface changes of app

Figure 4.1: User Personas

4.3 Phase 3 - Prototyping

Phase 3 of the methodology is prototyping. Prototyping allows researchers to determine whether the design will work as intended. This phase is divided into two iterations. Iteration 1 is dedicated to organizing, creating initial wireframes, and testing the technologies being used for Mixed Reality. Iteration 2 is dedicated to creating the high-fidelity prototype to showcase to participants and evaluating the software for suggested improvements. Figure 4.2 illustrates this phase.

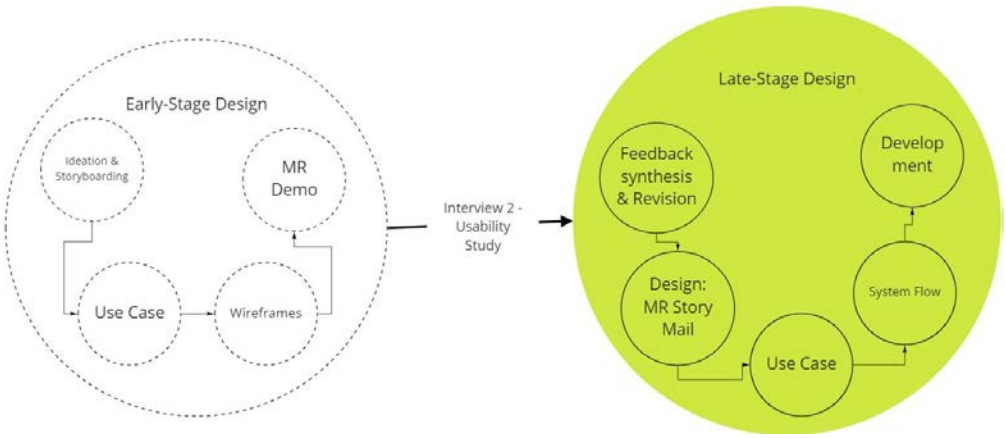


Figure 4.2: Phase 3 - Prototype process diagram

4.3.1 Iteration 1 - An Early-Stage Design

Ideation & Storyboarding - Early Stage

In this stage, the concept of combining social activities with storytelling is explored. The ideas that stood out the most were activities like board games, interactive narratives,

and wordplay. Based on participant interest revealed by the user stories, it was concluded that it is best to include multiple interpersonal and learning-based social activities/scenarios in the design such as; growing a plant; playing scrabble; and participating in a book club that supports storytelling. The reason for this is to give users the choice to select their favorite activity which will make the design flexible and interesting to use.

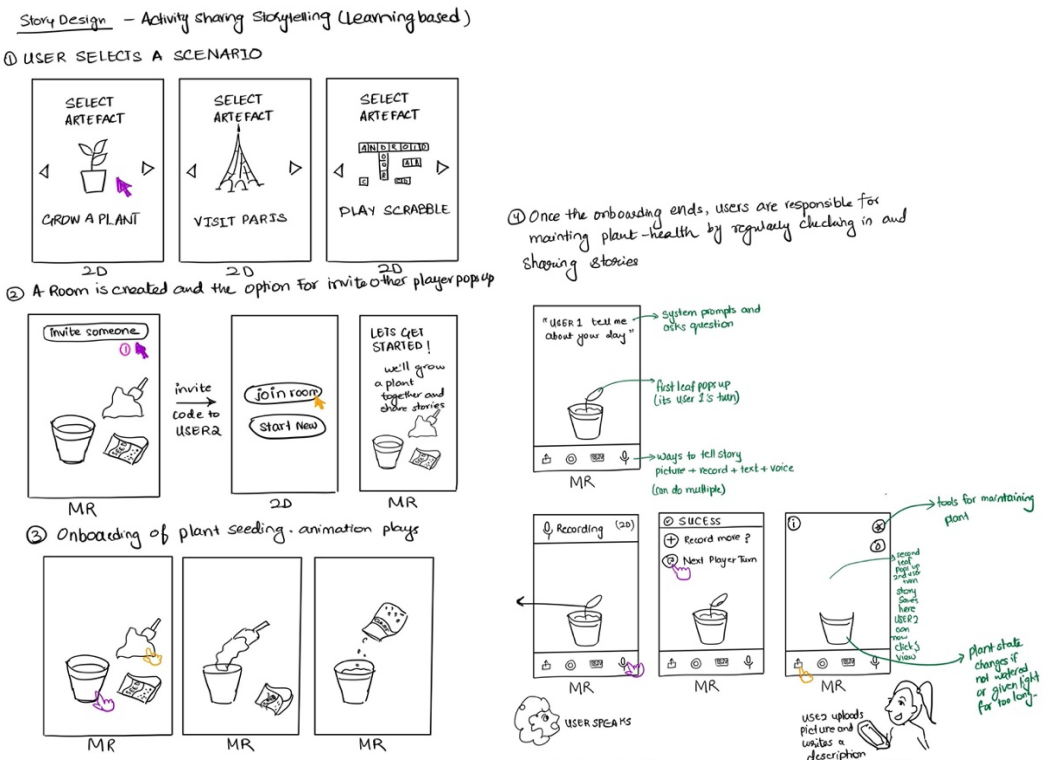


Figure 4.3: Ideation Storyboard for Early Design

To graphically organize this idea, storyboards were developed as shown in Figure 4.3. They illustrate how a user can select an activity; in this case growing a plant and then

inviting another user to share the activity with them. The plant was designed as a 3D mixed reality artefact which would grow whenever a story was shared.

Use case of design artefact

Use case diagrams are a way to capture the system's functionality and its requirements in a simple diagram. For an early-stage design, a use case diagram was made for a skeletal system of storytelling to facilitate the wireframing stage. This early use case consisted of users selecting a scenario, creating a networking room and inviting other users for a turn-based storytelling. This is illustrated in Figure 4.3.

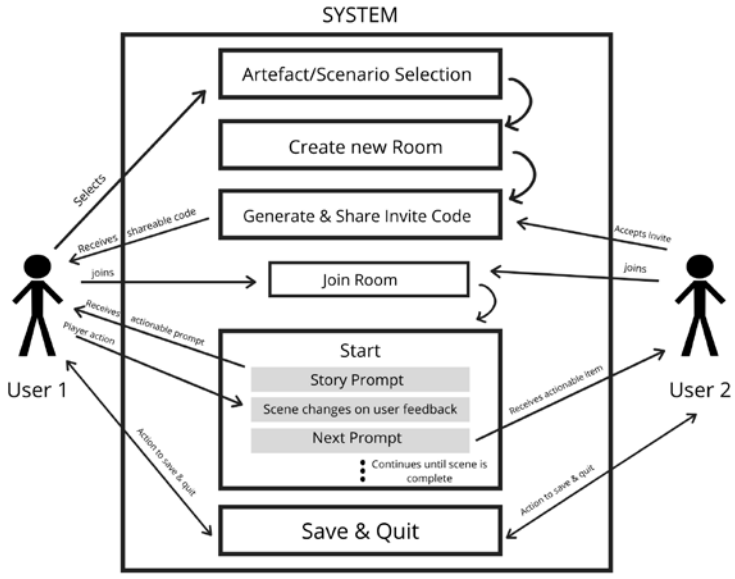
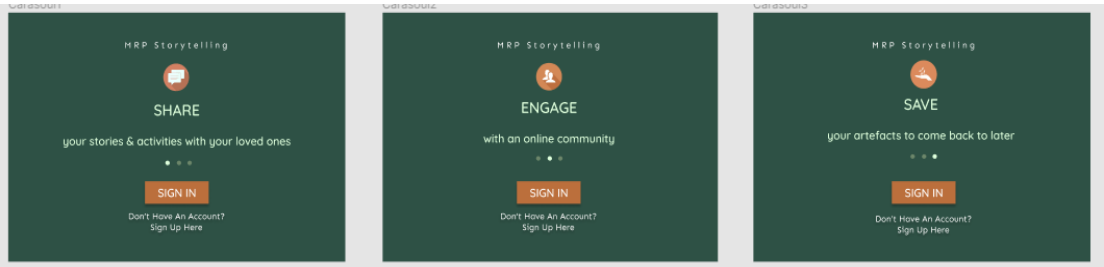


Figure 4.4: Use Case Diagram for an Early-Stage System

Wireframes

Wireframes provide a way to develop and present design ideas in the early stages of a project. The wireframes were developed in the Figma tool[18] to test the user interface of the system. A modern style mood board was used for inspiration. The 2D User Interface was made sure to comply with the WCAG standards (Caldwell et al., 2008) by using a contrast checker[19] to ensure that the font and background colors met the digital accessibility guidelines. Figure 4.5 shows the wireframes that were developed of the user selecting a scenario for the MR Demo.



[18] https://www.figma.com/
[19] https://contrastchecker.com/

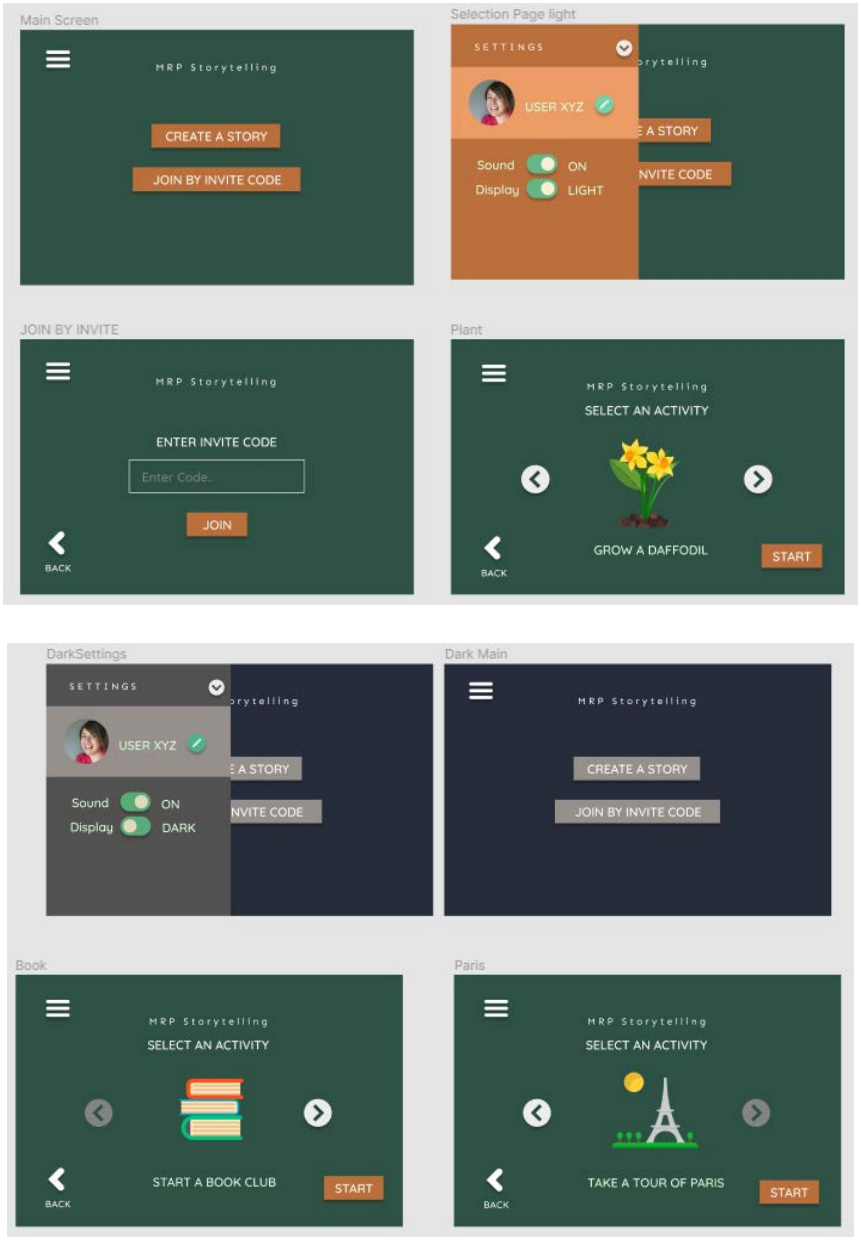


Figure 4.5: UI Wireframes for Selection of Scenario

MR Demo

To test user interaction in Mixed Reality, a demo of the plant growing scenario was built in Unity3D[20] using Mozilla WebXR API[21] (See Figure 4.6). The demo consisted of a 3D model projected in mixed reality but all user interactions in the system were through 2D buttons placed on the screen. The scene began by clicking the start button upon which a female character welcomes the users and ushers them into a plant growing area. At this stage no sounds or briefing was added. A watering can, seed pouch and plant pot were animated and were interactable and other objects in the scene like the butterfly and rabbit are animated Non-playable characters (NPCs). The story response was captured by animating the female character based on user responses who would watch the users taking turns to record their stories.

[20] https://unity3d.com/get-unity/download/archive
[21] https://github.com/MozillaReality/unity-webxr-export

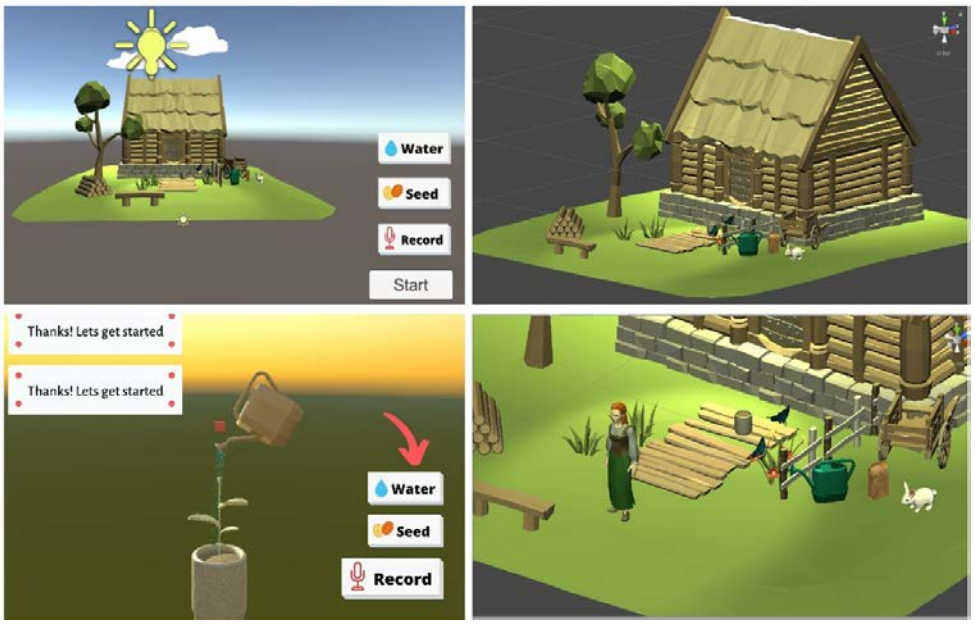


Figure 4.6: MR Demo

4.3.2 Usability Study

The first pass of wireframes and the demo were tested with users in an interview which consisted of a usability test followed by a co-design activity.

Participants were given access to the prototype via a web link and asked to complete a series of tasks during which each interaction was observed and problems that they encountered were recorded. The participants were also encouraged to think aloud as they used the prototype. This helped understand their behavior in the context of what they were trying to accomplish and to avoid any confusion in notetaking.

Following the user testing, the Virtuous Tornado[22] activity was carried out to practice co-design with participants. This method takes the needs and characteristics of the problem and injects it in each design iteration with the aim to make the solution more inclusive (Treviranus, 2018). This activity is meant to critique the existing design and consider diverse perspectives and needs of users. To start off, an explanation of the activity was given and then shared via screen share. The participants were then asked to reflect upon the system and comment on their experience. Every comment was then collaboratively placed using the Miro[23] tool into three categories; designs that I liked, designs that I had difficulty using and designs that I can't use, as illustrated in Figure 4.7.

[22] https://guide.inclusivedesign.ca/activities/virtuoustornado
[23] https://miro.com/

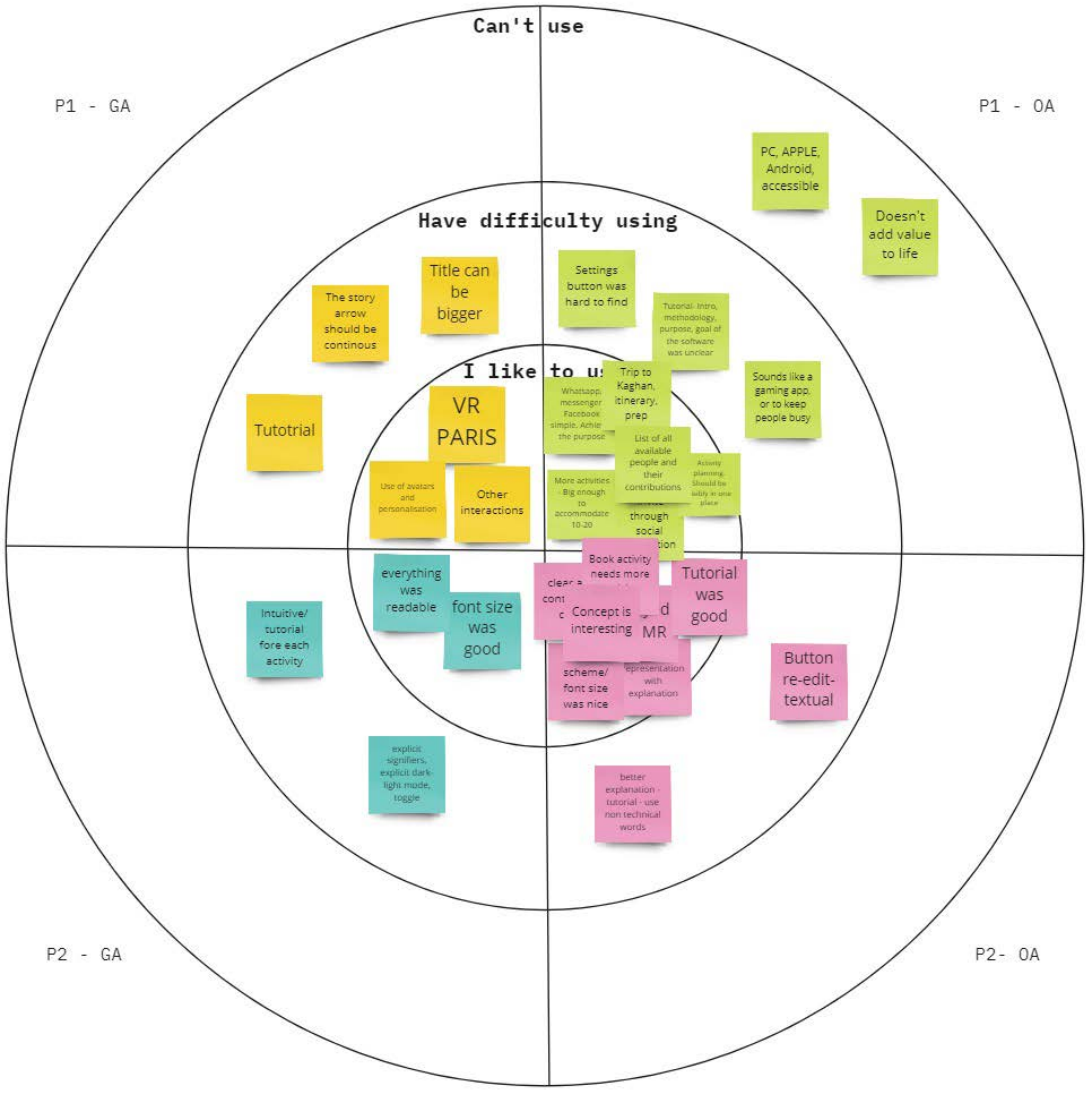


Figure 4.7: The online virtuous tornado activity for co-design using Miro

The findings were divided into two sections: usability test and co-design.

1) Findings from Usability Test:

Participants were generally able to navigate through the wireframes and interact with the demo. They expressed likeability of the colors and font sizes used. The main areas where difficulties were encountered are as follows:

1- In the wireframes, activity selection was not intuitive because it did not have a continuous slider.

2- UI icons that did not have a textual description were not perceived as interactable buttons.

3- While interacting with the Mixed Reality demo, it was noted that when participants were asked to “Water the Seed”, they touched the 3D artefact instead of the 2D button on the screen.

4- All participants noted the need for a tutorial to explain the purpose of the system. One such participant said that the goal and purpose of the system was unclear due to which they did not find any value in the system.

2) Findings from Co-design:

In the co-design activity, participants came up with creative design ideas that could help improve the current demo. They reflected upon their interaction with the system and vocalized the problems they found. They are summarized in the table below which were then fed back into the next iteration, followed by an improved design of the system.

Designs I like:	Participants said that they liked: 1- Big fonts 2- Bright colors 3- Mixed Reality feature Participants said that they would like: 4- To have a tutorial to explain the purpose of the app 5- More points of interactions in the system 6- To see more scenarios like the VR tour or book club 7- To invite social media friends and see them online. Big enough to accommodate 10-20 people. 7- To see visual representation of my friends as avatars and be able to personalize mine. 9- The system as a single source of truth for all activities.
Designs I have difficulty using:	1- As a communication app because other applications already serve that purpose. 2- Absence of intuitive onboarding before each activity
Designs I cannot use:	1- Do not see value in using system 2- Need to be accessible on android, apple platforms

Table 4.3: Findings from Co-design

4.3.3 Iteration 2 - A Late-Stage Design

The feedback from the usability studies highlighted important points on what needed to be changed in the design. To make the design effective, the second iteration revised the requirements for the systems based on the feedback received. As the previous design

was not effective to answer the research questions, changes were implemented in the final prototype.

Feedback synthesis and revision

In the second round of brainstorming, concepts of storytelling in Mixed Reality; specific to the research questions of the MRP, were investigated and different components of each concept were conceptualized. The components were mapped as sticky notes and categorized under each concept (Figure 4.8).

In this revision, exploration of combining social activities with storytelling in Iteration 1 was dropped as expanding upon more scenarios according to each participant's interest was time-expensive for this research. Following that, three more ideas for storytelling were generated (Figure 4.9). Idea 3 about the MR Story Mail system was decided to be carried forward to the next stage as it was deemed to have the most potential for representing the system. It is explained in detail in the following sections.

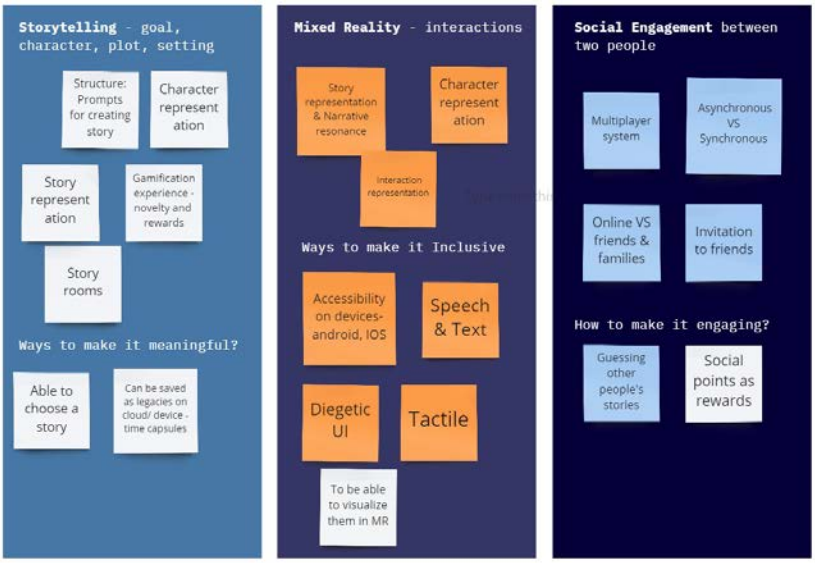


Figure 4.8: Concept mapping

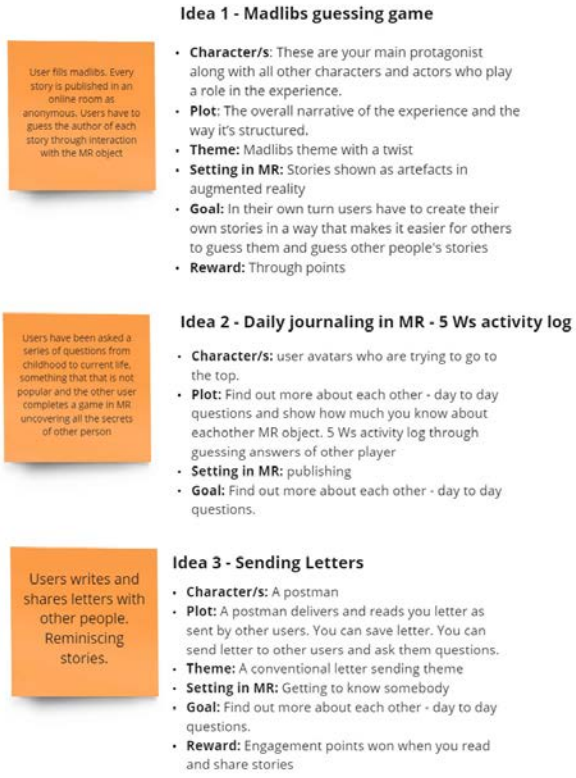


Figure 4.9: Idea Generation for Late Design

4.3.4 Prototype: A Mixed Reality (MR) Story Mail system

Figure 4.10: MR Story Mail: Log in

The Mixed Reality (MR) Story Mail system is the final design of this research project. The system incorporates storytelling by inviting users to write stories on categorized prompts/topics and offering them to share it with others in a shared 'room'. The use case diagram of the complete design (Figure 4.11), the Room structure diagram (Figure 4.12) and the system flow diagram (Figure 4.13) to sequentially represent the process are all illustrated below.

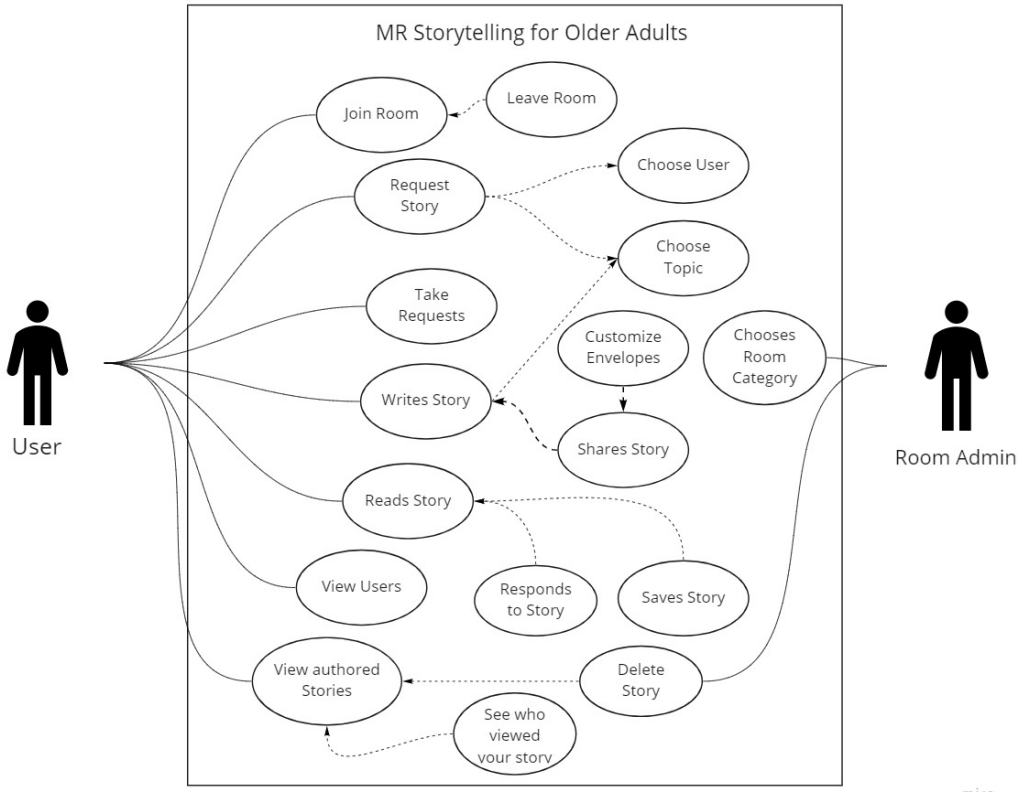


Figure 4.11: MR Story Mail: Use case diagram

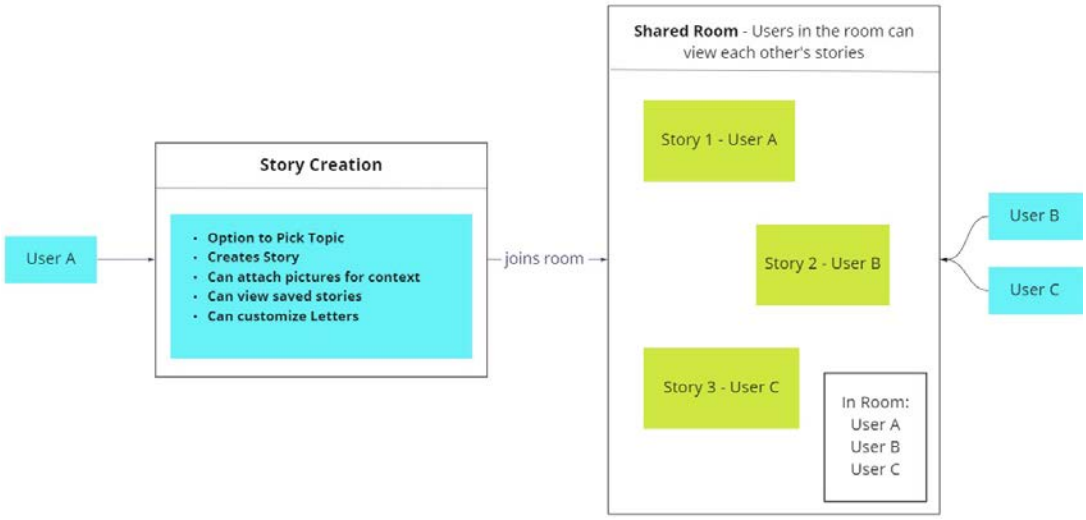


Figure 4.12: MR Story Mail: Room Structure

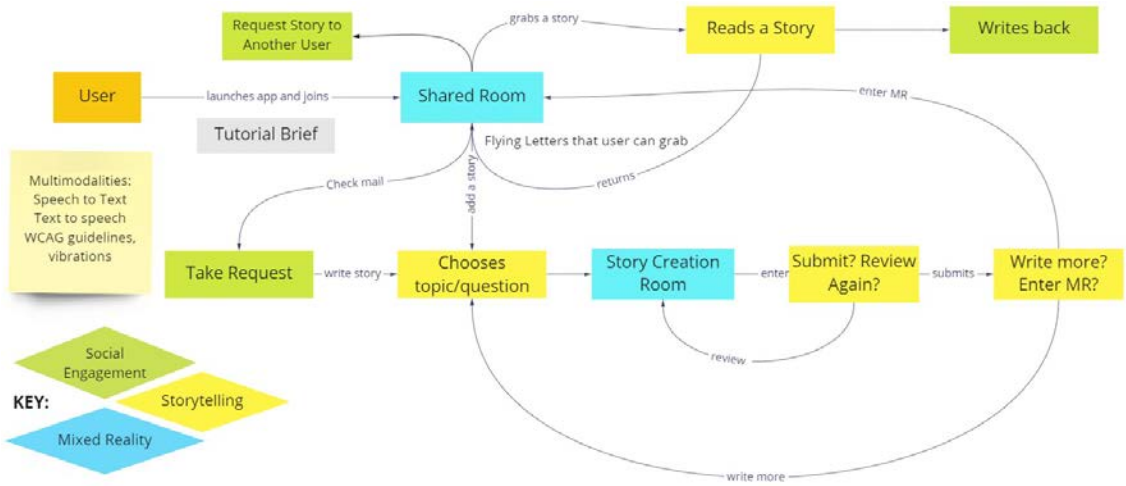


Figure 4.13: MR Story Mail: System flow diagram

The different components of the system are explained below with the snapshots from the actual system:

Goal: As a social story sharing platform, the purpose of MR Story Mail is to encourage older users to create and share stories with others.

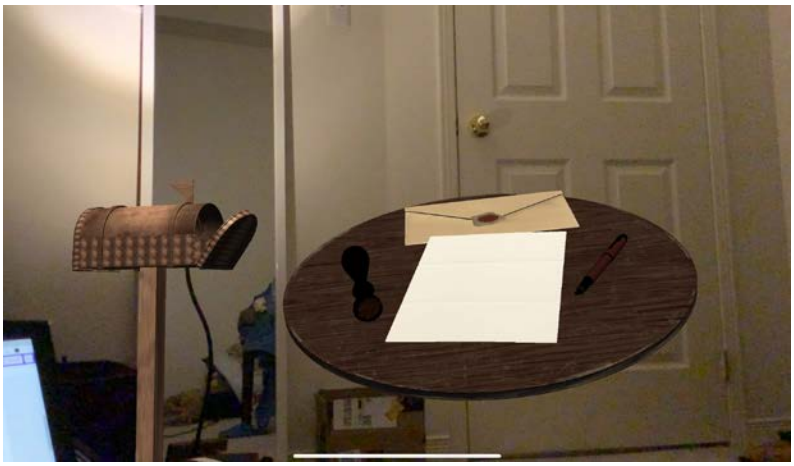


Figure 4.14: MR Story Mail: Theme & Setting

Theme & Setting: A conventional letter writing meant to resonate with the email system is the theme of the system. To resonate with the theme, 3D models relating to old-fashioned letter writing, set the scene in Mixed Reality. These include a table, post box, pen, paper, a traditional rubber stamp and envelope that blend with the environment (Figure 4.14). Clicking on the pen will start the story creation process. Upon finalizing, and submitting the story, it is shown as being written on a paper in the form of a letter and is enclosed in an envelope. Following this animation, the stamp will apply the user's personal logo on it and the letter will fly in the mailbox to inform the user that it has been shared.

Figure 4.15: MR Story Mail: Tutorial Briefing

Onboarding: To take the audience on a guided journey, the system starts off with a tutorial informing users about the various features of the system as part of the onboarding process (Figure 4.15). This is a one-time feature. But a "Help" button is always on the screen whenever a briefing is required. To not rush the user, briefing is

done in steps and will not move forward until the user presses the “Next” button. The option of a “Skip Tutorial” button is to facilitate users who would like to explore the system on their own. It is to note that the briefing is narrated aloud by the system as well as displayed textually on screen to support both modalities. Bright colored red arrows are indicators to facilitate the tutorial in the form of diegetic UI, meaning they are present in the world ie; the user's environment in mixed reality.

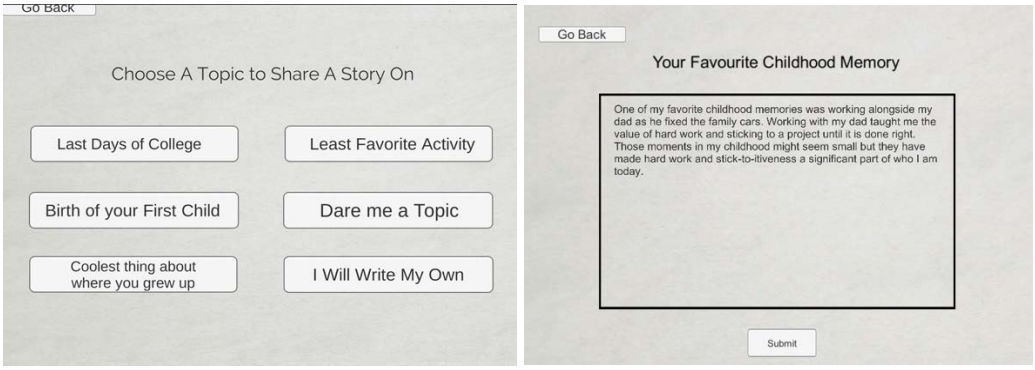


Figure 4.16: MR Story Mail: Story Creation

Story Creation: Storytelling in the system is designed by allowing users to choose a topic of the story (Figure 4.16). The topics are categorized in 3 types: 1) First three topics are reminiscent, 2) following two support novelty and the creative element 3) last option is for the user to define their own. The different topics are meant to add versatility to cater to a diverse participant personality. The user then writes the story through keyboard input.

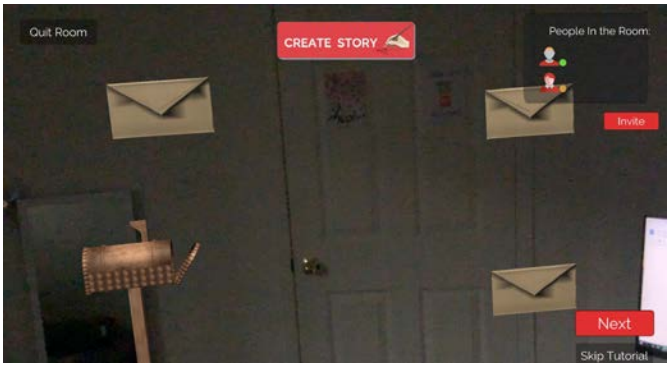


Figure 4.17: MR Story Mail: Shared Room

Story Sharing: Users can invite other people as connections. The story sharing room (Figure 4.17) is an online space where all the posted stories, in the form of enveloped letters, appear. These include the user's own stories as well as of their connections. Stories can be opened upon clicking on them.

Figure 4.18: MR Story Mail: Requested Stories

Requests & Response: Social Engagement in the system is through a request and response feature. The user can request a story on a chosen topic to their connection, in return get a response from another user and vice versa.

Housekeeping: For monitoring the shared content in the room, it is proposed that the system has a "Room admin" to ensure the system is not abused. However, this has not been developed in the prototype.

Development tools:

MR Story Mail is developed in Unity and deployed on WebGL. The Microsoft Mixed Reality Toolkit (MRTK) for Unity gives access to the Mixed Reality features and WebXR API located in the Rufus Simple WebXR[24] project. The API supports the deployment of the project as a WebGL build hosted on GitHub pages[25]. Networking in the project is done using Photon PUN2[26] API available on the Unity Asset store. Animations were done in Unity and rigging in Blender [27]. The 3D models were taken from Sketchfab[28] and remodeled to fit the project. The diagram below summarizes the tools and design decisions of the MR Story Mail System.

[24] https://github.com/Rufus31415/Simple-WebXR-Unity
[25] https://pages.github.com/
[26] https://www.photonengine.com/pun
[27] https://www.blender.org/
[28] https://sketchfab.com/

Feature	**Design Choice/ Explanation**
Content	
Text	The font size is large. Contrasts of font color vs background complies with WCAG guidelines ensure digital accessibility.
3D models	All models anchor in the air in the environment as the Mixed Reality Toolkit does not support spatial anchors in WebGL. The models were made interactive by touch with the MRTK buttons.
User Interface	This component was mixed. Unity 2D Sprites were used to make diegetic UI as part of the 3D scene in world space. Non-diegetic UI was made using 2D Images and UI on Canvas screen space overlay was used for information that needed to be present all the time. Adobe Photoshop was used to design the UI.
Rooms	The Story Creation and Shared Room were switchable through a button on the top panel
Animations	Animations were used on 2D menus as well as the 3D models were animated either in Unity or Blender. The animations consisted of: 1- Flying letters on startup and connecting screen 2- Moving tutorial arrows 3- Pen with a writing animation 4- Stamp 5- Idle, flying, opening, and closing animations of envelopes 6- Opening and closing of mailbox 7- Enclosing of letter in the envelope 8- 2D UI buttons
Sound	Sounds were used to give users an audible feedback on button clicks. The tutorial was also narrated.

Feature	Design Choice/ Explanation
Navigation	
Placing Game	MRTK places the game in users' surrounding environment.
Placing the Actors	Actors have a first person view of the world
Inputs	Keyboard textual input
User Engagement	Engagement is captured by scoring points whenever user shares or replies a story.
System Mechanics	
Making Decisions	Players take turns to play
Reviewing Decisions	System keeps a safe state that the users can go back to anytime using “player prefs” in Unity.
Inventory as a Choice	Offering several story prompts to choose from to cater to the interest of the user.
Making System Easy to Use	
Repeating Pattern	System itself has a repeated pattern and any novelty is added by the participatory response of other users when they reply or request stories
Testing the System	

Feature	Design Choice/ Explanation
Playability Issues	The playability experience of the system was observed to only be on larger displays like tablets.
Logistical Issues	The keyboard input on WebGL was found to be unsupported on mobiles which hindered the experience of testing. As WebXR is unsupported on the Safari browser, for IOS devices, the browser link had to be opened in the Mozilla WebXR viewer app which is freely available on the app store.
Deployment	WebGL was chosen as the deployment platform and GitHub pages are used to host the system. This results in a web link that could be opened in the browser. Works on Google Chrome and on a Web XR Viewer for IOS systems.
Networking	Photon Pun2 API is used to create the multiplayer experience
Privacy	The system requires access to the device's camera. As the system is hosted on browsers, it has an inbuilt feature of its own which asks for camera permissions when the AR mode is enabled for the first time. No user information is saved in the current prototype.

Table 4.4 Development Tools & Design Decisions

4.4 Phase 4 - Evaluation

Once the prototype was functional, participants were invited to the Zoom Interview for the final evaluation. The number of participants that took part in this session were

smaller than intended due to the challenges in online recruitment and remote delivery of research. The experiment first introduced the prototype as follows:

"You are in a room. You have letters around you. Each letter is a story that someone has shared about themselves. You can open and read their stories. You can create your own stories and share them too."

Following this the evaluation of the prototype began. The participants were encouraged to think aloud whilst they used it. As the keyboard input was not supported on mobile, the story recording was tested by a Wizard of Oz method where participants shared stories live on call as they used the mail system. It is important to note the participants who were unable to open the system on their browser were first shown the experience from the researcher's personal device via screen share (Figure 4.19) and then were given remote control (Figure 4.20). Following the experiment, participants were asked about their thoughts, and suggestions on each of the three concepts of this project i.e., storytelling, mixed reality and social engagement and to comment about the system use.

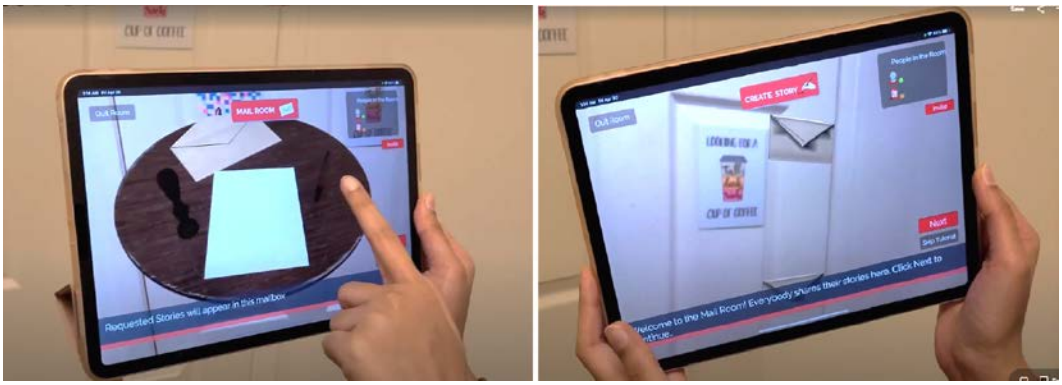


Figure 4.19: MR Story Mail in use

Figure 4.20: Participant Interacting with MR Story Mail

The aggregated feedback is shown in Table 4.5 below:

Question Prompts	**Older Participants**	**Younger Participants**
Did you notice improvements in the system that fit your initial feedback? (for co-design group)	System was found to be relatively more coherent after the usability test. Instructional briefing was recognized as one of the improvements as well as the display of online connections on the screen and textual icons.	The 3D models in the MR demo were seen as visually more attractive relative to the current theme.

Question Prompts	Older Participants	Younger Participants
How well does the experience cater to your needs versus the idea proposed in the demo? (for co-design group)	Conversational storytelling was seen as an activity that all participants enjoyed and practiced.	-
Any positive and pleasant experiences you would like to share.	2 out of 3 participants said that this experience reminds them of the time they gather with their friends and retell all their favorite life stories with them.	One of the participants noted that the story her paired older participant shared was something she had never known before.
Any negative feelings or system drawbacks that you experienced?	One participant did not find the instructions clear as opposed to the other who did. The exact words were “Instructions are not clear and shouldn’t come without asking”	Did not state a negative feeling when they used the system.
What did you like about the system?	2 out of 3 liked the idea of being able to save the stories as mementos for their grandchildren.	One participant who was fond of writing stated how it had a “journaling” element to it which she liked.
What didn’t you like about the system?	It required internet connection and all the participants expressed this as hindering because they often experience a bad internet connection where they lived	It was noted that the system was not socially engaging as they did not get to try it out with new people.

Question Prompts	Older Participants	Younger Participants
Do you know anyone that would like this system?	Friends of older participants were recognized as people who will be interested in the system as they practiced storytelling often.	-

Table 4.5: Feedback from Evaluation

Additional observations:

- Participants who used the system were sitting together and could not assess how socially engaged they felt. Additionally, it was noticed that the older participant with the enthusiastic personality chose a story topic on "Dare me a topic" while the rest of the older adults either picked reminiscent topics or their own.
- The older participants were able to narrate the story extremely well. The younger adults found it difficult to think of a story. One of the younger adults, therefore, chose to respond to the story that was shared by their paired older adult.

Participant suggestions to the system:

- 2-3 older participants mentioned how they would like to have other modalities that would support the recording of the stories. This was also validated by the younger participants.

- A younger participant mentioned how it could potentially be socially beneficial if she was sharing stories with people who were relatively new.
- One of the older adults expressed how having a story checklist criterion would help him narrate better stories. A draft mode would also allow him to come back to his drafted stories until they were ready to be published. The same participant suggested other improvements which included: indication of the author on the letter in the shared room, if one story could be constructed together by different collaborators sharing their ideas on eventful experiences so it can entail a valuable lesson which others could learn from, and classifications of published stories.

After the interview, the participants were asked to fill the post-survey form which concluded the final evaluation interview. The findings from the surveys and the qualitative feedback captured in this session are analyzed and discussed in the next chapter.

Chapter 5: Findings & Analysis

This chapter discusses the results gathered from the final evaluation phase which included observations and interviews. Although the evaluation sample was small, interesting, and considerable results were noted through quantitative and qualitative approaches. Data visualization is used to compare and analyze the results from the quantitative data. The qualitative data is interpreted as critical feedback and is compared with existing benefits and costs of storytelling.

The results of the user evaluation of the final designs are then used to address the research question of this project. Finally, the reflection of this chapter discusses the successes and shortcomings of the prototype's design and its impact on social engagement of older adults.

5.1 Results

Evaluation Group: The evaluation group of participants consisted of two pairs with one 65 years and above and one 18-64 years of age in each pair plus one additional pair consisting of both participants from the age group of 65 and above. The first two pairs were primarily involved in the co-designing of the system. The last pair was only

included in the final evaluation so that results could be compared by analyzing the feedback from the co-design participants with the new ones to be able to assess the flexibility of the design.

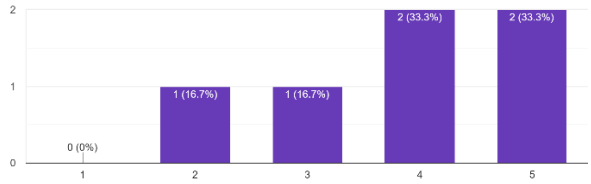
Demographic information was not obtained as it was not deemed important for assessment; however, participants were asked in the household section of the pre-survey about the number of people they were living with. This was to get an idea whether they were living alone or had social support at home. All the participants in the research were found to be living with at least two other family members.

Survey Results: Quantitative analysis on the perceived wellness (Appendix D - first three questions of Survey) that would have been a result of social engagement is not possible. This is because the data captured by the pre and post surveys on those metrics have a very small sample size of only six participants to be able to confidently apply the one-sample T-test as well as the non-interventional model of the research. Therefore, it has been nulled as it holds no statistical value.

Regarding the system evaluation section in the post survey (Section: Post Survey Appendix D), answers were analyzed by illustrating the results in graphs (Figure 5.1, 5.2, 5.3). The graphs demonstrate a general trend towards the right, which showcases positive sentiment for the system.

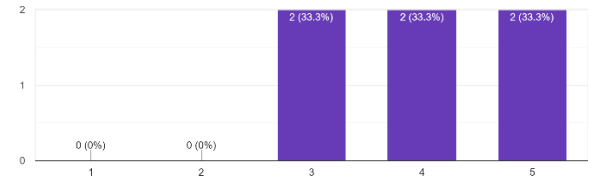
1. You felt engaged with each other's stories.

6 responses



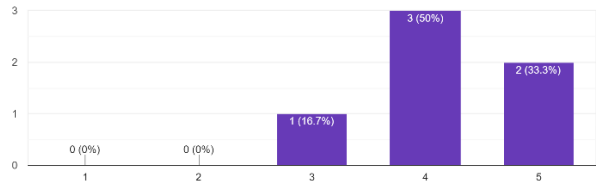
2. You felt positive effects on mood and social stimulation after using the application.

6 responses



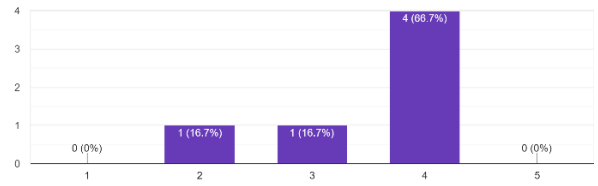
3. You enjoyed producing and telling stories

6 responses



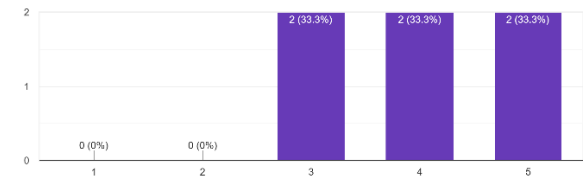
4. The application was good at replicating some of the physical social interaction

6 responses



5. You felt companionship in the experience

6 responses



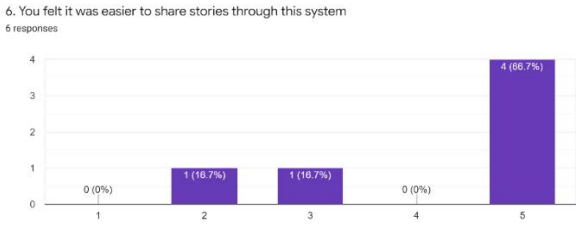


Figure 5.1: Post-Survey Evaluation: As a Storyteller

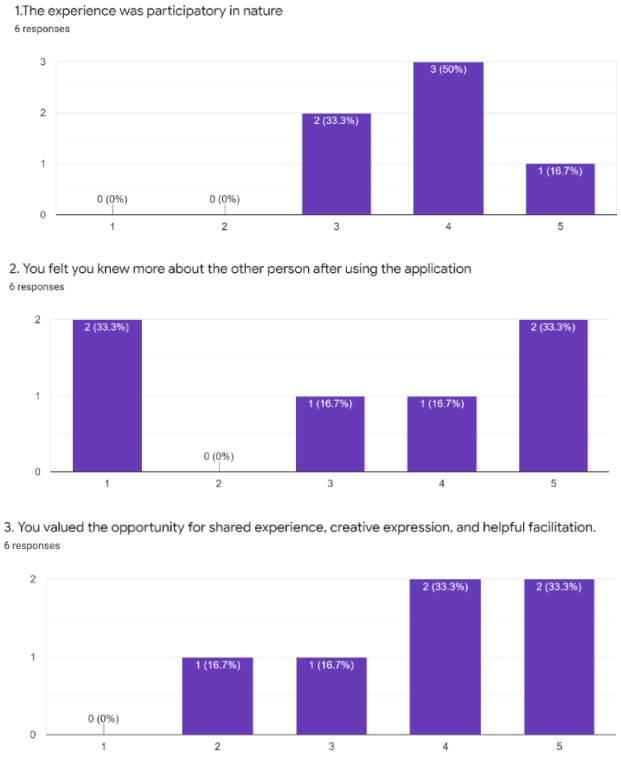
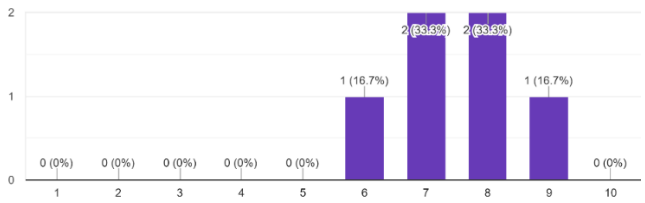


Figure 5.2: Post-Survey Evaluation: As a Storylistener

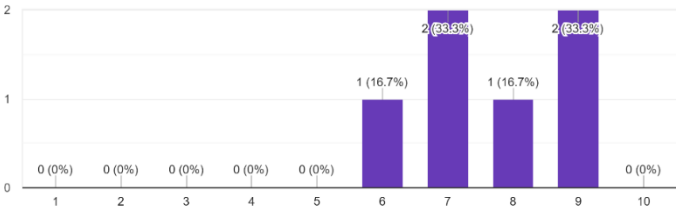
1. How satisfied are you with this system in terms of interaction

6 responses



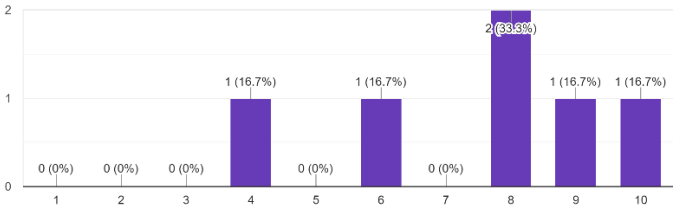
2. How satisfied are you with this system in terms of engagement

6 responses



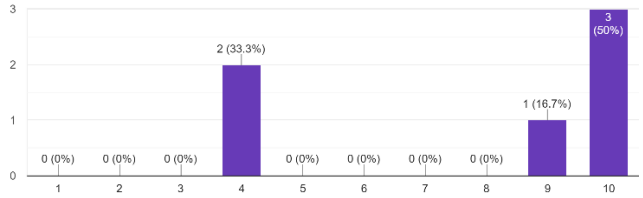
3.How satisfied are you with this system in terms of immersion. (Immersion is the feeling of presence in the environment)

6 responses



4. How satisfied are you with this system in terms of storytelling

6 responses



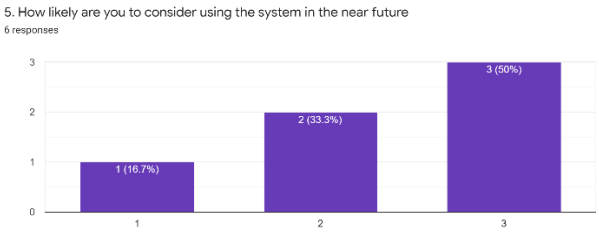


Figure 5.3: Post-Survey Evaluation: System

Moreover, data from the System Usability Scale (SUS) section (Appendix D – System Usability Scale) in the post survey provides insights on the ease of use of the system. The percentiles were calculated using a SUS calculator [29] online and then interpreted with an adjective rating using the general guideline provided there (See Table 5.1).

Participant (OA = Older Adult, GA = General Adult, N = New Group)	**Percentile**	**Ranking**
OA 1	52.5	Poor
OA 2	75	Good
N-OA	47.5	Awful
GA 1	97.5	Excellent
GA 2	95	Excellent
N-OA	40	Awful

Table 5.1: Evaluation of System Usability Scale

[29] https://uiuxtrend.com/sus-calculator/

Summary of Qualitative Results: The findings from the evaluation phase (Table 4.5 in Chapter 4), demonstrated an overall liking to the system and older participants expressed their joy in reminiscing. They were positive towards using it in the future thinking about how the prototype can be developed into a fully functional system. Pain points of the current system from all or at least one of the participants were: Instructions were not clearly conveyed, prototype was not accessible and did not run on their android device, story recording did not offer other types of inputs such as visual or audio and finally they could not comment on how socially engaging the system was for them.

5. 2 Research Outcomes:

Many of the quantitative analyses by studies on storytelling with older adults investigated in chapter 2, demonstrate that older adults enjoy sharing life stories (Lili & Rincon et al, 2018; Chu et al., 2016) which is validated by the findings from the qualitative studies of the MRP. Additionally, the ICT Typology Birkland (2019) (Table 2.3 in Chapter 2) and successful aging as a welfare Model (Lee & Park, 2020) explored in the literature are cross sectioned with the key takeaways on the ways a Mixed Reality Storytelling design can support the aforementioned frameworks which were considered at best when designing the system. This highlights an important contribution to the research on Mixed Reality storytelling for older adults.

Conversational storytelling is researched in this MRP and prior to usability and co-design sessions, it was designed to support several social activities based on participant interest, such as stories shared during a virtual trip to Paris, while growing a plant, or in a book club. This early design was later changed in iteration 2 to conversational storytelling as an interpersonal activity that involved narrating stories and sharing them with friends and family much like the email/social media system. This design is applied to the MR Story Mail, the prototype of the designed system. Revisiting the taxonomy of social engagement (Levasseur et al., 2010), the level of social engagement the MRP design outcome entails is an overlap of level 3: “Interaction with others (social contact) without doing a specific activity with them” which is accomplished through a Story Creation which is as individual activity but meant to be shared with others afterwards. And level 4: ‘Doing an activity with others (collaborating to reach the same goal)” which is achieved in the Shared Room that involves various collaborators populating the room with their stories.

Regarding Mixed Reality and technical tools, the SUS results (Table 5.1) showed that older adults did not find the system easy to use. This experience was rated poor for all the older adults who were android users. As the resulting prototype did not function on android, a possible reason for poor response could be that since they did not get to experience the system on their own, they were confused on how it worked. This is a

valuable outcome as it shows that older adults may not foresee technology usability until they have experienced the system fully which is an opportunity for future research.

Reflecting upon the methodology, the co-design and user centered approach was found to work in the favor of all participants as they felt more positive about the system after seeing that the final design incorporated their suggested feedback. This is demonstrated by the feedback evaluation on the overall improvement in design after the usability and co-design activity (Table 4.5, Row 2).

In addition, the table below (Table 5.2) evaluates the benefits of the designed system based on the qualitative studies, as well as the costs that future research can improve upon:

	Benefits	**Cost**
Networking	Regarding sharing, asynchronous storytelling can cater to the situation where family and friends are separated by time zones. This requires less planning and enables older adults to share their story at any time without feeling their audience is forced.	This feature can discourage storytellers who look for active feedback.
Content & Story Triggers	The use of variable story topics makes it easier for older adults to remember a story while at the same	Storyteller either had too little or too much to talk about and

	Benefits	Cost
	time having the option to choose their own gives flexibility to design.	system needs content management
Engagement	The concept of shared room in mixed reality encourages a social element where individuals can read their connections' stories much like having social media groups.	The system lacks interactive engagement. With gesture-based mixed reality, it can become a digital activity and can be improved upon to add layers of engagement.
Theme and context	The use of narrative resonance achieved through the use of 3D artefacts that were relevant to the theme i.e., letter writing made the experience intuitive.	The theme does not appeal to everyone.
Medium	Mixed Reality was a novel which sparked interest in users to use the system.	The mobile-based Mixed Reality was cumbersome to use for older adults.
Storytelling intention	Sharing stories as artefacts is enjoyable.	Stories need categorization.

Table 5.2: The costs and benefits of the MR storytelling Design

As a final contribution, Table 5.3 compares the benefits and costs (Chu et al., 2016) of related work on storytelling with older adults involving three kinds of mediums: tactile, digital workshop and Virtual Reality with that of MR Story Mail.

	Social/Emotional	Cognitive	Practical
Slots- Story (Tactile) (Li, Hu et al., 2018)			
Benefit	Intergenerational bonding and preservation of family history.	Increases awareness through recalling of memories.	It requires recording stories with a flash drive on a tactile box that has only two buttons and an LCD display. It is less of a learning curve and the delivery is asynchronous.
Cost	It is one – way from an older adult to the children.	The recording of stories is not moderated and may become repetitive.	It involves an in-person back-and-forth exchange of flash drive.
The Highway of Life (Virtual Reality) (Baker et al., 2020)			
Benefit	Older adults reminisce in a group about their past experiences and reflect on how far they have come.	It is thought provoking and reflective.	Involves multiple users co-present in a single virtual environment.
Cost	Might cause negative feelings if storytellers feel less accomplished than others.	As it about thinking on the pathway of life, it might lead to feelings of sadness.	Synchronous and is not flexible with other activities as it requires pre-planning.

	Social/Emotional	Cognitive	Practical
Sharing Life Stories (Digital Workshop) (Hausknecht et al., 2016)			
Benefit	Involves older adults getting together to know each other and writing and sharing stories.	It is learning-centered and involves tutorials on writing narratives.	Community-based and is appealing to storytellers who prefer in-person social groups and meeting new people.
Cost	Costs relating to the emotional risks of reminiscence such as sadness.	Time constrained and may make participants feel rushed.	Is event-based and requires planning to gather people and therefore cannot happen on a daily basis.
MR Story Mail (Mixed Reality)			
Benefit	Conversational benefits such as an increased ability to communicate.	Recalling of memories stimulates cognitive functioning.	It is asynchronous and can be flexibly done with other activities.
Cost	Might cause a negative feeling if shared stories do not get responses by others.	It is not moderated and may become repetitive.	Direct communication not possible and involves a relatively higher tech literacy curve.

Table 5.3: MR Story Mail compared to Related Work

Chapter 6: Conclusion and Final Thoughts

This research has presented a scan of existing literature and followed a participatory research approach to develop, evaluate and analyze the MR Storytelling prototype with the help of participating older adults and their friends and families.

This chapter discusses the challenges that were faced during the extent of the project and briefly captures the future work that can be done beyond the scope of the project. It sums up the work performed as part of the research project under conclusions.

6.1 Limitations:

The research faced challenges and limitations were discovered majorly caused by carrying out the project during the peak time of the Covid-19 pandemic. Interviews and co-designing activities were carried out remotely, with the efficacy of testing not being optimal as the research required testing the prototype on their personal devices which often failed to support WebXR. As a result, the evaluation on the ease of use of the system was not precisely measured.

Additionally, the research lacks statistical power because of its small sample size of participants and a self-reported assessment on social engagement. Due to difficulties in recruitment at the time of the research, there is also a lack of diversity in the audience in terms of socio-economic background, cognitive health, and culture. Therefore, findings from this research do not guarantee full inclusiveness.

The system was not mature and exhaustive enough to handle all use cases due to time and skill-level constraints of the researcher. The full features of the design are not tested, which does not evaluate the complete representation and experience of the designed storytelling system.

6.2 Lessons Learned

When designing storytelling, one of the lessons learned was the importance of having a story process that aided storytellers with the retrieval of details, mental organization, and tracking. Empirical data on social engagement relating to wellness is not to be used if the experiment is not of an interventional nature and henceforth was found not applicable to this study.

Within the scope of Mixed Reality, the most advanced MR see-through head-mounted-displays such as HoloLens 2, Magic Leap[30] and Nreal[31] has not reached critical mass use due to their expense. Hardware wise they are also chunky and have an extensive learning curve. Microsoft's Mixed Reality toolkits (MRTK), which this MRP utilizes to develop the prototype, is deployed on a mobile web platform. The window display from the mobile-based Mixed Reality limits affordances such as gesture controls and greatly reduces the situational awareness of the person giving a sense of separation from the virtual and real environment to the user. Affordances of immersion and presence that Mixed Reality can potentially offer with the lighter-weight headsets therefore remains untested with the MR Story Mail.

Nevertheless, the study demonstrates the potential to apply the designed system of this MRP to wearable Mixed Reality technology when developing immersive experiences.

6.3 Future Work

Inclusive design entails designing for the elderly who have physical impairments such as visual and auditory and individuals with motor disease such as Parkinson's. For future work, the vision is to provide an accessible set of input and output options to various

[30] https://www.magicleap.com/
[31] https://www.nreal.ai/

sets of people catering to their impairments and subsequently empowering them to socially engage with family and friends.

The input options in the market that support Mixed Reality include wearables such as HoloLens and NReal that supports both visual feedback and gesture-based interactions. For output, haptic feedback is a new generation tool being employed in popular technologies such as the Apple Watch.

Finding the right balance of acceptance and technology integration is important to enable elderly people to socially engage with the people around them. To achieve that, progression toward miniaturization of technology, one which Neuralink[32] has been able to achieve, is paving the way towards smart interfaces designed to allow better communication and can open new use cases for social networking.

Expanding upon the use of Artificial Intelligence in generating 3D models by narration, GPT-3[33] or DALL.E[34], are frameworks based on the concept of deep learning that enables production of human-like text and images, respectively. For the case of this MRP, both tools can be utilized to generate stories for users and users can create picture stories or animations to be shared with members.

[32] https://neuralink.com/
[33] https://gpt3.website/
[34] https://openai.com/blog/dall-e/

6.4 Conclusion

This project researched on the design of mobile-based Mixed Reality to provide a novel interactive platform for older adults where they can save and share stories with others. By co-designing with age-diverse participants over the course of three months, the participants identified types of communication habits and social behaviors that responded to their social needs, engaged with a relatively high-fidelity Mixed Reality Storytelling prototype developed from their user stories, and evaluated a refined design on its implementation. The findings of this project illustrated the appreciation of storytelling amongst older adults and the improvements they would like to see in using social MR as a platform. Findings on storytelling also highlight how previous studies resonate with it, giving it an extra layer of validation. Participants believed prospects of wearable Mixed Reality might offer advantages as a storytelling medium that will excite them to use it in the future. By reflecting on the participatory design process, this research highlighted some of the decision-making processes that informed the study as well as the challenges experienced in remote design. As a result of conducting this study, the research has advanced its understanding about older adults' views on the potential for Mixed Reality to be used as a meaningful medium for social storytelling. The future of designing storytelling applications is visioned as a tool powerful enough to visualize stories in mixed reality, inclusively designed to bring generations together.

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Appendix A: Recruitment Poster

Ontario College of Art & Design University
Graduate Studies

PARTICIPANTS NEEDED FOR RESEARCH IN

MIXED REALITY STORYTELLING FOR SOCIAL ENGAGEMENT WITH OLDER ADULTS

An online research study to investigate the use of Mixed Reality* by older adults when sharing stories and socializing at a distance.

Definiion: Mixed reality is a combination of Augmented Reality (AR) and Virtual Reality (VR) which can be used to generate 3D digital objects and environments in a physical world that can be experienced on a phone, tablet or a laptop device.

As a participant in this study, you would be asked to participate in online interviews, computer-based surveys and assessment questionnaires.

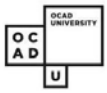
Your participation would involve:
2 online surveys of 15 mins each
1 video conferencing session of 60 minute each

ELIGIBILITY CRITERIA

- An adult 18 years of age or older and have a friend/family of 65 years or older who is willing to participate
- Have access to internet via computer and smartphone or tablet
- Not suffering from cognitive decline like Dementia (such as that caused by Alzheimer's) or risks such as PTSD (for physical & emotional safety)

For more information about this study or to volunteer for this study, please contact Amna Azhar, Graduate Student Researcher

Appendix C: Informed Consent



Consent Form

Date: 10 – March -2021
Project Title: Mixed Reality Storytelling for Social Engagement with Older Adults

PURPOSE

You are invited to take part in an online study as part of OCAD University Inclusive Design graduate student research project on **Mixed Reality Storytelling for Social Engagement with Older Adults**. Mixed Reality is defined as generating 3D digital objects and environments in a physical world, that is experienced on a smartphone, tablet or laptop device. **The purpose of this study is to investigate the use of Mixed Reality by older adults when sharing stories online and socializing at a distance.**

In this research, you will be partnered with another participant to work on shared storytelling. The following two types of participants can participate:

- **Older Adult (aged 65 or older),**
- **General (aged 18 - 64)**

Older Adults may choose to join the study together with a family, friend or other adult who fulfil this criterion.

Eligible participants will meet the following criteria:

- Minimal English-speaking proficiency (participants with English as a second language are encouraged to participate)
- Have access to the internet and a smartphone, laptop/computer or tablet with camera capabilities.
- Do not suffer from cognitive conditions like Dementia (such as that caused by Alzheimer's) or risks such as Post Traumatic Stress Disorder (PTSD) to maintain physical and emotional safety.

WHAT'S INVOLVED

As a participant, you will be involved in helping to understand mixed reality design sharing stories through giving feedback on prototypes.

Time commitment:	The study will take a **maximum total of 3.5 hours** of your time and will consist of three 1-hour session and two 15-min surveys.
Technology requirements:	You will require: **1) a smartphone, tablet or computer with a camera and** **2) internet access to participate** **3) a video conferencing software like Skype, Zoom or Microsoft Teams.** Before each session, an email will be sent with the link for the online meeting based on the availability that will be confirmed with you.
Pre-study & Post-study Surveys – 15 min	To understand your personality, an online survey in the beginning and end of the research will ask you standard questions from published research studies, about demographics and your **physical, social, or emotional well-being**. All questions will be of type Yes/No or rating scales. *You may skip any questions that you do not wish to answer.*
Session 1: Interview (Design) – 1 hour	This session will include **storytelling exercises and exploration of digital communication** to gain a better understanding of your preferred communication style, its challenges, and your offline and online social activities
Session 2: Testing (Design)- 1 hour	This session will be carried out between you, your group member (participants who did not opt for a group member, will be assigned a volunteer) and the researcher. Your group will explore an early-stage design of a mixed reality prototype software and will be asked to comment on what you thought of the application and its usability.
Sessions 3: Final Evaluation- 1 hour	This session will invite you and your group member to test the late-stage final research prototype software incorporating feedback from Testing Session 2, followed by a discussion to reflect on your experience of using the software.

Recording: Video and audio recordings of each session will be compiled with your permission (See page 5). You can still participate without having the session recorded.

POTENTIAL BENEFITS

Possible direct benefits of participation to candidates include:

- Experiencing positive feelings such as a sense of enjoyment from exposure to new interests, experiences and environment
- Benefits of social engagement and storytelling include promoting a sense of belonging, stimulating mental activity and supporting social needs to build companionships free from physical constraints.

Research will provide foreseeable benefits to society such as:

- Improvement in overall quality of life for older adults through encouraging social cohesion.
- A positive effect on overall contentment for family members and caretakers in old age and nursing homes.

Participation in study will contribute insights for future researchers to build upon advanced immersive experiences inclusively, which will also benefit older adults and society, if later adopted as part of a social engagement system to overcome negative feelings of isolation leading to depression.

POTENTIAL RISKS

There may also be minimal risks associated with participation. The foreseeable physical and psychological risks are associated with the:

- discomfort of answering interview/survey questions some of which are personal in nature
- visual fatigue from computer screen time
- frustration from understanding new software interfaces

In order to minimize these risks, participants:

- May choose not to answer any research question
- May take as many breaks as needed
- May stop the session at any point in time
- Will be provided instructional videos and textual instructions wherever required and encouraged to ask questions. Researcher will be available to provide support where needed.

CONFIDENTIALITY

- All information including the demographic data you provide is considered confidential and will be aggregated with responses from other participants, therefore you will not be identified individually in any way in written reports of this research.
- Any quotations from interviews or surveys will **not** be attributed to you without your permission.

- Video, photographic and audio recordings of participants will **not** be presented without permission.

Group Confidentiality:

Participants are requested not to share any personally identifiable information regarding the study which could identify others in order to preserve privacy.

Storage of Data

- All data collected during this study will be stored on a secure (encrypted) password protected computer or flash drive in locked cabinets that will only be accessible to the researcher, Amna Azhar, and faculty advisors, Dr. Alexis Morris, and Dr. Michelle Wyndham-West.
- Data will be kept for analysis reasons for 1 year until April 2022, after which time any paper documents will be shredded and digital documents (including auditory and visual data) erased and destroyed from the flash drive.

VOLUNTARY PARTICIPATION

All participation in this study is voluntary. If you wish, you may decline to answer any questions or not participate in any component of the study.

Furthermore, **you may review, edit and withdraw from this research at any point provided you contact the graduate researcher, Amna Azhar, before 15th March 2021.** Alternatively you may contact Dr. Alexis Morris by emailing at amorris@faculty.ocadu.ca or Dr Michelle Wyndham-West by emailing at mwyndhamwest@faculty.ocadu.ca. Your decision on whether to participate or not will **not** influence your future relations with OCAD University or the investigators involved in the research.

PUBLICATION OF RESULTS

The results of the research will be available in a written research report ie; the graduate Major Research Project on OCAD University's online research repository after publication in May 2021

Any request for additional feedback may be obtained by emailing the graduate researcher, Amna

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please ask. If you have questions later about the research, you may contact the graduate researcher, Amna Azhar or the

Faculty Supervisor Dr. Alexis Morris using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University [approval # 2021-05]

If you have questions regarding your rights as a participant in this study, please contact:
Research Ethics Board c/o Office of the Vice President, Research and Innovation
OCAD University
100 McCaul Street
Toronto, M5T1W1
416 977 6000 x4368
research@ocadu.ca

AGREEMENT

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Screen Recording of Prototype Usage:
With your consent, we wish to capture a recording of your screen during the testing of the prototype in the testing and evaluation sessions 2 & 3. Any information not pertaining to the study will be blurred or anonymized in any publications.

Audio/Video recording of online conferencing sessions:
For the purpose of the study, the online design and evaluation sessions will be video/audio recorded for the purpose of transcribing them. Any audio recording will be destroyed immediately after its transcription. We may use your video (without audio), only with your permission and with your faces blurred out or removed.

By signing the consent below you will agree to these recordings. It is completely optional, and you can still participate in the study if you choose to skip it.

☐ I agree to be [audio-/video-recorded/screen-recorded] for the purposes of this study. I understand how these recordings will be stored and destroyed.

Name: _____

Signature: _____ Date: _____
Thank you for your assistance in this project. Please keep a copy of this form for your records.

Appendix D: Data Collection Instruments

This appendix consists of (in the following order):

- 1 screening questionnaire,
- 1 pre survey,
- 1 post survey,
- 1 questionnaire for Interview Design Session #1,
- 1 questionnaire for Testing Design Session #2 and
- 1 questionnaire for Final Evaluation Session #3.

Screening Questionnaire

Thank you for your interest in participating in the study investigating Mixed Reality Storytelling for Social Engagement with Older Adults. Please read the information below carefully before applying for the study.

For this research the following two types of participants canparticipate:

- Older Adult (aged 65 or older),
- General (aged 18-64) – Family or friend of the older adult who would like to participate with them as a group OR other individuals supporting older adults.

Eligible participants will meet the followingcriteria:

- Minimal English-speaking proficiency (participants with English as a second language are encouraged to participate)
- Have access to the internet and smartphone, laptop/computer or tablet.
- Do not suffer from cognitive decline like Dementia, Alzheimer's or risks such as PTSD for physical and emotional safety

If you meet the above stated criteria, you are eligible to apply for the study. To apply, please fill out the form below:

1. Full Name:
2. Contact Information (Email, Phone):
3. Gender:

4. Age: (Choose from 18-40, 40-64, 65-75, 75-85, 85-95, 95 and above)
5. Please specify which of the following (any or all) devices with camera capabilities will be available to you:
    - Laptop: Choose from Windows or iOS?
    - Smartphone: Choose from Android or iOS?
    - Tablet: Choose from Android or iOS?
6. Please specify which browser do you use:
    - Google Chrome
    - Mozilla Firefox
    - Safari
    - Internet Explorer
    - Other

7. Do you wish to participate in (Each session is 1 hour long)
    - 2 Design + 1 Final Evaluation (3 hours)
    - Final Evaluation only (1 hour)

8. As this is a group session. You may opt to participate in the study with a family member or a friend. If you choose to do so, please specify their name and relationship to you: **Note: They will also be required to fill this questionnaire on their own.**
    - Full Name:
    - How would you describe your relationship with this person: family, friend or other

Pre- Survey

Date (Before session 1)

RATIONALE: This questionnaire will ask about demographics, participant personality (affects & emotions), and how familiar they are with Digital technologies. The purpose is to get an idea about participant personality and their overall feelings to assess their social engagement. With combination to postsurvey, it can show that what kind of users reacted more positively towards the system. These standard questions will also allow comparison with other studies.

1) Household information

Are you living with friends/ family or other individuals?

(Yes/No) How many individuals? (Choose none, 1, 2-4, 4 and

more)

1) Affects & Emotions

(**Likert scale** 1: Not at all – 5: extremely)

Please indicate the extent to which you have felt this way over the past few weeks:

A. Determined
B. Alert
C. Excited
D. Enthusiastic
E. Inspired
F. Nervous
G. Afraid
H. Upset
I. Distressed
J. Scared

Big five Inventory (**Likert scale** 1: Strongly disagree – 5: strongly agree) How much do you agree with the following? "I see myself who.."

A. -Is reserved
B. generally trusting
C. is relaxed
D. is outgoing, sociable
E. gets nervous easily
F. Tend to find fault in others
G. Handles stress well

2) Attitude and Perception towards an online communication system (Likert scale 1: Hardly ever – 5: Very Often)

A. How often do you rely on technology (phone, laptop, tablet) to connect to family, friends or online communities?

B. You are keen about using new applications.

C. You find it easy to trust technology?

D. How often do you share or view photos/videos on the internet?

E. How often do you use technology to keep up to date with other people?

F. You find visual content easier to follow than textual?

G. When meeting in person, you feel hindered by social or physical constraints (such as social distancing measures for Covid-19, transportation etc, mobility).

H. You feel online communication is easier and frequent than offline

Post- Survey

Date (After session 3)

This questionnaire will ask questions about how participants interacted with the system.

1) Affects & Emotions

(**Likert scale** 1: Not at all – 5: extremely)

Please indicate the extent to which you have felt this way while you used the prototype:

A. Determined
B. Alert
C. Excited
D. Enthusiastic
E. Inspired
F. Nervous
G. Afraid
H. Upset
I. Distressed
J. Scared

Big five Inventory (**Likert scale** 1: Strongly disagree – 5: strongly agree)

After using the prototype, How much do you agree with the following? "I see myself who.."

A. -Is reserved
B. generally trusting
C. is relaxed
D. is sociable
E. gets nervous easily
F. Tend to find fault in others
G. Handles stress well

2) Storytelling Evaluation

As a Storyteller (Likert scale 1: Strongly disagree – 5: strongly agree)

A. You felt engaged with each other's stories.
B. You felt positive effects on mood and social stimulation after using the application.
C. You enjoyed producing and telling stories
D. The application was good at replicating some of the physical social interaction
E. You felt companionship in the experience
F. You felt it was easier to share stories through this system

As a Storylistener (**Likert scale** 1: Strongly disagree – 5: strongly agree)

A. The experience was participatory in nature
B. You felt you knew more about the other person after using the application.
C. You valued the opportunity for shared experience, creative expression, and helpful facilitation.
D. You felt that intergenerational connections were healthy and improved awareness of the other generation's issues.

3) System Evaluation (**Likert scale** 1: Very dissatisfied – 10: very satisfied)

A. How satisfied are you with this system in terms of a) interaction, b) engagement, and c) immersive, d) storytelling? (definition of Interaction, engagement, Immersive and storytelling here)
B. How likely are you to consider using the system in the near future
C. How likely are you to recommend to a friend or family member to try out this system?

-> The following questions will be slightly customized according to how the prototype application is designed. Example questions look like:

System Usability Scale (**Likert scale** 1: strongly disagree-5:strongly agree)

1. I think that I would like to use this system frequently.

2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

User Studies Session 1 - Perceiving & Idealizing Communicative Storytelling

Date (1 week after REB approval)

This questionnaire will gain insights about user's preferences in communication, their online and offline social activities. The following will be the format of the session:

Intro & Consent (10 mins): I will introduce myself as the graduate researcher, the purpose of the research, the benefits of participating in the study and go over the group consent form with the participants after which I will obtain verbal consent on participation and video/audio recording for research purposes. I will also remind the participants of their right to withdraw from the research at any point in time.

After the introduction of researcher, briefing participants about the session and going over oral consent, the following open-ended questions will be asked:

1) Narrative Inquiry and communication methods (20 mins)

A. How do you feel about the same routine every day? Do you like incorporating new activities?
B. What are some of the activities or hobbies you enjoy doing with others?
C. How often do you communicate with family and friends or online

communities?

D. What are some of the social media apps that you are currently using and what do you like and dislike about them?
E. What type of messages/conversation do you prefer– short? informational? personal? photos? stories?
F. What makes you feel connected? What makes you feel close to [person or subject of conversation]?
G. Is there a particular object or thing (photo) that reminds you of [person or subject of conversation]?

   (In the event that the participant does not communicate with family or friends, try a third person scenario: Imagine there was a resident living here named James. How do you think he might communicate with his son?)

H. How do you initiate a conversation? Can you help me understand by walking me through the different steps? We can map it out together.
I. Are you living with or near someone that you consider a close friend/family or other?
J. If that person or you could not meet anyone in person, how would you like to be able to communicate with them?

Break (10 mins): The session will observe a break here.

After the break, the session will continue with the following discussion:

1) Identify some of the communication challenges in these (20 mins)
   A. What might make it difficult to communicate? (time of day, physical ability, rules, medication)
   B. How do these challenges make you feel?
   C. Which challenge frustrates you the most?
   D. If you could change anything what would it be?
   E. Can you think of a time when you wanted to talk to [] but you were unable to?
   F. How would you like to connect with [person or subject of conversation] in that situation?
   G. If you could create a way to communicate with [person or subject of conversation] and it could be any way you like, doesn't have to be

realistic,

H. When you feel lonely, upset or sad, what makes you feel better such as calming music, paintings, taking a walk, or other?

Usability Testing Design Session 2: Exploring Prototype and Usability Studies

Date (2 week after REB approval)

Introduction (5-10 mins): An introduction to the testing session will be provided and consent to record video and audio of the use of the prototype will be obtained verbally and over the written consent.

Testing (20 mins): Participants will test the prototype

Break (10 mins)

Discussion & Debriefing (20 mins): The following questionnaire will ask users feedback about the early-stage prototype that they will try out.

1. Any positive and pleasant experiences you'd like to share.
2. Any negative feelings or system drawbacks that you experienced?
3. What did you think of the activity?
4. What was the most enjoyable part of the session?
5. What was the least enjoyable or part that was difficult to understand?
6. What features did you find most engaging?
7. Did you find [specific design feature] useful?
8. What experiences did you like for creating or talking about an ideal storytelling tool?
9. What did you think of the tutorial that was provided? Was it helpful to understand the system better? Was it distracting? Confusing? Indifferent?
10. How can I make this [activity] better for the next person?

Final Evaluation Session 3: Prototype Evaluation & Providing Feedback

Date (5-6 week after REB approval)

Introduction (5-10 mins): An introduction to the testing session will be provided and consent to record video and audio of the use of the prototype will be obtained verbally and over the written consent.
Testing (20 mins): Participants will test the prototype.
Break (10 mins)
Discussion & Debriefing (20 mins): The following questionnaire will ask users to evaluate the experience of the final prototype after they try it out.

For participants that took part in Session 1 & 2 in addition to the ones below:

A. Did you notice improvements in the system that fit your initial feedback?
B. How well does the experience cater to your needs VS the previous version?

To all participants:

A. Any positive and pleasant experiences you'd like to share.
B. Any negative feelings or system drawbacks that you experienced?
C. What did you like about the product?
D. What didn't you like about the product?
E. Is there any product like this one?
F. What were your feelings about the instructions?
G. Do you know anyone that would like this product? (Ask them to describe those people. For many of us, it's easier to talk about people than about products).

Appendix E: User Stories Transcription (Group 1)

Key: OA - Older Adult GA - General Adult P1 - group 1 P2 is group 2

Themes & Findings	Participants	
	P1A - OA	P1B - GA
A- Routine Insights	Same routine but with new things and activities every now and then	Same routine. I want to add new activities - busy
B- Activities & Hobbies	online games scrabble, keeping up to date with friend	playing games, sport
C- Social Networks - family, friends, online	catches up with old friends, shares news about politics. Whatsapp groups where they share ideas, jokes. Even when it is not meaningful at times	Have to connect online everyday. Family overseas. Once a day to some, once a week with others
D- Valuable communication	When I share stories, I expect others to go through them and comment on them. I want to make sure they have gone through. Participation is important	Talking about our day to day lives
E Tech Use likes & dislikes		
Apps	Facebook, Linkedin, whatsapp, Sometimes twitter (haven't set up my own account but open it every now and then).	-
Likes	It helps you keep up to date.	-
Dislikes	Dislike is when we get unwanted comments from public people we don't want to share or posts that we don't want to see but we will see.	Dislike is time-waste. Addictive. Distracting. Disrupts routine
F, G, H- Communication Styles	Messages should be short more preferable. Read More is helpful because I normally ignore them. Informational messages arent Always needed. I enjoy sharing photos with families brothers and is always welcomed. Small Visual messages or small texts. Yes to making use of old photos when telling stories. Normally just text passes the message through. When communicating with somebody you know you don't have to introduce yourself. If we dont know eachother we need to give a small introduction/purpose. Conversation topics/triggers help. Eg something you see in the news can be a conversation trigger. Shared activities: Yes, dinner, lunch, going shopping, icecream. Remotely depends on the importance, I will usually call them.	Friends and family -> can be casual, I dont like posting too much on social media. But sharing photos with Close family/friends. Joke visual, text message. Pictures or objects are not important. I would be more comfortable when somebody is asking me questions than me talking on my own. As a shared activity with people I like to Watching TV, talking to families. Remote exampples: Video call, if you wanna shop and show them what you are buying
Tech Challenges	I remember the day when you have to dial 10-20 days to contact my parents and every min was precious and we had to be very specific to what we wanted to take. Now its easier. However you cannot determine the mood of someone you are talking to before the call. You feel like you are disrupting or distracting them. Happens many time. Especially when you want information or opinion urgently, the other one is not available. Because they could be sleeping. Even when I talk to somebody from america, they call when we are sleeping.	Internet Connection. Timezone is a big problem. Unavailable people. And then you forget what you wanted to share so you cant share anyone
Feeling of Challenges	(did not speak)	Buzzkill, sometimes its okay
Co-creation	Sharing screen, map, information it all depends. If technical problem, visual will be the best option	Video. Highlights of the story gathered automatically and told to someone automatically
Likes when upset, lonely or sad	Keeping busy in some way or the other, really likes scrabble or reading a book. Fitness informational	Talking, game, doing something productive, exercising

Appendix E: User Stories Transcription (Group 2)

Key: OA - Older Adult GA - General Ad		
Themes & Findings		
	P2A - OA	**P2B - GA**
A- Routine Insights	Likes doing different things in routine	Busy usually but lockdown has made life frustrating. Has a hectic schedule when talking to friend overseas. Prefers a stable routine during this time
B- Activities & Hobbies	Likes to share ideas and talk with people. Enjoys meeting and parties. But loves reading books.	drawing and writing. Watching films. Comfortable with introverted actviites but like to meet people in person
C- Social Networks - family, friends, online	Talks to children overseas everyday. Is an active voluteers so has a large community	Very often
D- Valuable communication	I don't like to share my personal feelings with everyone	Being able to communicate verbally and asking them about their day. I value physically meet ups
E Tech Use likes & dislikes		
Apps	Whatsapp. Can't reject technology but its very inaccessble and its hard to understand. Always have people to help	Uses Instagram and snapchat
Likes	Whatsapp is easiest. Likes to share poetry with friends on facebook. Likes reponses and feedback fro friends on her post	Liked to share art and monetize it on instagram
Dislikes	Have to learn other apps. Stuff needs to be boldly there. Need visually bold menus and text is preferred	Doesn't like constant visual updates. Had to completely leave instagram as an art sharing platform due to updates
F, G, H- Communication Styles	Really depends on context and people you are sharing with. I love to share my photos. I like textual because I can read it over and over again. Shared activities are restricted because of corona. Like physical games more than mobile	Generally visual over text. I like textual things on twitter because they're informational. But not on instagram because the platform is meant for visual stories. Prefers physical shared actvities like visiting and going out in person with friends and families
Tech Challenges	Internet issues where they live occur quiet often	Doesn't experience any on her own but solves her grandmother's
Feeling of Challenges	I like to be independant and I wan to learn how to deal with my challenges	-
Co-creation	I have book clubs where I like to share whatever we have read, I would like that	-
Likes when upset, lonely or sad	Writing poetry and my feelings	Sleeping and eating. Talking to people. Sometime it becomes a viscous cycle

Appendix F: Unity Code:

Script#1 Launcher.cs (For login and connecting to Photon)

```
using UnityEngine;
using UnityEngine.UI;
using Photon.Pun;
using Photon.Realtime;


public class launcherScript : MonoBehaviourPunCallbacks

{

    #region Private Serializable Fields

    [Tooltip("The maximum number of players per room. When a room is
full, it can't be joined by new players, and so new room will be
created")]
    [SerializeField]
    private byte maxPlayersPerRoom = 4;

    [Tooltip("The Ui Panel to let the user enter name, connect and
play")]
    [SerializeField]
    private GameObject controlPanel;
    [Tooltip("The UI Label to inform the user that the connection is in
progress")]
    [SerializeField]
    private GameObject progressLabel;

    #endregion

    bool isConnecting;


    #region Private Fields


    /// <summary>
    /// This client's version number. Users are separated from each other
by gameVersion (which allows you to make breaking changes).
    /// </summary>
    string gameVersion = "1";
```

```
    #endregion


    #region MonoBehaviour CallBacks


    /// <summary>
    /// MonoBehaviour method called on GameObject by Unity during early
initialization phase.
    /// </summary>
    void Awake()
    {
        // #Critical
        // this makes sure we can use PhotonNetwork.LoadLevel() on the
master client and all clients in the same room sync their level
automatically
        PhotonNetwork.AutomaticallySyncScene = true;
    }


    /// <summary>
    /// MonoBehaviour method called on GameObject by Unity during
initialization phase.
    /// </summary>
    void Start()
    {
        progressLabel.SetActive(false);
        controlPanel.SetActive(true);
    }


    #endregion


    #region Public Methods


    /// <summary>
    /// Start the connection process.
    /// - If already connected, we attempt joining a random room
    /// - if not yet connected, Connect this application instance to
Photon Cloud Network
    /// </summary>
    public void Connect()
    {
```

```
        Debug.Log ("Is this working");
        progressLabel.SetActive(true);
        controlPanel.SetActive(false);
        if (PhotonNetwork.IsConnected)
        {
            PhotonNetwork.JoinRandomRoom();
        }
        else
        {
            isConnecting = PhotonNetwork.ConnectUsingSettings();
            PhotonNetwork.GameVersion = gameVersion;
        }
    }


    #endregion

    #region MonoBehaviourPunCallbacks Callbacks


    public override void OnConnectedToMaster()
    {
        if (isConnecting)
        {
            // #Critical: The first we try to do is to join a potential
existing room. If there is, good, else, we'll be called back with
OnJoinRandomFailed()
            PhotonNetwork.JoinRandomRoom();
            isConnecting = false;
        }
    }


    public override void OnDisconnected(DisconnectCause cause)
    {
        progressLabel.SetActive(false);
        controlPanel.SetActive(true);
        isConnecting = false;
        Debug.LogWarningFormat("PUN Basics Tutorial/Launcher:
OnDisconnected() was called by PUN with reason {0}", cause);
    }

    public override void OnJoinRandomFailed(short returnCode, string
message)
    {
```

```
        Debug.Log("PUN Basics Tutorial/Launcher:OnJoinRandomFailed() was
called by PUN. No random room available, so we create one.\nCalling:
PhotonNetwork.CreateRoom");

        // #Critical: we failed to join a random room, maybe none exists
or they are all full. No worries, we create a new room.
        PhotonNetwork.CreateRoom(null, new RoomOptions { MaxPlayers =
maxPlayersPerRoom });

    }

    public override void OnJoinedRoom()
    {

        PhotonNetwork.LoadLevel("Room1Letters");

    }

    #endregion

}
```

Script#2 PhotonGameManager.cs (For room creation and connecting players)

```
using System;
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;
using UnityEngine.SceneManagement;
using Photon.Pun;
using Photon.Realtime;

public class PhotonGameManager : MonoBehaviourPunCallbacks
{


    public GameObject MRRoom;
    public GameObject WritingRoom;
    public GameObject EnterMRButton;
    public GameObject WritingRoomButton;
    public GameObject StoryWritingCanvas;
    public GameObject  StampObj;
    [Tooltip("The prefab to use for representing the player")]
```

```
    public Text usersinRoom;
    public Text Question;
    public Text Answer;
    public GameObject SubmitButton;
    public static PhotonGameManager Instance;
    #region Photon Callbacks

    public Tutorial tutorialscript;


    /// <summary>
    /// Called when the local player left the room. We need to load the
launcher scene.
    /// </summary>
    public override void OnLeftRoom()
    {
        SceneManager.LoadScene(0);
    }

    #endregion

    void Start()
    {
        if (!PhotonNetwork.IsConnected)
        {
            SceneManager.LoadScene(0);

            return;
        }

        Instance = this;
        Debug.Log("Room1called");
        LoadMR();
    }

    #region Private Methods

    void UpdatePlayerList(){


        foreach (Player player in PhotonNetwork.PlayerList)
        {

            usersinRoom.text = usersinRoom.text + "\n" +
player.ToString();
```

```
        }
    }


//This will be a button click to the letter writing room
    public void WriteLetter()
    {
        WritingRoomButton.SetActive(false);
        EnterMRButton.SetActive(true);
        MRRoom.SetActive(false);
        WritingRoom.SetActive(true);
        //end tutorial

    }
    public void Submit(){
        // if spawn points have been used, give a full mailbox error
        // letter number + question
        StartCoroutine(Stamp());
        tutorialscript.setitsrequest(false);
        tutorialscript.arrowsfalse();
        //
    }


    IEnumerator Stamp(){

        StoryWritingCanvas.SetActive(false);
        WritingRoom.GetComponent<Animator>().SetTrigger("writepen");
        yield return new WaitForSeconds(5f);
        StampObj.GetComponent<Animator>().SetTrigger("stamp");
        yield return new WaitForSeconds(1.5f);
        WritingRoom.GetComponent<Animator>().SetTrigger("poststory");
     //   yield return new WaitForSeconds(6f);
        Debug.Log("Written");
        PhotonView photonView = SubmitButton.GetComponent<PhotonView>();
        photonView.RPC ("UpdateLetter", RpcTarget.MasterClient,
Question.text.ToString()); //Question.text.ToString()
        // if you want to go back
        LoadMR();
    }


   // letter.GetComponent<Transform>().parent =
MRRoom.GetComponent<Transform>();


    public void LoadMR()
```

```
    {
        WritingRoomButton.SetActive(true);
        EnterMRButton.SetActive(false);
        MRRoom.SetActive(true);
        WritingRoom.SetActive(false);
    }



    #endregion


    #region Public Methods


    public void LeaveRoom()
    {
        PhotonNetwork.LeaveRoom();
        usersinRoom.text = "user left";

    }

    #endregion

    public void QuitApplication()
    {
        Application.Quit();
    }

    public void Reset()
    {
        PhotonNetwork.LoadLevel("Room1Letters");
    }



    public override void OnPlayerEnteredRoom(Player other)
    {
        Debug.LogFormat("OnPlayerEnteredRoom() {0}", other.NickName); //
not seen if you're the player connecting
        UpdatePlayerList();

        if (PhotonNetwork.IsMasterClient)
        {
            Debug.LogFormat("OnPlayerEnteredRoom IsMasterClient {0}",
PhotonNetwork.IsMasterClient); // called before OnPlayerLeftRoom
```

```
          //  LoadMR();
        }
    }


    public override void OnPlayerLeftRoom(Player other)
    {
        Debug.LogFormat("OnPlayerLeftRoom() {0}", other.NickName); //
seen when other disconnects
        UpdatePlayerList();

        if (PhotonNetwork.IsMasterClient)
        {
            Debug.LogFormat("OnPlayerLeftRoom IsMasterClient {0}",
PhotonNetwork.IsMasterClient); // called before OnPlayerLeftRoom


           // LoadArena();
        }
    }



}
```

Script#3 Tutorial.cs (For programming tutorial)

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;
using DG.Tweening;

public class Tutorial : MonoBehaviour
{

    public GameObject stamp_arrow;
    public GameObject pen_arrow;
    public GameObject postbox_arrow;
    public GameObject letter_arrow;
    public GameObject story_arrow;
    public GameObject tutorial_panel;
    public Text tutorial_text;
    Animator animatorbar;
    bool firsttime = true;
    int tutorial_count = 0;
```

```
public Text HelpButton;
public Button NextButton;
public GameObject Requestletter;
public GameObject TopPanel;
public GameObject Notification;
public GameObject TopicPanel;
public Text Question;
public Animator PostBox;
public static bool itsrequest = false;
AudioSource audioData;
public AudioClip audio0;
public AudioClip audio1;
public AudioClip audio2;
public AudioClip audio3;
public AudioClip audio4;
public AudioClip audio5;
public AudioClip audio6;
public AudioClip buttonclick;
// Start is called before the first frame update
void Start()
{
    animatorbar = gameObject.GetComponent<Animator>();
    audioData = gameObject.GetComponent<AudioSource>();
    arrowsfalse();
    Requestletter.SetActive(false);
    StartTutorial();
    Notification.SetActive(false);
    TopicPanel.SetActive(true);
}

public void Help(){
    audioData.Stop();
    if(HelpButton.text == "Help"){
        audioData.PlayOneShot(buttonclick);
        StartTutorial();
        tutorial_count = 0;
    }
    else{ // skip tutorial
        End_Tutorial ();
    }

}


public void End_Tutorial (){

    arrowsfalse();
```

```
        firsttime = false;
        tutorial_count = 0;
        NextButton.gameObject.SetActive(false);
        animatorbar.SetTrigger("close");
        HelpButton.text = "Help";

    }

    public void setitsrequest(bool boolean){

        itsrequest = boolean;

    }

    public bool getrequest(){

        return itsrequest;

    }

    public void StartTutorial(){
        audioData.PlayOneShot(buttonclick);
        animatorbar.SetTrigger("popup");
        tutorial_text.text = "";
        audioData.PlayOneShot(audio0);
        tutorial_text.DOText("Welcome to the Mail Room! Everybody shares
their stories here. Click Next to continue..", 5f, true,
ScrambleMode.None, null);
        NextButton.gameObject.SetActive(true);
    }

    public void PostboxButton(GameObject obj){
        audioData.PlayOneShot(buttonclick);
        arrowsfalse();
        Requestletter.SetActive(true);
        TopPanel.SetActive(false);
        PostBox.SetTrigger("lidopen");
        obj.SetActive(false);
        animatorbar.SetTrigger("close");
    }

    public void TakeRequest(){
        audioData.PlayOneShot(buttonclick);
        Requestletter.SetActive(false);
        TopPanel.SetActive(true);
        Question.text = "Your Favourite Trip To Murree";
        if(firsttime){
```

```
        Debug.Log("comeshere");
        tutorial_count ++;
        tutorial_count ++;
        StartCoroutine(TutorialMail(tutorial_count));

    }
    PostBox.SetTrigger("lidclose");
    TopicPanel.SetActive(false);
    itsrequest = true;
}


public void clickPen(){

    End_Tutorial();
    if(itsrequest == false){
        TopicPanel.SetActive(true);

    }

}

public void GoBack(){
    audioData.PlayOneShot(buttonclick);
    Requestletter.SetActive(false);
    TopPanel.SetActive(true);
    PostBox.SetTrigger("lidclose");

}

public void Next(){
    audioData.Stop();
    audioData.PlayOneShot(buttonclick);

    tutorial_count ++;
    StartCoroutine(TutorialMail(tutorial_count));

}



public void arrowsfalse(){

    stamp_arrow.SetActive(false);
    pen_arrow.SetActive(false);
    postbox_arrow.SetActive(false);
    letter_arrow.SetActive(false);
```

```
        story_arrow.SetActive(false);


    }

    public void CreateStory(){
        audioData.PlayOneShot(buttonclick);
        if(firsttime){

            tutorial_count ++;
            StartCoroutine(TutorialMail(tutorial_count));
            firsttime = false;

        }
        TopicPanel.SetActive(true);


    }

    public void ChooseTopic(int n){
        audioData.PlayOneShot(buttonclick);
        if(!itsrequest){

            switch (n)
            {
                case 1:
                    Question.text = "Last Days Of College";
                    break;
                case 2:
                    Question.text = "Least Favourite Activity";
                    break;
                case 3:
                    Question.text = "Birth of Your First Child";
                    break;
                case 4:
                    Question.text = "If You Were On A Desert Island, But
Your Needs For Food And Shelter Were Totally Taken Care Of, What One
Luxury Item Would You Wish For? Why? What would happen?";
                    break;
                case 5:
                    Question.text = "Coolest Thing about where you grew
up";
                    break;
                case 6:
                    Question.text = "Your can write a story on any topic
you want here";
                    break;
```

```
                default:
                    break;
            }
            TopicPanel.SetActive(false);

        }

    }

    // Update is called once per frame
   IEnumerator TutorialMail(int n)
    {   animatorbar.SetTrigger("popup");

        if (n ==   1){
            arrowsfalse();
            NextButton.interactable = false;
            tutorial_text.text = "";

            audioData.PlayOneShot(audio1);
            tutorial_text.DOText("People can request you Stories...", 1f,
true, ScrambleMode.None, null);
            yield return new WaitForSeconds(3f);
            postbox_arrow.SetActive(true);
            tutorial_text.text = "";
            audioData.PlayOneShot(audio2);
            tutorial_text.DOText("Requested Stories will appear in this
mailbox", 3f, true, ScrambleMode.None, null);
            NextButton.interactable = true;
            Notification.SetActive(true);
        }

        if (n ==   2){ // requires clicking create story

            arrowsfalse();
            tutorial_text.text = "";
            audioData.PlayOneShot(audio3);
            tutorial_text.DOText("You can write stories", 3f, true,
ScrambleMode.None, null);
            yield return new WaitForSeconds(6f);
            story_arrow.SetActive(true);
            tutorial_text.text = "";
            audioData.PlayOneShot(audio4);
            tutorial_text.DOText("Click on Create a Story to write your
first story", 3f, true, ScrambleMode.None, null);
            NextButton.interactable = false;

        }
```

```
        if (n ==   3){

            arrowsfalse();
            tutorial_text.text = "";
            audioData.PlayOneShot(audio5);
            tutorial_text.DOText("This is your story writing room. You
can click on the pen to start writing your story.", 2f, true,
ScrambleMode.None, null);
            NextButton.interactable = true;
            pen_arrow.SetActive(true);
           // stamp_arrow.SetActive(true);

        }

        if (n ==   4){

            arrowsfalse();
            tutorial_text.text = "";
            audioData.PlayOneShot(audio6);
            tutorial_text.DOText("That's all there is! Goodluck.", 2f,
true, ScrambleMode.None, null);
            yield return new WaitForSeconds(6f);
            animatorbar.SetTrigger("close");
            NextButton.gameObject.SetActive(false);
            HelpButton.text = "Help";

        }
       yield return new WaitForSeconds(0f);

    }

}
```

Script#4 StoryController.cs (For programming storywriting room)

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;


public class storycontroller : MonoBehaviour
{
```

```
    public GameObject StoryWritingCanvas;
    public Text Question;
    public InputField Answer;
    // Start is called before the first frame update

    void Start(){

      StoryWritingCanvas.SetActive(false);

    }
    // Update is called once per frame
    public void WriteStory()
    {
      StoryWritingCanvas.SetActive(true);

    }

    public void Stamp()
    {
        Debug.Log("Stamped");

    }

    public void Submit()
    {

      StoryWritingCanvas.SetActive(false);
    }


    public void CrossWriting()
    {
      StoryWritingCanvas.SetActive(false);

    }

    public void CrossLetter(GameObject obj)
    {
      obj.SetActive(false);

    }

}
```

Script#5 openletter.cs (For letter viewing in Shared Room)

```
using System.Collections;
```

```
using System.Collections.Generic;
using UnityEngine;

public class openletter : MonoBehaviour
{
    // Start is called before the first frame update
    public GameObject canvas;
    public GameObject open;
    Animator animatorletter;
    void Start()
    {
      canvas.SetActive(false);
      open.SetActive(true);
      animatorletter = gameObject.GetComponent<Animator>();
    }

    public void OpenLetter(){

      StartCoroutine(OpenLetterPlease());

    }

    public void CloseLetter(){

      canvas.SetActive(false);
      open.SetActive(true);
      animatorletter.SetTrigger("closeletter");

    }

    IEnumerator OpenLetterPlease()
    {

      animatorletter.SetTrigger("openletter");
      yield return new WaitForSeconds(1.1f);
      canvas.SetActive(true);
      open.SetActive(false);
    }


}
```