

**Enhancing South Asian Folktales through Mixed Reality: Exploring
Accessibility, Contextualization, and Discovery**

Anantha Purushothama Chickanayakanahalli

A thesis exhibition presented to OCAD University in partial fulfillment of the requirements for
the degree of Master of Design in Digital Futures
Toronto, Ontario, Canada, 2023

Abstract

The rich cultural heritage of South Asian folktales gets shared across generations through various storytelling styles and channels, such as oral traditions, books, cartoons, comics, and blogs. However, with the rapid evolution of new media, there is a growing need to adapt these traditional stories to modern formats to ensure their continued accessibility, contextualization, and discovery. This project aims to explore the potential of Mixed Reality (MR) in enhancing the experience of South Asian folktales by creating immersive and engaging story environments that connect to their geographical roots. Using Research Through Design (RTD) methodology, I iteratively developed and evaluated prototype setups to identify critical design decisions that shape the user experience. The findings from this study will provide insights into the design of MR applications for storytelling and contribute to the preservation and dissemination of South Asian folklore in the digital age.

Land Acknowledgement

I wish to acknowledge the ancestral and traditional territories of the Mississaugas of the Credit, the Haudenosaunee, the Anishinaabe and the Huron-Wendat, who are the original owners and custodians of the land on which we stand and create.

Acknowledgements

I want to thank my supervisors, Dr. Alexis Morris, Dr. Cindy Poremba and Professor Ilene Sova, for their continuous support in guiding me through this journey and for being patient with me and motivating me. I want to thank my faculty, Dr. Emma Westecott, for their expertise and suggestions throughout my thesis development. I would like to thank my dear parents and my brother's family for their understanding and continuous encouragement during my studies. This accomplishment would not have been possible without your support.

Copyright Notice

This document is licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) License. To view a copy of this license, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

You are free to:

Share — copy and redistribute the material in any medium or format

Under the following conditions:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for commercial purposes.

NoDerivatives — If you remix, transform, or build upon the material, you may not distribute the modified material.

With the understanding that:

Waiver — Any of the above conditions can be waived if you get permission from the copyright holder.

Public Domain — Where the work or any of its elements is in the public domain under applicable law, that status is in no way affected by the license.

Other Rights — In no way are any of the following rights affected by the license:

- Your fair dealing or fair use rights, or other applicable copyright exceptions and limitations;
- The author's moral rights;
- Rights other persons may have either in the work itself or in how the work is used, such as publicity or privacy rights.

Notice — For any reuse or distribution, you must make clear to others the license terms of this work. The best way to do this is with a link to this web page.

Table of Contents

Abstract.....	2
Land Acknowledgement.....	3
Acknowledgements.....	4
Copyright Notice.....	5
Table of Contents.....	6
List of Figures.....	10
List of Tables.....	12
1.0 Introduction.....	13
1.1 Motivation.....	13
2.0 Research Summary.....	19
2.1 The Problem.....	19
2.2 Research question.....	19
2.3 Hypothesis.....	19
2.4 Goal and Objectives.....	19
2.5 Approach and method.....	21
2.6 Project Contributions.....	21
2.7 Intended Audience.....	21
2.8 Limitations and scope.....	22
3.0 Context.....	23

3.1 Overview..... 23

3.2 Folktales are getting lost 24

3.3 Access to Folktales & Folklore..... 25

3.4 Social impact of the loss of Folktales (timeless wisdom, history, values, morals)..... 26

3.5 Storytelling modes have changed/new modes outpaced the traditional modes..... 26

3.6 Storytellers, People Remembering Stories & Loss of Context..... 27

3.7 How the Context of Folktales is tied to Place..... 29

3.8 South Asian Folktales 30

3.9 Story of 'The Thirst Crow' 33

3.10 Interactive Stories 34

3.11 Spatial Storytelling..... 36

3.12 Mixed Reality..... 38

3.13 Related Works..... 39

3.15 Summary 43

4.0 Methodology 44

4.1 Overview..... 44

4.2 Research Through Design..... 44

4.3 Application of RTD 46

4.4 Summary 48

5.0 Prototypes 49

5.1 Overview.....	49
5.2 Prototype 1.0.....	51
5.3 Prototype 2.0.....	56
5.4 Prototype 3.0.....	59
5.5 Prototype 4.0.....	64
5.4 Prototype 5.0.....	65
5.5 Prototype 6.0.....	68
5.6 Summary.....	70
6.0 Evaluation & Results	72
6.4 Evaluation Frameworks/Criteria.....	74
6.5 Evaluation	82
6.6 Exhibition.....	89
6.7 Summary.....	90
7.0 Conclusion	92
7.1 Overview.....	92
7.2 Limitations	92
7.3 Future work.....	94
7.4 Final Remarks	96
8.0 References.....	98
9.0 Appendix.....	102

9.1 Source code of ClickDetector C# Script of final prototype 6.0..... 102

List of Figures

<i>Table Number</i>	<i>Description</i>	<i>Section</i>	<i>Page</i>
1	Figure 1. Dodda Ganeshana Gudi Hindu temple in Basavanagudi, Karnataka, India. [Photograph]. Licensed under Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0). Retrieved from https://en.wikipedia.org/wiki/File:Dodda_Ganeshana_Gudi_Hindu_temple,_Basavanagudi,_Karnataka,_India.jpg	1.1	18
2	Mode of Transmission of Stories [Illustration]. Created by A. Chickanayakanahalli, 2023.	1.1	19
3	Screenshot from the UNESCO document illustrating [Short description of the screenshot content]. Adapted from "Recommendation on the Safeguarding of Traditional Culture and Folklore," by UNESCO, 1989. Retrieved from https://www.unesco.org/en/legal-affairs/recommendation-safeguarding-traditional-culture-and-folklore	3.2	29
4	Thirsty crow drinking water from a pot (DallE-2, 2022)	3.9	41
5	Diagram showing Mixed Reality in the extended reality continuum (adapted from Milgram et al., 1995)	3.12	47
6	Concept for table-top based shared AR experiences [Illustration]. Created by A. Chickanayakanahalli, 2022.	5.1	62
7	Poster for first prototype [Illustration]. Created by A. Chickanayakanahalli, 2022.	5.2	64
8	Image for story acts [Illustration]. Created by A. Chickanayakanahalli, 2022.	5.2	65
9	Artboards in Figma for exporting as GIF [Screenshot]. Created by A. Chickanayakanahalli, 2023.	5.2	66
10	Artboards in Figma for exporting as GIF	5.2	67
11	Adobe Aero - placing layers in 3d space	5.2	68

12	Adobe Aero - Actions setup	5.2	69
13	Artboard in Figma for export	5.2	69
14	Betaal Pachisi in Mental Canvas Tool on iPad	5.3	71
15	Image of Vikram Betaal Stories in Chandamama Digest	5.3	71
16	Storyboard of Vikram Betaal to appear on a building wall	5.3	72
17	Prototype 3 in Mobile Device showing modified Aframe AR Template	5.4	74
18	GPS coordinates from Google Maps to include in the code	5.4	75
19	GeoAR.js Template	5.4	75
20	GeoAR.js Template tweaked	5.4	76
21	AI generated 3d model	5.4	77
22	Image to 3d model	5.4	77
23	3d model rigging	5.4	78
24	Prototype 3 in Mobile Device	5.5	79
25	Prototype 5 in Mobile Device	5.4	81
26	ClickDetector Script in Visual Studio	5.4	82
27	Prototype 5 in Unity Scene View	5.5	84
28	Venn Diagram showing overlap of Folktales and Mixed Reality	6.4	92
29	Radar chart of Assessment of Related Works	6.5	102
30	Radar Chart showing assessment of MR Roller Coaster and Prototype 6	6.5	104
31	Ordinary Extraordinary 2023 - Digital Futures Thesis Exhibition	6.6	105

List of Tables

<i>Table Number</i>	<i>Description</i>	<i>Section</i>	<i>Page</i>
1	Evaluation Framework 1	6.4	78
2	Evaluation Framework 2	6.4	79
3	Assessment of Related Works - Part A	6.5	83
4	Assessment of Related Works - Part B	6.5	85
5	Assessment of MR Roller Coaster and Final Prototype	6.5	89

1.0 Introduction

Folktales are an integral part of the cultural heritage of any society, passed down through generations to preserve the values and beliefs of a community. These stories offer a window into the past, providing insights into a bygone era's traditions, customs, and norms. However, as society becomes increasingly digitized, it is becoming challenging to maintain the oral tradition of storytelling. Advances in technology have opened new possibilities for preserving, adapting, and sharing folktales in innovative and engaging ways, such as through mixed reality (MR) storytelling.

MR, among other technologies, helps blend digital and physical elements to create immersive and interactive experiences. In MR storytelling, the digital and physical elements combine to create a narrative that can be personalized, adaptive, and multi-sensory. The potential of MR storytelling for folktales lies in its ability to transform how we experience and engage with these timeless stories. By blending the real and virtual worlds, MR storytelling can offer new ways of interpreting and understanding folktales while preserving their cultural significance.

This research aims to explore the potential of MR storytelling as a means of adapting and preserving South Asian folktales. The study will focus on identifying the technical and creative challenges involved in developing MR experiences that are faithful to the cultural context of these tales while providing an engaging and immersive experience for the user. Furthermore, by developing a framework for designing and implementing South Asian folktales in MR, this research will contribute to the broader discussion on how MR can be used to preserve and promote cultural heritage.

1.1 Motivation

Some stories are primal. Some have drawn the attention of readers for centuries or even millennia—they might be national epics, sacred texts, or myths that explain some quality of the world. Depending on the reader, they might be all those things. But just as certain stories retain the ability to hold an audience rapt, so too do they inspire a particular group of writers to retell them. And perhaps that's the biggest testimonial of all to the staying power of some of these narratives: whether

straightforward or revisionist, they can be adapted into countless forms, and experienced in a host of ways. Some of these stories date back to the oral tradition; a series of repeated retellings was what made them endure over the years, the decades, the centuries. Retelling might involve a storyteller finding their own perspective on something timeless; it might involve using an ancient tale to illuminate something contemporary. (Carroll, 2019)

Tobias Carroll (2019), a writer and essayist in *Electric Literature*¹, emphasizes in his article "Why We Keep Telling the Same Stories", that retelling stories in new ways can help to engage readers on a deeper level. This thesis is a similar attempt--retelling a folktale from a comic book in more dimensions. The aim is to revitalize the knowledge in these stories, which may get lost because of the rapid changes in our everyday life and our ways of consuming information and stories. The folktale explored in this thesis is "The Thirsty Crow" from Jataka Tales from South Asia (Chaturvedi, n.d.).

I have grown up listening to Jataka Tales. They are an ancient collection of stories from India believed to have originated more than two millennia ago. According to *Encyclopedia Britannica* (n.d.), Jataka Tales is a voluminous body of literature native to India that mainly concerns Gautama Buddha appearing in human and animal forms and imparting wisdom. Tales include the previous lives of the Buddha, and each tale tells a story about one of the Buddha's past lives and the moral lesson that can be learned from it (Appleton, 2015).

I loved stories as a child. To this day, I fondly remember many of the traditional Indian folktales my grandmother told me. Stories like the Mahabharata and Ramayana from South Asia have an intricate web of related stories and contexts with mythical creatures with the typical and good winning over evil in witty and unconventional ways. These traditional folktales enchanted me. Many of the morals in these stories are valid even today and contain timeless wisdom for our society. Unfortunately, these critical narratives will vanish from our lives due to the proliferation of contemporary modes of entertainment. Our folktales of the past will always need help to compete with the exciting media landscapes at our fingertips. It is fascinating to contemplate

¹ *Electric Literature* is a digital quarterly journal.

how these ancient tales will materialize in future interfaces. My imagination in this area was sparked in 2012 when I saw the interactive story of Ramayana in Google Chrome (Rodgers, 2012). It showed me how something timeless, like the story of Ramayana, could be successfully adapted, stitched, and woven into a very different context.

My grandmother had told me how the name of the city ‘Bengaluru’ (India), had come into being. It is based on folklore that a king passing with his entourage had stopped by a poor old lady’s house who had offered them boiled beans. The King, moved by that gesture, renamed the town ‘The Town of Boiled Beans,’ translated from ‘Bendakalooru’ in Kannada, which became shortened to ‘Bengaluru.’ Such tales had me mesmerized back then. I am intrigued by how insightful stories are about the heritage of a place and its history. There is a famous temple in Bengaluru called Doddabasavanagudi, The Big bull temple (Dodda Basavana Gudi, n.d.).



Figure 1. Dodda Ganeshana Gudi Hindu temple in Basavanagudi, Karnataka, India. [Photograph]. Licensed under Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0). Retrieved from https://en.wikipedia.org/wiki/File:Dodda_Ganeshana_Gudi_Hindu_temple,_Basavanagudi,_Karnataka,_India.jpg

Although the place is touristy, the folklore behind the name of the temple and its origins is not widely known even to the tourist guides, let alone the residents of Bengaluru. Other stories like *The Thirsty Crow* (Chaturvedi, n.d.) are captured in archives and well-documented in Karnataka universities. Should someone go looking for it, they will find it. I am thrilled about the prospect of these stories being accessible to anyone interested, with the added advantage of being contextualized (meaning stories available about the places one may be standing at in that moment), and with a faster delivery due to the power of advanced computing, thanks to the continuous improvement of mobile phones.

I am aware that stories which were once upon a time only shared orally from one to another began to be documented in different formats, including books, live-action (Appleton, 2015).

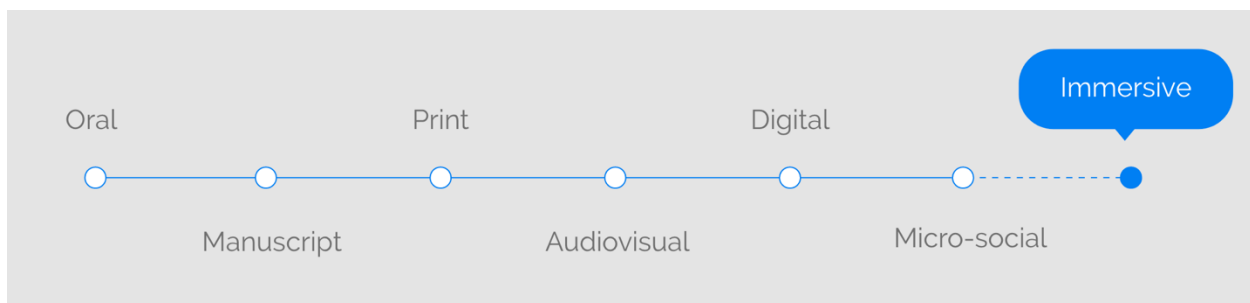


Figure 2. Mode of Transmission of Stories [Illustration]. Created by A. Chickanayakanahalli, 2023.

As the transmission mode evolved, the stories became accessible to more people. Folktales passed down through generations have been shared for centuries without using the Internet. The Internet has allowed for the easier sharing and accessibility of folktales. Many websites, articles, and social media platforms now feature folktales worldwide, especially folktales that were not previously available. The Smithsonian Folklife and Oral History Center, the World Digital Library (USC Libraries, n.d.), and the Library of Congress all provide access to various folktales worldwide. Social media platforms such as TikTok and Instagram also feature folktales from various cultures, allowing for further reach and accessibility.

Thanks to this diverse set of devices already claiming their fair share of people's limited attention, any new experience designed around this should aim to be responsive to the upcoming trends. The mediums of storytelling are evolving, and newer ways of experiencing stories are becoming possible. In the book *Mixed Reality and Gamification for Cultural Heritage*, Marinos Ioannides, Nadia Magnenat-Thalmann, and George Papagiannakis mention that due to the revival of MR hardware (such as the Oculus Rift, Google and Cardboard) and the corresponding intense commitment from the ICT industrial sector (Google, Microsoft, Sony, Facebook), which dramatically advances this field by instilling "Presence," there has recently been a renewed rapid proliferation in Virtual Reality (VR) and Augmented Reality (AR), collectively termed Mixed Reality (MR). Furthermore, recent advancements in gamification have produced a new breed of intelligent education and heritage applications. Gamification involves the employment of game design principles in nongame situations and activities. Numerous recent studies have highlighted the advantages of implementing Mixed Reality in these applications by combining it with gamification concepts (Ioannides, Magnenat-Thalmann, & Papagiannakis 2017).

Ruler of Dubai, H.H. Sheikh Mohammed Bin Rashid Al Maktoum, puts these concepts aptly in *The Global 50: Future Opportunities Report 2023* (Dubai Future Foundation, n.d.), a report that shares fifty opportunities for Future Growth, Prosperity, and Well-being by Dubai Future Foundation. In the report, he states that to shape the future, we must not simply wait for it to happen. Instead, we must utilize the latest technologies and knowledge tools to meet its challenges, starting today. This concept should also apply to traditional storytelling. Folktales can evolve into newer landscapes and newer mediums as we advance as a civilization. However, they can be lost and only relevant to contemporary societies if they do.

Through this project, I want to see what is possible when they evolve into the next frontier in experiencing stories. Secondly, there are many ways folktales can be revived. One of the most recent and potent ways to do this could be by bringing folktales into Mixed Reality (MR). MR can make experiencing stories possible in immersive computer-generated environments in which elements of a physical and virtual environment can be combined. This thesis includes enabling folktales to be consumed in different modes like mobile devices and wearable devices (like Augmented Reality glasses, Virtual Reality headset's Passthrough feature).

Furthermore, a newer paradigm could be used to access them- discoverability by location. This paradigm will enable them to be tied to where they have been created or have evolved. Thus, helping provide deeper context to a story. More than passive consumption – folktales can be explored to be interactive. As folktales evolve to meet new standards of story consumption, they have the potential to be widely shared and propagated, leading to increased popularity and relevance.

Assessing existing works in the area through a comparative analysis while standing outside the domain is possible. However, building the experience of a folktale in Mixed Reality from scratch will provide first-hand information on what works, what is feasible, and what needs improvement in the format of storytelling and the technology stack. Assessing existing works in the area through a comparative analysis while standing outside the domain is possible. However, building the experience of a folktale in Mixed Reality from scratch will provide first-hand information on what works, what is feasible, and what needs improvement in the format of storytelling and the technology stack.

2.0 Research Summary

2.1 The Problem

When stories of people and places, which appear as folklore and folktales, are not consistently shared through various media, or adapted to contemporary channels such as social media and popular culture, they risk becoming obsolete. In addition, as lifestyles and methods of accessing information evolve, folklore and folktales may become less accessible to modern audiences. Furthermore, when people encounter these traditional tales today, they often need more context to appreciate their significance fully.

2.2 Research question

This thesis attempts to explore the following questions:

- How might mixed reality storytelling help increase discoverability of folktales?
- How can mixed reality storytelling help preserve the context of a story?

2.3 Hypothesis

One may discover value in encountering folktales in a new form as these stories have evolved and continue to hold significance. By exploring the potential of mixed reality technology to address the problems of access and contextualization of South Asian folktales, this research aims to develop a framework for designing and implementing MR experiences that are faithful to the cultural context of these tales while providing an engaging and immersive experience for the user. The use of MR will increase the discoverability of folktales and allow for a deeper understanding and appreciation of the cultural heritage of South Asia. Additionally, by leveraging the unique features of MR, such as the ability to blend physical and digital elements, this research aims to preserve the context of the stories and offer new ways of interpreting and engaging with these timeless tales.

2.4 Goal and Objectives

This project aims to investigate the potential of mixed reality in enhancing the discoverability of folktales while preserving the context and nuances of oral storytelling. The ultimate objective is to share more meaningful stories and moral tales with people, which can contribute to the development of stronger societies through generations of refinement. Various measures are possible to address the continued decline of folktales. First, revitalizing oral storytelling traditions in communities through festivals, workshops, and community events can reignite interest in these stories. Additionally, integrating folktales into educational curricula can ensure they continue imparting their wisdom and values, fostering a deeper understanding of cultural heritage, and preserving these treasured narratives. Although these may be effective ways, it will not be a part of this thesis. Finally, we can give folktales a new platform (using mixed reality) to engage and inspire audiences while preserving their cultural significance for future generations.

This research includes material and projects centrally themed around stories represented in Mixed Reality. Also considered are readings that look at spatial storytelling and interactive narrative experiments. The following collection identifies the sub-components of Mixed Reality, Virtual Reality and Augmented Reality and evaluates from their arguments as to which would be ideal for the project's context of retelling folktales in the new medium as well as the assessment of the level of engagement/interactions of the audience with the installation.

The research looks at identifying related works on this topic and identifying unique criteria that help improve discoverability and revive the context of the stories—reflecting on these designs, identifying the decisions based on the chosen criteria, and making a comparative analysis of these consolidated reflections. For example, some criteria may include the type of stories and motifs found in South Asian Folktales. Further criteria could be the social angle to this project, exploring if the moral lessons are being transmitted and valuable insights through engaging narratives. Next would be to explore how can discoverability of folktales can be improved. Finally, the research intends to explore and identify location-based MR experiences to better the prototype and build on existing limitations.

This thesis project includes creation of a prototype of *The Thirsty Crow* (Chaturvedi, n.d.) for an indoor tabletop experience. It will succeed in reflecting how creating such MR storytelling experiences helps increase the visibility of the folktale. The MR prototype will be of

a story from a South Asian folktale called 'The Thirsty Crow,' which is adapted from the Kannada Language tale of 'ಬದ್ಧಿವಂತ ಕಾಗೆ.'

2.5 Approach and method

The project aims to explore how we might reimagine folktales in Mixed Reality using methods such as Research Through Design (Gaver, 2012). The project will examine various junctures where design decisions were taken and reflect on each of those decisions to gain a comprehensive understanding. The project includes making six prototyping iterations through Research Through Design. The evaluation of prototypes will involve identifying criteria to reflect and compare with related works, as well as with the prototypes themselves.

2.6 Project Contributions

This project's primary contribution will be to produce a working prototype that can be installed for anyone to experience on a mobile device and help bring to attention the access to folktales problem and bringing to the surface stories that may be hidden or tucked away in archives (internet as well as conventional libraries). Furthermore, using an exhibition of the installation, we can speculate with the audience about the extent to which the problem of loss of context exists and how this installation contributes to bringing attention to the issue.

2.7 Intended Audience

This project is intended to be for children and younger adults who are of South Asian Origin (who may be able to recognize the story) as well as non-South Asian audience. Folktales can be beneficial for people of all age groups, even in today's urbanized and rapidly changing world. However, they may be most impactful for children and young adults, as they are still developing their understanding of the world, values, and social norms. Folktales can serve as a powerful tool for teaching life lessons, imparting wisdom, and providing cultural context.

Children are more receptive to learning through stories, as they can easily engage with the characters and themes. Folktales help children develop their imagination, empathy, and

critical thinking skills. For young adults, these stories can provide a deeper understanding of their cultural roots and history, while also fostering a sense of belonging and identity. Given the displacement of families and loss of traditional storytelling customs, it is essential to preserve these folktales through various mediums like books, videos, and digital platforms. This allows people from all age groups to access and appreciate the wisdom and cultural significance carried by these stories, even in the face of urbanization and language shifts. The narrative of the folktale can be thought-provoking, encouraging discussions that involve adults sharing their insights and perspectives on the morals or wisdom embedded within the story. This may emphasize the benefits of folktales for fostering intergenerational communication and learning.

2.8 Limitations and scope

This project has some limitations and scope that need to be considered. One of the main limitations is the novelty of mixed reality technology in storytelling, which requires a certain level of expertise and skill to implement. The prototype developed in this project will use basic animations and limited interactions to simulate the story's plot. As a result, the project's scope will be limited to a single story from South Asian folktales, specifically the story of The Thirsty Crow. This short story provides an ideal foundation for experimenting with the technology and assessing audience responses.

Furthermore, this project aims to address the problem of access to folktales and the loss of context that can occur in their retelling. It does not seek to displace other storytelling methods and intends to avoid creating perfect mixed-reality experiences. The project does not address non-folktale stories or incorporate advanced mixed reality devices like headsets.

The time and skillset available for this project are also limited. While the project aims to produce a working prototype accessible on a mobile device, there may be more comprehensive solutions to the problem. Additionally, the project's scope does not include an in-depth study of the prototype's audience response or cultural impact. This project acknowledges its limitations and focuses on a specific scope to provide a foundation for the future.

3.0 Context

3.1 Overview

Throughout history, human knowledge has been enriched by contributions from people of diverse cultures and backgrounds. The thoughts and spirit of generations of civilization, contextual to a place, get told and retold as stories, becoming folklore (UNESCO, 2013). Folklore and folktales are often passed down through oral traditions and as a community's collective memory, like traditional stories. Folklore weaves together the enchanting stories of survival, how civilization prospered, and the pathways that shaped society. These decisions helped a community and the specific moments of crisis that the people had to endure. Also, the values that governed those decisions get painted into the picture in the story. Folktales provide an invaluable understanding of how civilization is intertwined with its environment, which can make it more sustainable and self-sufficient if one pays attention to it. In this context, the importance of morals and wisdom comes into the picture and why we as a civilization should strive to revive them -- develop new ideas and approaches to prevent them from becoming obsolete or disappearing.

At any location, there will be a variety of folktales that can be found. They could be tales of morality or the origins of a specific location from folklore. They are usually stories where the author is likely unknown. Also, the stories have many versions. As technology advances, folktales are increasingly being forgotten and are often on the verge of extinction. (Yusof et al., 2021). The primary purpose of traditional stories was to stimulate the imagination of their audience and promote the development of creative abilities (Miyazaki et al., 2007). These stories, folktales, and legends must be maintained in this modern era to prevent the precious legacy from extinction (Tuli et al., 2015). Folklore and mythology often contain sociological understandings from the past. These stories were often used to explain and teach about the world and society, such as their values and expectations. The stories of the Epic of Gilgamesh (Sandars, 1960) and the Odyssey (Homer, 1996) are excellent examples of this, as they contain themes such as power, friendship, loyalty, and the importance of virtue. These stories are still relevant today, depicting timeless themes that can be applied to our modern society.

3.2 Folktales are getting lost

The digital age has revolutionized how people access, consume, and share information (Frayne, 2016). As a result, folktales, traditionally preserved through oral storytelling and community gatherings, need help to maintain their relevance in an era of information overload (UNESCO, 1989).

B. Recommendation on the Safeguarding of Traditional Culture and Folklore¹

The General Conference of the United Nations Educational, Scientific and Cultural Organization, meeting in Paris from 17 October to 16 November 1989 at its twenty-fifth session,

Considering that folklore forms part of the universal heritage of humanity and that it is a powerful means of bringing together different peoples and social groups and of asserting their cultural identity,

Noting its social, economic, cultural and political importance, its role in the history of the people, and its place in contemporary culture,

Underlining the specific nature and importance of folklore as an integral part of cultural heritage and living culture,

Recognizing the extreme fragility of the traditional forms of folklore, particularly those aspects relating to oral tradition and the risk that they might be lost,

Stressing the need in all countries for recognition of the role of folklore and the danger it faces from multiple factors,

Judging that the governments should play a decisive role in the safeguarding of folklore and that they should act as quickly as possible,

Having decided, at its twenty-fourth session, that the safeguarding of folklore should be the subject of a recommendation to Member States within the meaning of Article IV, paragraph 4, of the Constitution,

Adopts the present Recommendation this fifteenth day of November 1989:

Figure 3. Screenshot from the UNESCO document [Short description of the screenshot content]. Adapted from "Recommendation on the Safeguarding of Traditional Culture and Folklore," by UNESCO, 1989. Retrieved from <https://www.unesco.org/en/legal-affairs/recommendation-safeguarding-traditional-culture-and-folklore>

Furthermore, with the advent of social media, streaming platforms, and various other digital channels, people's attention is increasingly drawn to contemporary, easily accessible content. Consequently, the transmission of folktales is waning, and the younger generations must catch up with this vital aspect of their cultural heritage.

Folktales are an irreplaceable part of our shared human experience, and their gradual disappearance threatens the preservation of cultural identity, values, and artistic expression.

However, by recognizing the factors contributing to their decline and actively working to revitalize and adapt these stories for modern audiences, we can ensure that these vital narratives continue to enrich the lives of future generations. (UNESCO, 2013).

3.3 Access to Folktales & Folklore

In the past, when technology was not as advanced, the dissemination of folktales was limited, with stories being shared orally at specific times and places. The earliest written literature dates to the Sumerian civilization in Mesopotamia around 3400 BCE. There is evidence of storytelling and oral literature that predates 3400 BCE. For example, cave paintings from the Upper Paleolithic period, which is 40,000-10,000 BCE, have been interpreted as evidence of stories being told. However, between 4000 and 3000 BCE, the development of writing in Egypt and the Mesopotamian civilization at Sumer led to increased written literature, including records of law, business, and storytelling.

The introduction of print technology dramatically increased the dissemination of folktales, allowing them to be consumed simultaneously by a wider audience. With the advent of modern technologies such as animation, Mixed Reality, and location-based discovery through mobile devices, folktales have the potential to become more accessible and versatile. Now, these stories can be discovered at various locations, and their reach is limited only by the quality of their narration. Folklore is the oral traditions such as tales, legends, proverbs, and jokes shared by a particular group of people which encompasses the traditions common to that culture, subculture, or group (UNESCO, 2013)². Folktales are the stories of bygone eras that survived till today from being exchanged orally from one person to another (have been passed on from generation to generation in a local community). The way these stories have been exchanged is constantly evolving. It is often the case with primarily oral traditions, the elements of the narrative shift with each retelling (Gilmore, 2010).

² The UNESCO framework provides a comprehensive approach to understanding the challenges and opportunities surrounding the preservation and revitalization of folktales in the digital age. By adopting this framework for your project on mixed reality storytelling of South Asian folktales, you can address critical aspects such as the social impact of the loss of folktales, the changing modes of storytelling, and the role of context and location in the stories' meaning and relevance.

What was once being exchanged by word of mouth became accessible to more people when it came in the form of print. The internet has allowed stories to be distributed and accessible instantly at an even larger scale. The disappearance of folktales may be attributed to lifestyle changes and the nuclear family structure, which restricts children's access to previous generations. Further, leveraging digital technology and modern media platforms can help bring folktales to contemporary audiences. Adapting these stories into e-books, animations, podcasts, and interactive apps can make them more engaging (also immersive) and accessible to younger generations. In the domain of new media, folktales can be adopted into a newer dimension of storytelling - mixed Reality. Making these essential tales accessible on devices such as mobile phones and existing technology present without the need for specialized gear could be one of the potential solutions.

3.4 Social impact of the loss of Folktales (timeless wisdom, history, values, morals)

Urbanization and globalization have significantly altered the social fabric of communities. As people migrate to cities and adopt new lifestyles, the intimate connections and shared experiences that foster the growth and transmission of folktales are disrupted. Additionally, the gradual loss of languages due to the dominance of global languages like English, Spanish, and Mandarin further threatens to preserve these rich oral traditions.

The decline of folktales has far-reaching consequences for society. Firstly, the loss of these stories results in the erosion of cultural identity and shared values. Folktales often reflect a particular community or culture's unique characteristics, beliefs, and experiences. As these stories fade away, so does the understanding and appreciation of the collective history and identity. Folktales are essential educational tools, transmitting moral lessons and valuable insights through engaging narratives. The disappearance of these stories deprives future generations of a rich source of wisdom and guidance.

The loss of folktales represents the extinction of an essential artistic expression. The diverse array of folktales found across the world showcases the creativity and imagination of our ancestors. Allowing these stories to vanish diminishes the cultural wealth of humanity.

3.5 Storytelling modes have changed/new modes outpaced the traditional modes.

During the Industrial Age, the news took significant time to disseminate. However, in the digital age, stories can be published and spread across the internet within seconds, potentially reaching a global audience in hours. (Sharma, 2021). The transformation of storytelling modes can be attributed to a combination of factors. The advent of digital technology, social media, evolving audience preferences, cross-cultural exchange, commercialization, and educational shifts have all played a role in shaping the development of new storytelling modes and outpacing traditional forms in terms of accessibility and appeal. The storytelling of 'The Thirsty Crow' prioritizes the immersive experience of the story. It uses interactivity and personalization of the story by making the viewer a part of the experience by making them play with the crow and help complete the story. All of these give a framework for how newer stories are being told and how to align with the new modes if getting a newer flavour to the folktale is the goal. Social media has also played a role in shaping new storytelling modes. Platforms like Facebook, Twitter, and Instagram have popularized shorter, bite-sized content that caters to the reduced attention spans of modern audiences. In mixed reality storytelling of The Thirsty Crow, the story can be presented in a more digestible, easily shareable format on social media platforms. One of the goal of the prototypes is to exploring this easy sharing of the MR experience.

3.6 Storytellers, People Remembering Stories & Loss of Context

As the modes of storytelling have evolved, the role of storytellers and how people remember stories have also changed significantly. Some critical aspects of this transformation include the decline of traditional storytellers and reduced emphasis on memory and retention. (Bruchac, 2017)

The evolution of storytelling has profoundly impacted the role of storytellers and how people remember stories. While digital technology offers numerous advantages, it also challenges preserving traditional storytelling's human connection, cultural transmission, and richness. Advancements in technology have significantly altered the way stories are consumed, leading to the emergence of interactive narratives, shorter exchanges, and even memes. These changes have, in turn, influenced people's cultural preferences in storytelling.

Several aspects might need to be included in modern storytelling methods. These aspects include the significance of oral traditions, the role of performance in storytelling, and the connection between literacy and religion in oral cultures (UNESCO, 1989). By understanding these elements, we can better appreciate the nuances of traditional storytelling and adapt them to contemporary storytelling methods.

Oral Tradition and Human Connection.

Oral storytelling fosters a deep human connection between the storyteller and the audience. The storyteller's voice, expressions, gestures, and the audience's reactions contributed to a rich and engaging narrative experience that went beyond the words themselves.

Cultural Context.

The cultural context in which stories were created and shared played a significant role in shaping the narratives and the messages they conveyed. Folktales often reflected their communities' values, beliefs, and customs, ensuring that the stories remained relevant and meaningful to the audience. For example, considering the influence of colonialism, mainly the British, Portuguese, and French colonization of India, brought about new ways of thinking, living, science, technology, philosophy, and religion but also caused the loss of substantial Indigenous knowledge that had thrived. Traditional values such as sustainability and self-sufficiency have developed for an extended period throughout the Indian Subcontinent. These ideas or constructs of the way of life have gotten coded into traditional stories.

Intergenerational Transmission.

The passing down of stories from one generation to another played a crucial role in preserving cultural knowledge, history, and values. In addition, this intergenerational transmission created a sense of continuity and connection, ensuring the community's collective wisdom and experiences were not lost.

Adaptability and Flexibility.

Oral storytelling allows for changes in the story based on the storyteller's interpretation or the audience's reactions. However, this adaptability and flexibility often need to be improved in modern storytelling formats, which tend to be more rigid and fixed.

Moral Lessons and Shared Values.

Folktales often incorporated moral lessons and shared values that reflected the cultural beliefs and practices of the community. These stories guided how to behave and make decisions in everyday life, instilling a sense of cultural identity and continuity.

Sense of Community.

Traditional storytelling often brought people together, fostering a sense of belonging and shared identity. In addition, the experience of listening to stories together allowed individuals to bond over familiar narratives, values, and cultural heritage.

Understanding the importance of oral traditions, performance, and the connection between literacy and religion in traditional storytelling can help identify aspects that should be incorporated into modern storytelling methods. As storytelling evolves, challenges such as the decline of traditional storytellers and reduced emphasis on memory and retention emerge (Bruchac, 2017).

Modern storytelling methods, like MR experiences for folktales, should prioritize human connection and cultural context, fostering a sense of community and enabling meaningful discussions³. For example, designing a system that encourages parents and children to engage in stories together and promoting conversations about cultural traits, traditions, and morals could be one of the approaches. This format should allow for pauses, re-iteration, and questioning, ensuring that essential aspects of traditional storytelling are preserved in contemporary methods.

3.7 How the Context of Folktales is tied to Place

³ The UNESCO framework also emphasizes the importance of intergenerational transmission and the role of storytellers in preserving folktales. Your project can leverage the immersive and interactive nature of mixed reality to create engaging storytelling experiences that foster human connection, cultural context, and a sense of community, while still embracing the adaptability and flexibility of traditional oral storytelling.

The context of folktales is closely tied to where they originate⁴ or are set, as they often reflect the unique characteristics, customs, and values of the community from which they emerge. The cultural background, local landmarks, historical events, myths and legends, language and dialect, environmental factors, and social issues of a place can all contribute to the context and richness of a folktale, making it an integral part of the local cultural fabric (Zipes, 2012). By making folktales discoverable by location on mobile devices, we can add multiple layers of contextual information that enhance the audience's understanding of the story. For instance, if a story originates in Singapore and is viewed by someone travelling to Singapore, they can better appreciate the latent nuances in the story due to their exposure to the local culture. This approach allows the story's meaning to come across more comprehensively and engagingly.

Suppose someone needs to be exposed to the idea that crows and ravens are intelligent. In that case, they may not fully appreciate the story of the thirsty crow, as they may need to understand the significance of the bird's problem-solving abilities. One challenge here is that the concept of animal intelligence is often culturally constructed and can vary across different communities and societies. Additionally, the interpretation of the story may also depend on the individual's personal experiences and beliefs. Therefore, providing additional context and information may be necessary to help the audience fully appreciate the story's meaning. The takeaway is that more than translating a story in a newer medium available to anyone may be required, but also ensures the context part of the folktales is considered in the design of the experience.

3.8 South Asian Folktales

India occupies an important place in the history of world folklore. Especially in folktales and fables, she has played the part of the mother country. Indian fables

⁴ The UNESCO framework highlights the significance of place and context in the understanding and appreciation of folktales. By incorporating location-based discovery in this project, we can provide a richer and more authentic experience for the audience, allowing them to connect with the cultural background, local landmarks, historical events, and other contextual elements that contribute to the story's meaning and depth.

have influenced the entire folktale literature of the western world, and even Aesop's fables of Greece contain some Indian stories in their changed and distorted versions. The history of the translations of Panchatantra in the Middle Ages in the different languages of the western world is very significant for the student of folklore. (Williams, 2019)

Folktales are an essential part of South Asia's cultural heritage. The most famous examples of South Asian folktales include Panchatantra, a collection of ancient Indian animal fables. It is believed to have been written around 200 BC and is one of the oldest works of Indian literature. The stories in the Panchatantra are meant to teach moral lessons and are often characterized by their use of animals as the main characters. The name Panchatantra means "five principles" in Sanskrit, and the stories are organized into five books, each dealing with a different principle. The stories are still popular and have been translated into many languages. The Jataka tales, originating in India, are a compilation of stories within the Buddhist canon that convey essential lessons and principles (BBC, n.d.). They tell the stories of the previous lives of the Buddha and are meant to teach moral lessons.

Naithani's (2009) approach to studying folklore is grounded in the field of folkloristics, which involves the analysis of oral tradition, customs, and beliefs of a community. In her 2002 book "Folktales from Northern India," she collects and analyzes traditional narratives from the region, examining their themes, motifs, and cultural significance. She draws on methods and theories from this field to explore the social and cultural contexts of the folktales she studies. In her work, Naithani highlights the importance of understanding the complex interplay between tradition and modernity and how these forces shape and transform folktales. In addition, she examines how folktales are used to construct and reinforce social norms and values. In her other work, "In Quest of Indian Folktales" (Naithani, 2009), she provides a scholarly exploration of the tradition of oral storytelling in India and how this tradition has been impacted by modernization and globalization. The themes discussed in her book are as follows:

The Decline of Oral Storytelling.

The widespread availability of books, television, and the internet has led to a decline in the popularity of oral storytelling in many parts of India. As a result, many young people

are no longer interested in listening to their elders' stories, preferring to read books or watch television.

The Transformation of the Storyteller's Role.

As oral storytelling becomes less popular, the role of the storyteller is changing. In many cases, storytellers are now viewed as entertainers rather than repositories of cultural knowledge. They are often hired to perform at events such as festivals and weddings and are expected to adapt their stories to suit the tastes of their audience.

The Potential for the Preservation and Reinvention of Folktales.

Despite the challenges posed by technology, Naithani argues that new media can also be used to preserve and reinvent the tradition of Indian folktales. For example, some storytellers use social media platforms to reach new audiences and share their stories in new ways. In addition, filmmakers and other artists are using traditional folktales as inspiration for new works, which can help to keep these stories alive for future generations.

South Asian folktales include motifs like Karma, Fate and 'Headwriting.'⁵ (Kent, 2009) As mentioned in Jataka tales, other motifs include rebirth, which implies that what one does in this birth will reflect in their other births.

This project wants to use a story that has a repeating or recurring pattern found in South Asian folktales which is wise Animals. This could be the skeleton for a simple story to be taken up for prototyping. A video by Topolpet on Instagram⁵ shows a crow using a stick to grab food. Not only does it use the stick, but the crow goes on to modify the stick by curving one of its edges to aid in lifting the food from inside a container. Like the story of 'The Thirsty Crow' to be prototyped, it shows that crows are wise animals.

The moral of the thirsty crow story is often interpreted as wisdom, resourcefulness, and perseverance. The crow demonstrates these qualities by using its intelligence to solve its problem, using the resources available, and giving up when it achieves its goal. The story serves as a reminder that one should use their intellect and determination to overcome obstacles rather

⁵ Topolpet on Instagram. (2022, December 17). Instagram. Retrieved February 20, 2023, from <https://www.instagram.com/reel/CmSZ-kftyF8/>

than relying solely on physical strength or external help. It also needs to be communicated by the prototype. Inspired by Naithani's approach, this work wishes to explore how folktales can construct and reinforce social values. It brings in the aspect of modernity by experimenting with a new medium for telling traditional folktales.

3.9 Story of 'The Thirst Crow'



Figure 4. Dalle-2 rendering of a thirsty crow drinking water from a pot. (Dalle-2, 2022).

Jataka tales are a collection of stories narrating the Buddha's previous lives, Siddhartha Gautama, in both human and animal forms. These tales originated in ancient India and are essential to Buddhist literature. While the Jataka tales are specific to Buddhism and its teachings, they can be considered "indigenous" to the Indian subcontinent because they originated there and are deeply rooted in the region's culture and tradition. (Encyclopedia Britannica, n.d.)

South Asian folktales are significant cultural artifacts that offer insights into the region's history, beliefs, and customs. These stories often reflect the values and morals of the communities that created and passed them down through generations. They are a means of preserving and transmitting cultural Knowledge, including language, customs, and social structures. Additionally, they can offer a sense of belonging and identity for those with the same cultural background. South Asian folktales are often rich in symbolism and metaphors that reflect the region's natural environment and social structures. They also provide a glimpse into the spiritual and religious beliefs of the communities that created them. For example, Jataka

Tales, a collection of Buddhist stories originating in India, offer insights into Buddhist philosophy and ethics (The Editors of Encyclopaedia Britannica, 1998).

Using new and emergent media to present folktales can also help revitalize and modernize the stories while being respectful and giving credit to the original ideas and traditions. For example, an artist might create a contemporary interpretation of a folktale using a modern art style or medium. This interpretation can help to create stories that are relevant and engaging to a new audience and can help to ensure that they continue to be relevant and appreciated in the future (Azuma, 2015).

3.10 Interactive Stories

Stories can be composed with interactivity, including involving the reader or audience in the story and creating a more personalized experience. It also allows the audience to be more active in the storytelling process. There is also a learning angle to stories. The amount of information a teacher imparts in a class does not solely determine the extent of a student's learning; students also construct their understanding of fundamental concepts through active engagement. Learning is optimized when students participate in activities that are both challenging and personally meaningful to them. (Persellin and Daniels 2012, 3).

This thesis wants to identify workable ways of translating stories in an interactive format and understanding how interactive storytelling and games work may help. The interactive story of *The Thirsty Crow* draws on many of the same techniques and principles used in game design to create an engaging and immersive experience for the viewer. Interactive storytelling is a technique often used in game design. In interactive storytelling and game design, the audience is encouraged to actively engage with the story or game world rather than passively consume it. As Bura (2008) says in the publication in *Gamasutra*, players do not play games to complete them, just as readers do not read books solely to finish them. Instead, players engage in games to experience emotions. Game design involves crafting these experiences to engineer specific emotions. Considering a game design format is challenging because the output of it is an interactive system that is twice removed from its ultimate objective. The game designer creates rules for interaction that, when combined with the player's participation, generate game states that elicit emotions in the player. It is not ideal if someone were to finish viewing the story of the

'Thirsty Crow' in MR too soon -- much quicker than how it would play out if they were to be listening to it conventionally. Bringing it into an interactive format is not worth it if we were to quicken the entire activity.

In his book "Emotional Design," Norman (2001) identifies three distinct levels of experience processing: visceral, behavioural, and reflective. According to Norman, the visceral level concerns how the experience shapes the person's feelings. In contrast, the behavioural level pertains to how well the experience serves its intended purpose or function, and the reflective level considers how the person's self-image is impacted. The following are the ways of translating stories in an interactive format: -

Choose-your-own-adventure type of stories or including decision points in the story.

These types of stories allow the reader to choose the story's direction, give the audience choices at specific points, and let them decide what happens next, creating a more personalized and engaging experience for the reader. (Google Arts & Culture, n.d.)

Interactive games or puzzles.

These stories incorporate gameplay elements and challenge the reader to solve puzzles or complete tasks to advance the story. In a video game, the player can control the main character and their actions, allowing them to choose, decide and affect the story. (Google Arts & Culture, n.d.)

Live events or performances use physical elements to create interactive experiences and involve the audience in storytelling.

This could involve using props, costumes, or other physical elements to allow the audience to interact with the story in a more tangible way. In addition, these types of storytelling involve audience participation through activities or challenges or allowing the audience to choose and influence the story's direction. For example, in a live event, such as a theatre performance or escape room, the audience can participate and affect the story's outcome. (Google Arts & Culture, n.d.)

Online or app-based stories or using technology to create interactive experiences.

This could involve using virtual or Augmented Reality or creating a website or app that allows the audience to interact with the story in various ways. For example, in a film or television show, the audience can choose which characters to follow or which paths to take using technology such as branching storylines or interactive apps. These stories can

be accessed through a website or app and may include interactive elements such as videos, animations, or games. (Google Arts & Culture, n.d.)

The interactive story of 'The Thirsty Crow' created in Mixed Reality may not offer viewers choices on the story's direction. However, it does provide the viewer with a sense of agency, allowing them to control the pace at which the story unfolds. This sense of control is an essential aspect of game design, as it helps to keep players engaged and invested in the experience, and thus the story is made more engaging and impactful. They get to trigger the flow of each act in the story. With the artifacts in the scene being evident and direct, stones and a pot with water, the entire interactive design setup enhances the visceral nature of the story. While the puzzle elements in the interactive story of The Thirsty Crow may be minimal, they still represent a crucial aspect of game design. Many games include puzzle-solving elements to engage players and encourage critical thinking. In addition, various elements of the scene become involved in the story, such as the placement of the pot and the stones in the room. This spatial spreading out of the story makes it more active, allowing viewers to experience the story more immersively. Both the game design and the interactive story of The Thirsty Crow aim to provide an immersive experience for the audience. By creating a compelling and engaging world, designers can draw players or viewers into the experience and create a sense of emotional investment.

3.11 Spatial Storytelling

In "Digital Media: Transformations in Human Communication" (2nd ed.), Smith (2017) discusses spatial storytelling within the context of digital media, particularly focusing on how digital technology enables new ways of telling stories using spatial elements. The author explains that spatial storytelling involves the use of location, direction, and movement to convey narrative meaning. In digital media, this can manifest through interactive maps, virtual reality experiences, or geolocation-based applications. By integrating spatial elements into storytelling, digital media can create immersive experiences and offer new ways of engaging with narrative content. Spatial storytelling is a way of telling a story using spatial elements such as location, direction, and movement. It can be a powerful tool for engaging the audience and keeping them interested in

the story. It can effectively tell a story and create a more profound, more engaging experience for the audience. There are several benefits to using spatial storytelling:

1. It can create a more immersive experience for the audience, allowing them to feel like they are part of the story.
2. It can help better convey the characters' emotions and actions, as the audience can see the story unfold in a specific space.
3. It can add depth and complexity to the story, as the audience can see how the different elements of the story relate to each other in a spatial context.
4. It can help the audience understand the story better, as the spatial elements provide additional information and context.

McKelvey and Hunt (2019) discuss the idea of 'surrounds,' which goes beyond just one screen. First and second-screen setups, applications, desktops, dashboards, and—increasingly—digital assistants like Amazon Echo or Google Home—are examples of these. Oswald and Packer (2012) broadly defined the flow in the wake of new media as the "material set of practices, techniques, and technologies that integrate individuals into the temporal and spatial dynamics of contemporary economics and cultural expectations." This changing landscape of viewers' attention and expectation has become very real and will impact how stories are told over our various devices.

3.12 Mixed Reality

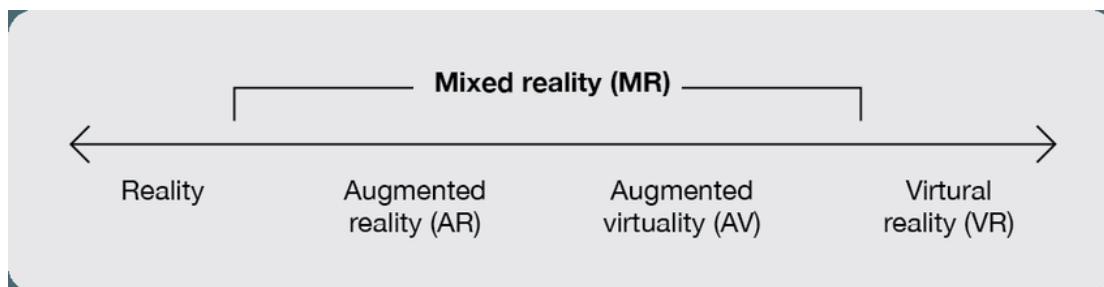


Figure 5. Diagram showing Mixed Reality in the extended reality continuum (adapted from Milgram et al., 1995). [PDF screenshot]

A technology that blends virtual and real-world elements, creating an immersive and interactive experience for the user, Mixed reality (MR) combines virtual reality (VR) and augmented reality (AR) to create a hybrid environment where digital and physical objects coexist and interact in real time. However, unlike VR, which creates an entirely digital environment, and AR, which overlays digital elements in the real world, MR allows digital and physical objects to interact seamlessly. This interaction is possible through sensors, cameras, and other advanced hardware and software technologies that enable overlaying of computer-generated in the real world. With MR, users can experience a new level of immersion, interacting with digital objects in the real world and seeing them as if they were there. This technology has many applications, from gaming and entertainment to education, healthcare, and industrial settings, where it can enhance training, visualization, and collaboration. Milgram, Takemura, Utsumi, and Kishino (1995) introduced the concept of mixed reality as a class of displays on the reality-virtuality continuum.

Mixed reality can combine the experiences of stories in immersive computer-generated worlds in which elements of physical and virtual environments can be combined. This thesis lies at the intersection of storytelling and pushing the boundaries of how folklore can be introduced to the next generation through Mixed Reality. Mixed Reality and Immersive 3D technologies also create new opportunities for organizations and brand owners to connect with consumers through interactive and virtual reality storytelling (Augmented Reality in Marketing, 2019).

Mixed reality (MR) offers new ways for storytellers to engage their audiences by creating immersive and interactive experiences. By blending digital and physical elements, MR enables storytellers to create more accurate and engaging worlds than traditional media. One of the main benefits of MR in storytelling is its ability to create a sense of presence, or the feeling that the user is in the story world. Using spatial audio, haptic feedback, and other immersive technologies, a personalized experience for each user is possible (Ritchie, 2020). In addition, MR can adapt the story to the user's location, movements, and other inputs using sensors and tracking technologies. It also has numerous benefits for society, such as enhancing people's efficiency when working and studying remotely in dynamic surroundings and extending people's imaginations from physical limitations to the virtual environment.

Several studies have explored the potential of mixed-reality storytelling to enhance the storytelling experience. Audiences perceive MR-based storytelling as more immersive and engaging than traditional storytelling techniques. These studies have found that mixed reality storytelling can provide audiences with a more engaging and immersive experience by allowing them to interact physically with the story world and characters. In addition, mixed reality storytelling can also provide new opportunities to experience traditional stories in unique and creative ways.

3.13 Related Works

Following are the reviews of works that combine mixed reality and storytelling that can provide insights into how folktales should be approached to be able to be adapted to the new medium.

1. Le Petit Chef.

Le Petit Chef is a restaurant experience that combines the best of theatre and dining. Le Petit Chef, a miniature chef who is projected along with the story elements on the dining table, takes a viewer through an immersive culinary journey following the footsteps of Marco Polo. The Chef makes the dish by bringing it onto your plate step by step but in an animated style projected from the top, leaving the viewer in a state of wonder. For example, if a customer has ordered fish, the Chef catches fish from outside the plate and tosses the food. The servers then bring over the actual dish, which is placed

on the projected plate portion. This reflects how mixing the environment, and digital elements of the story can happen in harmony by overlaying them and having the story tie the two together. Similarly, the Mixed Reality Storytelling of South Asian Folktales project aims to create an immersive experience for the audience, leveraging the unique features of mixed reality to bring traditional stories like the thirsty crow to life. By overlaying digital elements onto the physical environment and weaving the story together, the project aims to create a pleasant and engaging experience that honours the rich cultural heritage of South Asian folktales while taking advantage of the innovative possibilities of mixed reality technology.

2. Mixed Reality Roller Coaster.

Learning about physics and construction principles in augmented reality can be much fun - as this early prototype of Coaster Mania shows. The new generation of wearable augmented reality headsets leaves your hands free to sculpt, build and interact with your digital creations. (David W. Sime on LinkedIn, 2023)

In the above quote, David Sime talks about the projection of a roller coaster in the passthrough feature showing an indoor space. The player can move the coaster about and be able to manipulate the virtual objects. Objects behave like physical ones with the effects of gravity and the workings of sloping surfaces. Coaster Mania is a prime example of mixed reality, and this is the exact translation of experience that should come in the Story of 'The Thirsty Crow.'

3. Disney+'s short film 'Remembering.'

Another approach that looks at a user's context for extending the story into the physical space can be seen in Disney's AR-enabled short film, 'Remembering.'

"It is an experiment in seeing if AR can serve to enhance movie storytelling even when viewers are watching in their living rooms."
(Forristal, 2022)

The environment in the screen extends outwards in three dimensions, almost continuing from inside and fills up the living room to give the user the augmented experience of the fairy tale. As the website explains, this experience requires the viewer to install an app from Disney+. Further requires the viewer to content on Disney+ App on their TV and scan the physical location. As designers, we need to ensure the audience knows where to look and to what extent the mixed reality experience will be covered in their room once deployed. Also, to note is the simplicity of steps needed to talk to the user, and whenever user onboarding steps come up in websites or apps, users tend to close it the moment they are denied access to the actual content. All these points account for the learnings in making such a system.

4. Komik App - North Sumatran Folktales Based in Augmented Reality.

Wasilah et al. (2022) describe the process of designing the Komik app for mobile devices, which adapts well-known North Sumatran folktales, such as The Legend of Lau Kawar and Gundaling, into a collection of illustrated comic stories. The development process involves creating a user-friendly system that is easy to understand and designing 3D objects, sound files, and image libraries that can be used as markers for the Augmented Reality (AR) component. The next step is to combine all these elements into a single AR project and carry out the coding process. The Komik App project demonstrates how AR technology can be used to preserve and promote local folklore and traditions (Wasilah et al., 2022). By adopting these folktales into an interactive format, the project helps ensure that these stories remain relevant and accessible to younger generations who may not be familiar with them. Furthermore, as users actively engage with the content rather than passively consuming it, it showcases how traditional forms of storytelling can be adapted and integrated into modern digital platforms and drive a broader discussion on the role of technology in redefining the boundaries of art and culture and how it can be used to create new, engaging experiences for audiences.

5. Google Arts & Culture.

Google Arts & Culture ⁶ is a non-profit project collaborating with artists and cultural organizations worldwide. Its purpose is to digitize and safeguard the world's art and culture, enabling easy access to anyone, regardless of location.

Their website contains the Play page, which hosts a sub-section called 'Objects in Augmented Reality' under the 'Play with your Camera' section. "Experience art and culture in new ways" by bringing art to life and allowing users to interact with it in new ways; these experiences can help users gain a deeper understanding and appreciation of the world around them. Google Arts & Culture offers a variety of augmented reality (AR) experiences that allow users to explore art and culture in new and interactive ways. This project gives us an idea of how the scale of different locales and spaces, all the way to the scale of different artifacts like pots and other objects, can be weaved into mixed reality experiences. Some examples of AR experiences available on Google Arts & Culture include:

Pocket Gallery.

This AR experience allows users to create their virtual art gallery by selecting paintings from a collection of over 1,000 works of art from famous museums worldwide.

Art Projector.

With this AR experience, users can project famous works of art onto their walls and see them in their own space.

Art Selfie.

This feature uses facial recognition technology to match a selfie with a portrait from a collection of art worldwide.

Wanderlust.

This AR experience takes users on a virtual tour of some of the world's most iconic landmarks and monuments.

The Hidden Worlds of the National Parks.

⁶ Google Arts & Culture. (n.d.). Play. Retrieved March 21, 2023, from <https://artsandculture.google.com/play>

This AR experience allows users to explore the hidden worlds of several U.S. National Parks, including Yosemite and Yellowstone.

Google Arts & Culture, through its AR experiences, democratize access to art and culture by allowing users from around the world to experience and interact with famous works of art and landmarks without physically visiting the locations. This can help bridge the gap between people with limited access to cultural experiences and those who can travel to cultural institutions. Furthermore, these immersive and interactive learning opportunities can lead to a deeper understanding and appreciation of art and culture, as users can actively engage with the content rather than passively consume it. Using AR technology is helping preserve and document cultural heritage, the importance of digitizing art and cultural artifacts, and the role technology play in safeguarding our shared history for future generations. All in all, showing us a unique way of telling stories, creating new narratives, and sharing cultural knowledge with a global audience.

6. Between Worlds.

"Between Worlds" is an interactive Augmented Reality (AR) narrative experience created by Experience Anomaly. It immerses users in a magical world that blends fantasy and reality. By integrating AR technology with storytelling, "Between Worlds" not only offers a unique and engaging experience for its audience but also challenges traditional narrative formats and creates new possibilities for engaging audiences through innovative technology. Blending realms of fantasy and reality can help develop creativity by encouraging users to think beyond the constraints of their everyday environment. The project involves collaboration among artists, storytellers, technologists, and other creative professionals. A discussion of how such interdisciplinary collaborations can lead to innovative ways of using technology to present and share cultural content, as well as the potential for fostering cross-cultural exchange and understanding, is possible.

3.15 Summary

This section discusses various projects that combine mixed reality and storytelling, providing insights into how folktales can be adapted to new media. The projects covered include Le Petit Chef, which merges dining with immersive storytelling; the Mixed Reality Roller Coaster, which explores physics and construction principles in augmented reality; Disney+'s short film 'Remembering,' which uses AR to extend the story into the viewer's living room; North Sumatran Folktales Based in Augmented Reality, which adapts local folktales into interactive comic stories; Google Arts & Culture, which offers a range of AR experiences to explore art and culture; and Between Worlds, an interactive AR narrative experience created by Experience Anomaly. These projects demonstrate the innovative ways mixed reality technologies can create new, engaging experiences for audiences while preserving and promoting cultural heritage.

The critical takeaway from reviewing these contextual works is that Mixed Reality Experiences are here to stay. There is a vast world of openings for this kind of storytelling and a need for this. Like how TV did not kill books, Mixed Reality will not kill oral storytelling but will be a different portal into information that can be packaged in mesmerizing ways to tell stories.

4.0 Methodology

4.1 Overview

Research through Design (Gaver, 2012) is a research methodology that leverages the design process to investigate, understand, and generate knowledge. In the context of folktales' mixed reality (MR) storytelling, Research through Design (RTD) can be a valuable approach to explore, create, and evaluate novel MR experiences that immerse users in these timeless narratives.

4.2 Research Through Design

Over the last number of years, design practitioners have become increasingly integrated within the HCI research community. Their work often takes the form of research through design,

in which design practice is brought to bear on situations chosen for their topical and theoretical potential; the resulting designs are seen as embodying designers' judgments about correct ways to address the possibilities and problems implicit in such situations, and reflection on these results allow a range of topical, procedural, pragmatic, and conceptual insights to be articulated. The output of this work takes the form, primarily, of artifacts and systems, sometimes with associated accounts of how these are used in field tests, but increasingly includes a variety of methods, conceptual frameworks and theories presented separately from accounts of practice. (Gaver, 2012)

RTD methodology is a popular approach used in design research that emphasizes creating tangible artifacts to explore research questions and generate new knowledge. Unlike traditional research methods, RTD prioritizes using design practice as a means of inquiry, allowing researchers to investigate complex design problems by constructing and testing physical prototypes rather than relying solely on abstract theories or models. This approach is beneficial for Master of Design theses, where students are often required to develop innovative and practical design solutions to complex problems. By combining research and design practices, RTD allows designers to generate new insights, methods, and tools that can be used to address real-world challenges more effectively and sustainably. Several critical concepts are associated with Research Through Design (RTD) methodology. These concepts form the approach's foundation and help guide the design process and research activities.

Design as a mode of inquiry.

RTD emphasizes the use of design practice as a way of exploring research questions and generating new knowledge. The goal is to create tangible artifacts that can be used to investigate and test design ideas and concepts. (Gaver, 2012)

Iterative design process.

RTD involves an iterative design process where designers create and refine prototypes in response to feedback from stakeholders and users. This process allows designers to learn from their mistakes and continuously improve their designs. (Gaver, 2012)

Holistic approach.

RTD considers the entire design process an interconnected system, from ideation to implementation. This holistic approach encourages designers to consider the broader

context in which their designs will be used, including cultural, social, and environmental factors. (Gaver, 2012)

Emphasis on reflection.

RTD requires designers to reflect on their design decisions and the implications of their designs. This reflective process helps designers identify new research questions, refine their design strategies, and improve their designs' effectiveness. (Gaver, 2012)

Contribution to knowledge.

RTD aims to generate new knowledge about design practice and its role in addressing complex problems. The goal is to produce insights, methods, and tools that can be used to inform future design practice and advance the field of design research. (Gaver, 2012)

These fundamental concepts provide a framework for designers to engage in research and create innovative and practical design solutions. By following these principles, designers can develop a deep understanding of the challenges they are addressing and create well-informed, contextually appropriate, and sustainable designs.

4.3 Application of RTD

Application of Research through Design in mixed reality storytelling of folktales can be investigated by focusing on the iterative design process, knowledge generation, and the implications for MR experiences: -

1. Iterative Design Process.

A. Problem identification.

The RTD process begins by identifying the challenges and opportunities of adapting folktales to mixed reality. This includes understanding the cultural context, preserving authenticity, and creating engaging, immersive experiences.

B. Concept development.

Drawing from understanding the problem space, designers generate initial concepts for MR storytelling experiences. These concepts may include interaction

models, visualizations, and narrative structures that leverage the unique affordances of mixed reality.

C. Prototyping.

Designers use tools such as storyboards or mock-ups to create low-fidelity prototypes of their concepts. These prototypes allow designers to explore the feasibility of their ideas and gather early feedback from users, cultural experts, and other stakeholders.

D. Iterative refinement.

Based on feedback and insights from prototyping, designers iteratively refine their concepts, producing increasingly refined and sophisticated prototypes. This process continues until a satisfactory solution is achieved, balancing the needs of users, the cultural context, and the technological constraints.

2. Knowledge Generation.

A. Design insights.

The RTD process generates knowledge by designing and refining MR experiences. Design insights emerge as designers grapple with the complexities of creating immersive, culturally sensitive MR folktales, leading to a deeper understanding of the design space and potential solutions.

B. Evaluative knowledge.

By testing and evaluating prototypes with users, designers gather valuable knowledge about the effectiveness of their MR experiences. This evaluative knowledge can inform future design decisions for the specific folktale project and for mixed reality storytelling more broadly.

C. Transferable knowledge.

The knowledge generated through RTD is often transferable to other contexts and projects. For example, the insights gained from designing MR folktales can inform the design of other mixed-reality experiences, contributing to the broader understanding of MR storytelling.

3. Implications for Mixed Reality Experiences.

A. Informed design.

Research through design can lead to more informed and effective design decisions for mixed-reality storytelling, resulting in experiences that are engaging, immersive, and culturally sensitive.

B. Innovation.

RTD encourages designers to push the boundaries of existing MR storytelling techniques, fostering innovation and developing new approaches to adapt folktales to mixed reality.

C. Collaboration.

The RTD process often involves collaboration between designers, users, cultural experts, and other stakeholders. This collaboration ensures that diverse perspectives are considered, resulting in more holistic and inclusive MR storytelling experiences.

4.4 Summary

The Research through Design (RTD) methodology is a practical approach for developing mixed-reality storytelling experiences for folktales. By employing an iterative design process, emphasizing self-reflection, and generating knowledge through design, RTD enables the creation of immersive, engaging, and contextually appropriate MR experiences that respect the cultural heritage of folktales while utilizing the unique possibilities of mixed reality technology.

5.0 Prototypes

5.1 Overview

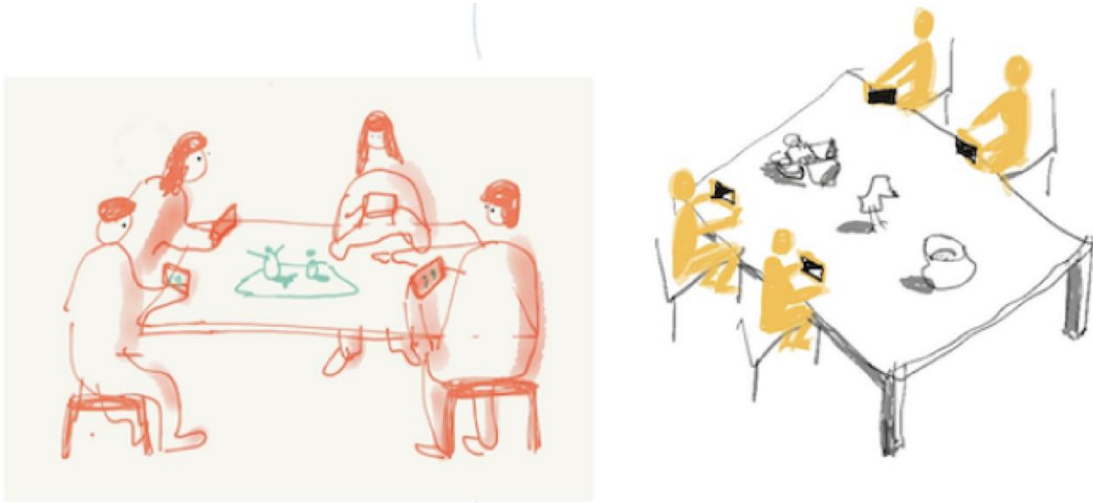


Figure 6. Concept for Table-top based shared AR Experiences [Illustration]. Created by A. Chickanayakanahalli, 2022.

Creating and testing prototypes can be a complex process that may require several iterations. However, it can offer new opportunities and generate novel questions for further testing. As a result, prototype testing should aim to identify the strengths and weaknesses of the product, generate new ideas and questions, and provide an overall evaluation of the product. Ultimately, if the product successfully addresses the initial problem it was designed to solve, it can be considered a successful prototype testing and product development. As identified by Singh (2023) in their blog, prototype testing should reveal:

- What worked?
- What did not work?
- New questions
- New ideas
- Overall evaluation in general

Some of the platforms considered for prototyping the story of 'The Thirsty Crow' in MR for mobile devices are shown below. These are covered in the post by Ibn Sayed, S. (n.d.). '*Top AR, and VR Prototyping tools.*'

1. ARCore (Android) / ARKit (iOS)

ARCore and ARKit are AR development platforms provided by Google and Apple, respectively. They enable developers to create AR experiences for Android and iOS devices by allowing digital content to be overlaid on the physical world.

2. Unity3D

Unity is a widely used game engine that supports the development of mixed reality experiences for mobile devices. Unity has built-in support for ARCore, ARKit, and other AR/VR platforms, making it a versatile tool for creating both AR and VR applications.

3. Unreal Engine

Unreal Engine is another powerful game engine that supports the development of mixed reality experiences for mobile devices. It offers built-in support for ARCore, ARKit, and other AR/VR platforms, as well as a visual scripting system called Blueprints.

4. Vuforia

Vuforia is an AR development platform that enables developers to create mixed reality experiences for mobile devices. Vuforia supports various platforms and devices, including Android and iOS, and offers features like image recognition, object tracking, and location-based experiences.

5. 8th Wall

8th Wall is a web-based AR platform that allows developers to create AR experiences that can be accessed through mobile browsers. This makes it easy for users to engage with mixed reality content without needing to install a separate app.

6. A-Frame

A-Frame is an open-source web framework for creating VR and AR experiences that can be accessed through mobile web browsers. With its HTML-like syntax and entity-component system, A-Frame simplifies the process of creating mixed reality experiences for web developers.

7. Lens Studio (Snapchat) / Spark AR (Facebook)

Lens Studio and Spark AR are development platforms provided by Snapchat and Facebook, respectively, for creating AR experiences that can be shared on their social media platforms. These tools allow developers to create immersive and interactive mixed reality experiences that can be easily accessed by users through their mobile devices.

Zappar (Zappar Ltd., 2011) and Niantic Lightship (Niantic Lightship, n.d.) were also considered in prototyping. The learning curve was considerably more.

5.2 Prototype 1.0

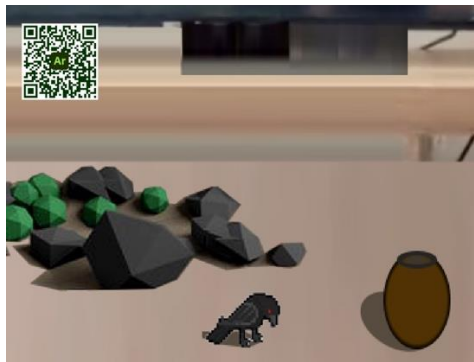


Figure 7. Poster for first prototype [Illustration]. Created by A. Chickanayakanahalli, 2022.

What is the idea/goal?

- A Mixed Reality Experience to be created having a couple of stones present around in the space (preferably in the scale of a tabletop) along with the crow and the half-filled pot which holds water inaccessible to the crow. The audience who is looking at this experience through their mobile device, needs to trigger the story to play out in mixed reality -- the crow looks for water, see the rocks, flies about back and forth carrying the stones to the pot to drop them. Once it has dropped a few rocks in, water comes up and crow can quench its thirst and fly away.

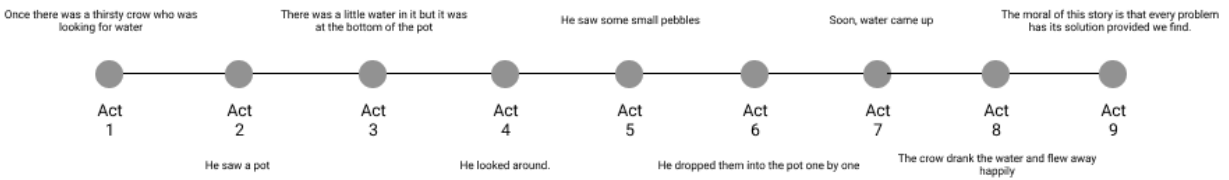


Figure 8. Image for story acts [Illustration]. Created by A. Chickanayakanahalli, 2022.

Design/development.

- **Tools used:** Adobe Aero, Figma, Procreate

Adobe Aero is an augmented reality authoring and publishing tool developed by Adobe. It allows designers to create interactive experiences and immersive content for mobile devices and headsets using 2D and 3D assets. The tool features a user-friendly interface with drag-and-drop functionality and supports a variety of file formats. Adobe Aero also includes features such as animation tools, physics simulations, and real-time collaboration, enabling users to create compelling and dynamic augmented reality experiences. With Adobe Aero, designers can bring their ideas to life and engage audiences with immersive and interactive content.

- **Storyboard:** Imagined the story to appear as virtual characters on a wall and a walker by & interacting with it.

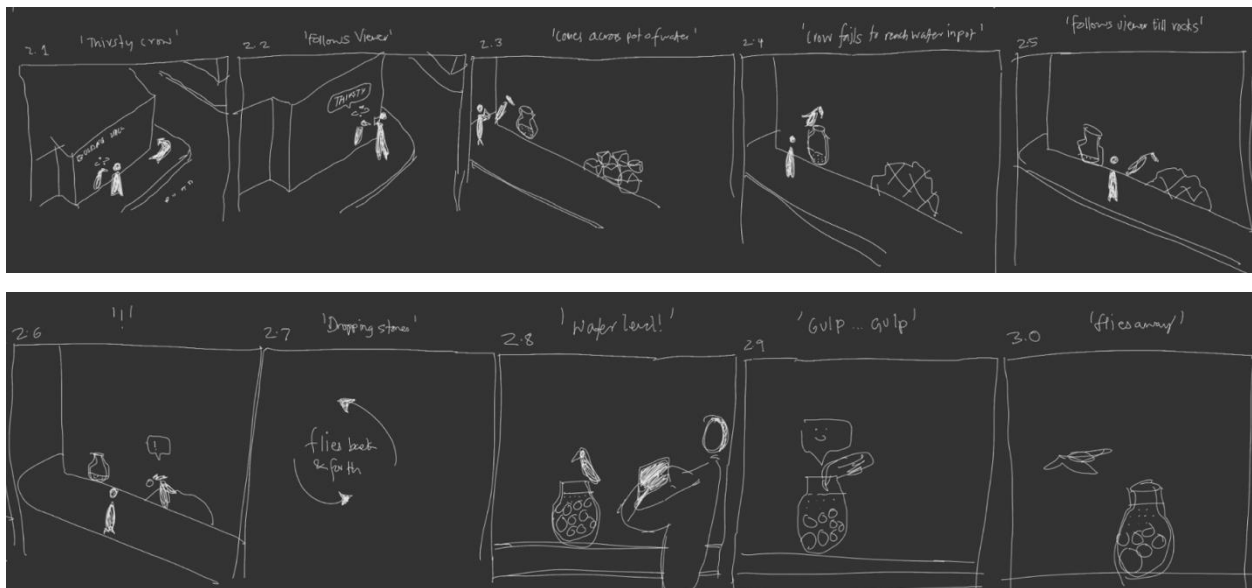


Figure 9. Artboards in Figma for export [Screenshot]. Created by A. Chickanayakanahalli, 2023.

- Created a gif file from combining PNG files with transparent background in Figma.
- Placed the gif file content and the Stones PNG at two different depths.

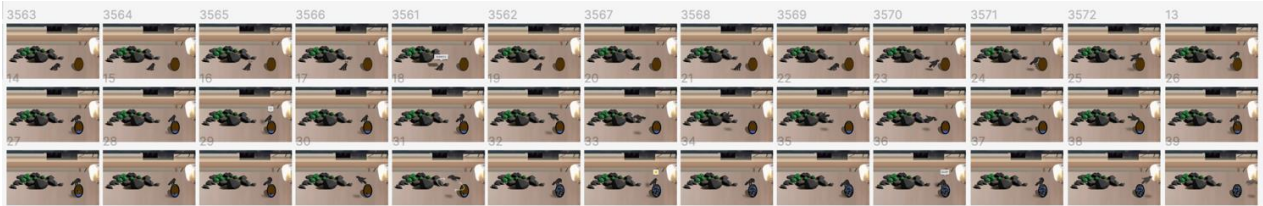


Figure 10. Artboards in Figma for exporting as GIF [Screenshot]. Created by A. Chickanayakanahalli, 2023.

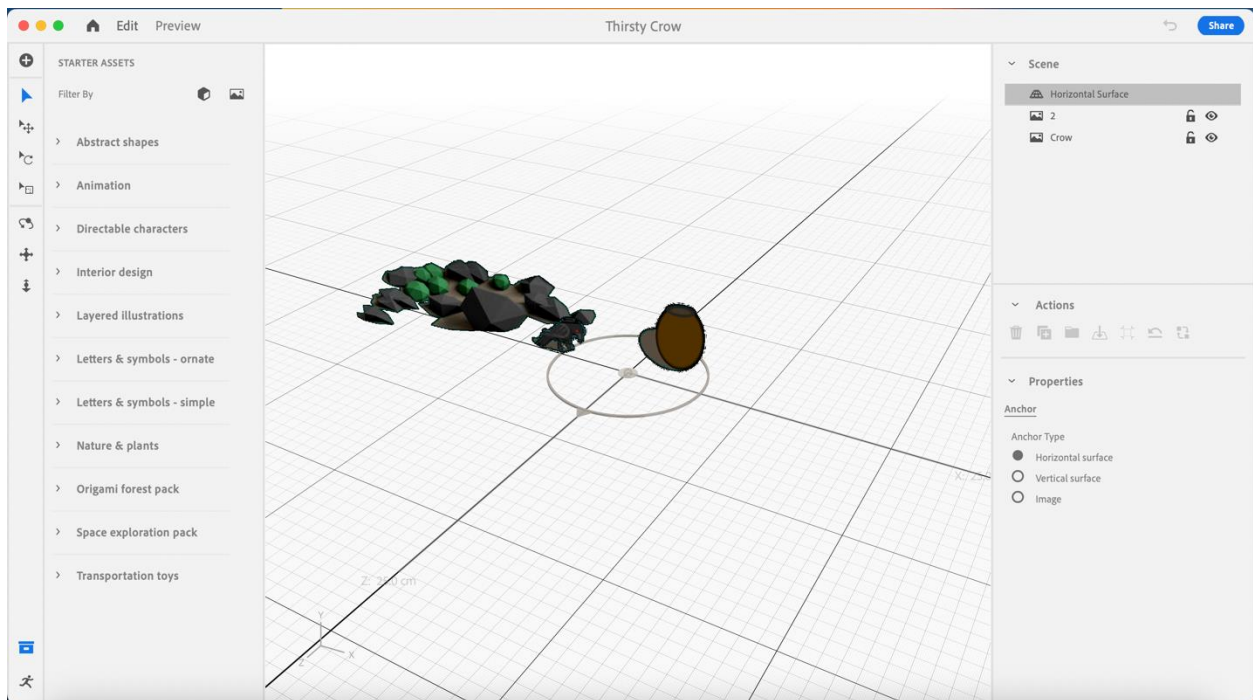


Figure 11. Adobe Aero - placing layers in 3d space [Screenshot]. Created by A. Chickanayakanahalli, 2023.

- Added interaction when user clicks on the crow or the pot (shown as CROW layer in the image) to get the animation of the GIF file playing.

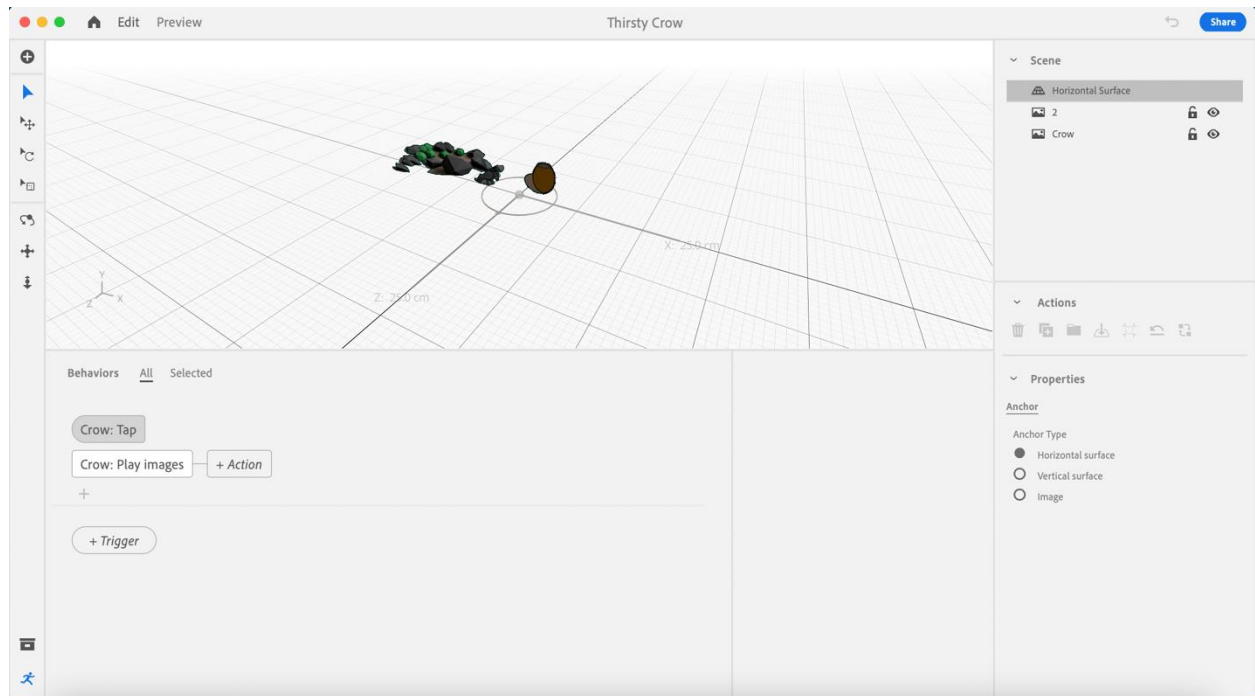


Figure 12. Adobe Aero - Actions setup [Screenshot]. Created by A. Chickanayakanahalli, 2023.

- **Link to experience:** <https://adobeaero.app.link/uXCAGwZfDub>
- **Link to the video:** <https://youtu.be/MhQEYtDM5Wo>

Reflection/evaluation.

What worked?

- The placement, surface detection was very accurate and intuitive in Adobe Aero.
- Trigger to get the story playing turned out to be intuitive.
- The emojis and callouts work very well.



Figure 13. Artboard in Figma for export [Screenshot]. Created by A. Chickanayakanahalli, 2022.

What did not work?

- Forces viewer to download Adobe Aero app and then place the experience on a surface which is too much to ask from the viewer. If they open a link, it should appear.
- Some part of the experience where the crow needs to bring the stones from the pot is automated and is not interactive and there are no more viewer dependant triggers after the initial 'play' to get the story playing.
- Making any changes is cumbersome with the re-exporting of gif needed each time.

New questions.

- Would audience accept 2d imagery made to look 3d in augmented reality because that would be a shortcut but also encourages anyone else build up on this work without having to build muscles in learning other AR tools?

New ideas.

- Even though this experience when displayed was able to wow others, it didn't go all the way to tempting them to install the Aero app to experience it. So, the next prototype must consider the possibility of finding a way to host this on a server and provide only the link to access this. Only then will this be shared and tweeted and re-tweeted.

Overall evaluation in general.

- This was a very early, although rough visually, but a complete prototype that gave the research team a full picture of bringing a story into mixed reality. These tools are new for the area of research and require knowledge and skill-building with code. This means that the prototype will utilize a basic animated tale with few interactions to simulate the plots of the story.
- This story is short in length and acts as an ideal foundation to experiment with the technology and responses to it.
- It aims to create an interactive mixed reality experience of 'The Thirsty Crow' story, utilizing Adobe Aero and Figma. The prototype successfully demonstrated accurate placement and surface detection, as well as an intuitive trigger for the story. However, limitations included the requirement for viewers to download the Adobe Aero app and limited viewer-dependent interactions after the initial 'play' trigger.

5.3 Prototype 2.0



Figure 14. Betaal Pachisi in Mental Canvas Tool on iPad [Screenshot]. Created by A. Chickanayakanahalli, 2022.

What is the idea/goal?

- Figure out how an interactive and immersive 3D drawing can help visualize the story of 'Vikram-Betaal' as artefacts that can be placed in 3d space.
- Betaal Pachisi is the 25 tales of King Vikram and the ghost Betaal
Story: https://en.wikipedia.org/wiki/Baital_Pachisi



Figure 15. DeepAI. (n.d.). Story of Betaal Pachisi showing king Vikram carrying the ghost Betaal [Generated image]. Fantasy World Generator. Retrieved May 4, 2023, from <https://deepai.org/machine-learning-model/fantasy-world-generator>

Design/development.

- **Tool used:** Procreate, Mental Canvas
- **Storyboard:**



Figure 16. Storyboard of Vikram Betaal to appear on a building wall[Screenshot]. Created by A. Chickanayakanahalli, 2022.

- Mental Canvas is a spatial drawing platform that allows users to create and navigate through interactive 3D drawings. It provides a unique and immersive experience, allowing users to create and manipulate objects in space using a combination of 2D and 3D techniques. The experience is like sketching on a flat surface, but with the added ability to add depth and dimension to drawings. Mental Canvas allows for free-form exploration of ideas and concepts, making it a useful tool for designers, artists, and anyone who wants to visualize their ideas in a more dynamic and interactive way.
- **Link to the video:** <https://youtu.be/Cj5iIrk1mkI>

Reflection/evaluation.

What worked?

- Got an idea of working with a more complicated storyline (Vikram Betaal) than Thirsty Crow.
- Got to notice how would a viewer engage with multiple parts of a story in the same scene as Mental Canvas allows users to pinch zoom and move about in a natural user interface pattern.

What did not work?

- Forces viewer to download Adobe Aero app and then place the experience on a surface which is too much to ask from the viewer. If they open a link, it should appear.
- Some part of the experience where the crow needs to bring the stones from the pot is automated and is not interactive and there are no more viewer dependant triggers after the initial 'play' to get the story playing.

New questions. N/A

New ideas. N/A

Overall evaluation in general.

- This provided a good picture of how characters can be placed in a view and in 3d space.
- Helps visualize the 'Vikram-Betaal' story using Mental Canvas, exploring the potential of an interactive and immersive 3D drawing.

- This prototype offered insight into working with more complex storylines and demonstrated how viewers could engage with multiple parts of a story within the same scene. Despite its success, this prototype shared a similar limitation with Prototype 1.0, requiring viewers to download an app to access the experience.

5.4 Prototype 3.0

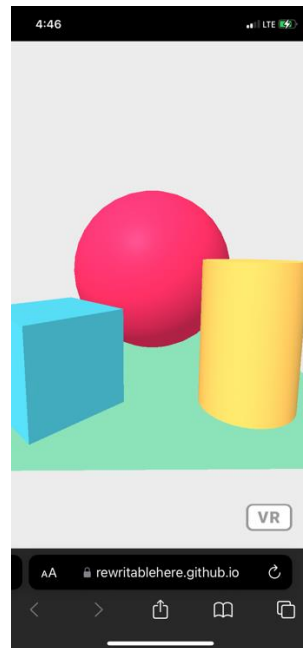


Figure 17. Prototype 3 in Mobile Device showing modified Aframe AR Template [Screenshot]. Created by A. Chickanayakanahalli, 2022.

Link to experience: <https://rewritablehere.github.io/intersections/aframe.html>

What is the idea/goal?

- Hosting Mixed Reality experiences on server so that they are accessible by URL directly.
- Mixed Reality Experience needs geotagging
- Quick development of 3d assets for the story.

Design/development.

- **Link to code:** <https://github.com/rewritablehere/intersections/blob/main/index.html>

- Tried to place a text "Triceratops" in virtual space at the current GPS location (pulled from google maps) to be able to spot it with a mobile device.

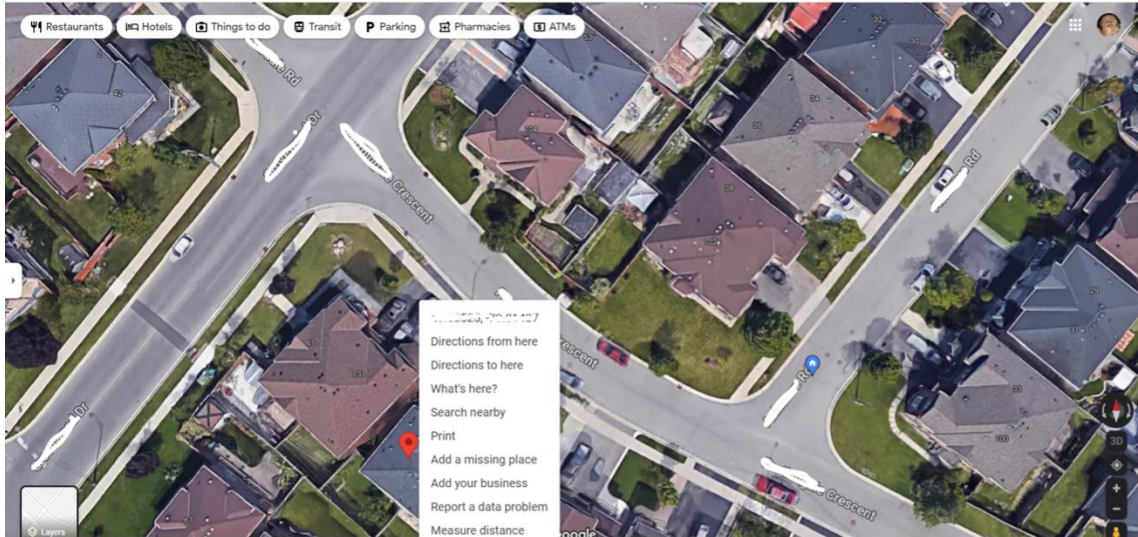


Figure 18. GPS coordinates from Google Maps to include in the code [Screenshot]. Created by A. Chickanayakanahalli, 2022.

```

1 <!DOCTYPE html>
2 <html>
3 <head>
4   <meta charset="utf-8" />
5   <meta http-equiv="X-UA-Compatible" content="IE=edge" />
6   <title>GeoAR.js demo</title>
7   <script src="https://aframe.io/releases/1.0.4/aframe.min.js"></script>
8   <script src="https://unpkg.com/aframe-look-at-component@0.8.0/dist/aframe-look-at-component.min.js"></script>
9   <script src="https://raw.githubusercontent.com/AR-js-org/AR.js/master/aframe/build/aframe-ar-nft.js"></script>
10 </head>
11
12 <body>
13 <a-scene
14   vr-mode-ui="enabled: false"
15   arjs="sourceType: webcam; videoTexture: true; debugUIEnabled: false;"
16 >
17   <a-text
18     value="This content will always face you."
19     look-at="[gps-camera]"
20     scale="120 120 120"
21     gps-entity-place="latitude: 39.7651117051276; longitude: -7.144306501172;"
22   ></a-text>
23   <a-camera gps-camera rotation-reader> </a-camera>
24 </a-scene>
25 </body>
26 </html>

```

Figure 19. GeoAR.js Template [Screenshot]. Created by A. Chickanayakanahalli, 2022.

```

1 <!DOCTYPE html>
2 <html>
3   <head>
4     <meta charset="utf-8" />
5     <meta http-equiv="X-UA-Compatible" content="IE=edge" />
6     <title>GeoAR.js demo</title>
7     <script src="https://aframe.io/releases/1.0.4/aframe.min.js"></script>
8     <script src="https://unpkg.com/aframe-look-at-component@0.8.0/dist/aframe-look-at-component.min.js"></script>
9     <script src="https://raw.githack.com/AR-js-org/AR.js/master/aframe/build/aframe-ar-nft.js"></script>
10  </head>
11
12  <body>
13    <a-scene
14      vr-mode-ui="enabled: false"
15      arjs="sourceType: webcam; videoTexture: true; debugUIEnabled: false;"
16    >
17      renderer="colorManagement: true;"
18      info-message="htmlSrc: #messageText"
19      model-viewer="glTFModel: #triceratops; title: Triceratops">
20    <a-assets>
21      <!--
22        Model source: https://sketchfab.com/3d-models/triceratops-d16aabe33dc24f8ab37e3df50c068265
23        Model author: https://sketchfab.com/VapTor
24        Model license: Sketcfab Standard
25      -->
26
27    <a-asset-item id="reticle"
28      src="https://cdn.aframe.io/examples/ar/models/reticle/reticle.glTF"
29      response-type="arraybuffer" crossorigin="anonymous" look-at="[gps-camera]"
30      scale="120 120 120"
31      gps-entity-place="latitude: 43.06325127091270; longitude: -73.6145065027472;"></a-asset-item>
32
33    </img>
34    <a-asset-item id="messageText" src="message.html"></a-asset-item>
35  </a-assets>
36
37    <a-camera gps-camera rotation-reader> </a-camera>
38  </a-scene>
39 </body>
40 </html>

```

Figure 20. GeoAR.js Template tweaked [Screenshot]. Created by A. Chickanayakanahalli, 2022.

- ***Creation of artifacts to be used in the scene(s):*** Generated urn by tweaking a barrel generated in sloyd.ai

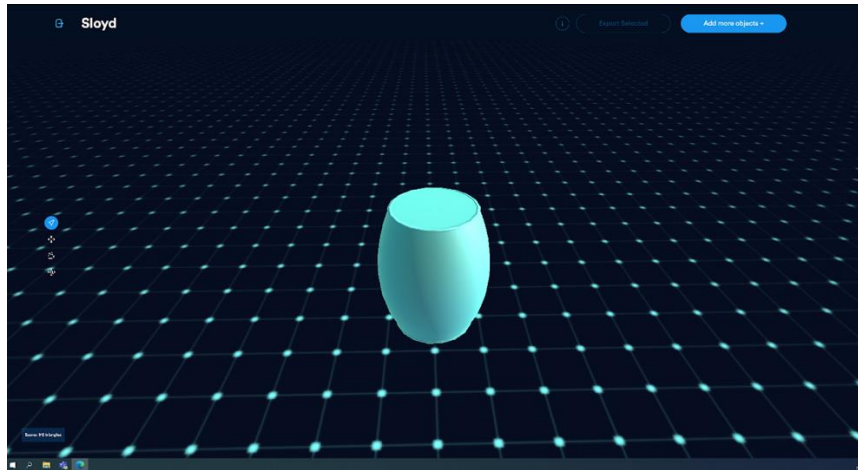


Figure 21. AI generated 3d model [Screenshot]. Created by A. Chickanayakanahalli, 2022.

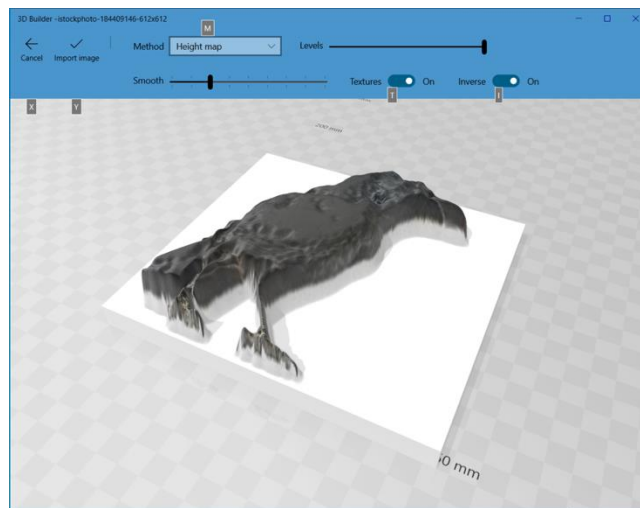


Figure 22. Image to 3d model [Screenshot]. Created by A. Chickanayakanahalli, 2022.

- Reused a free crow model with creative commons license from Sketchfab. Rigged it in blender which allows animating the crow model using the 'Armature' created.

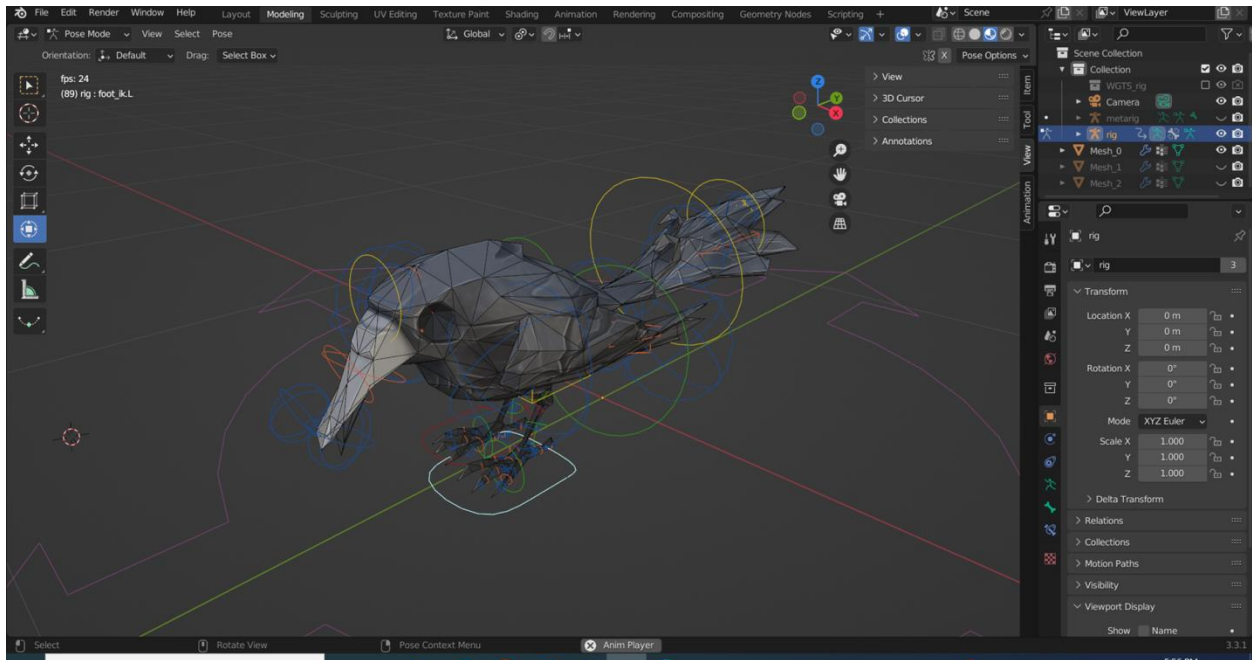


Figure 23. 3d model rigging in Blender [Screenshot]. Created by A. Chickanayakanahalli, 2022.

Reflection/evaluation.

What worked?

- The AI way of generating 3d models worked for simple forms like the urn or pot.
- Triceratops text was appearing but in the next room beyond this room's wall.

What did not work?

- The AI way of generating 3d models for crow was still cumbersome as it required further armature rigging in blender.
- This wasn't giving sufficient results to continue with the platform(s) for next prototype.

New questions.

New ideas.

Overall evaluation in general.

- Provided valuable insights into the possibilities of server-hosted mixed reality experiences and the potential of AI-generated 3D models. However, the limitations in generating more complex models and the issues with geotagging accuracy require further exploration and refinement in future iterations.

5.5 Prototype 4.0



Figure 24. Prototype 3 in Mobile Device [Screenshot]. Created by A. Chickanayakanahalli, 2022.

What is the idea/goal?

- A Mixed Reality Experience to be created having a couple of stones present around in the space (preferably in the scale of a tabletop) along with the crow and the half-filled pot which holds water inaccessible to the crow. The audience who is looking at this experience through their mobile device, needs to trigger the story to play out in mixed reality -- the crow looks for water, see the rocks, flies about back and forth carrying the stones to the pot to drop them. Once it has dropped a few rocks in, water comes up and crow can quench its thirst and fly away.

Design/development.

- **Tool used:** 8th Wall.
- **Link to experience:** <https://ananthac.8thwall.app/thirstycrow/>
- In Desktop, the simulation uses a sand background. In a mobile device, it can place the crow models wherever viewer taps in the screen.

Reflection/evaluation.

What worked?

- A Mixed Reality Experience was created with a Crow model in the scale of a tabletop. Wherever user taps, the surface is detected, and a crow model gets spawned.

- It is a web-based AR experience which doesn't require signup or installation of app on mobile devices which is an intended goal.

What did not work?

- Animation of the crow model was not readily available in the tutorials.

New questions. N/A

New ideas. N/A

Overall evaluation in general.

- Demonstrated the potential of using web-based AR tools like 8th Wall for creating mixed reality experiences without requiring app installation or sign-up. However, the limitations in animating the crow model suggest that further exploration and experimentation with other tools, such as Unity, may be necessary to achieve a more immersive and interactive experience.

5.4 Prototype 5.0



Figure 25. Prototype 5 in Mobile Device [Screenshot]. Created by A. Chickanayakanahalli, 2023.

What is the idea/goal?

- A Mixed Reality Experience that captures 5 stones present around in the room along with the crow and the half-filled pot which holds water inaccessible to the crow needs to be

created. The audience who is looking at this experience through their mobile device, needs to nudge the crow to see the rocks, which it shall carry to the pot. Once it can drop a few rocks in the pot, water comes up and crow can quench its thirst and fly away.

Design/development.

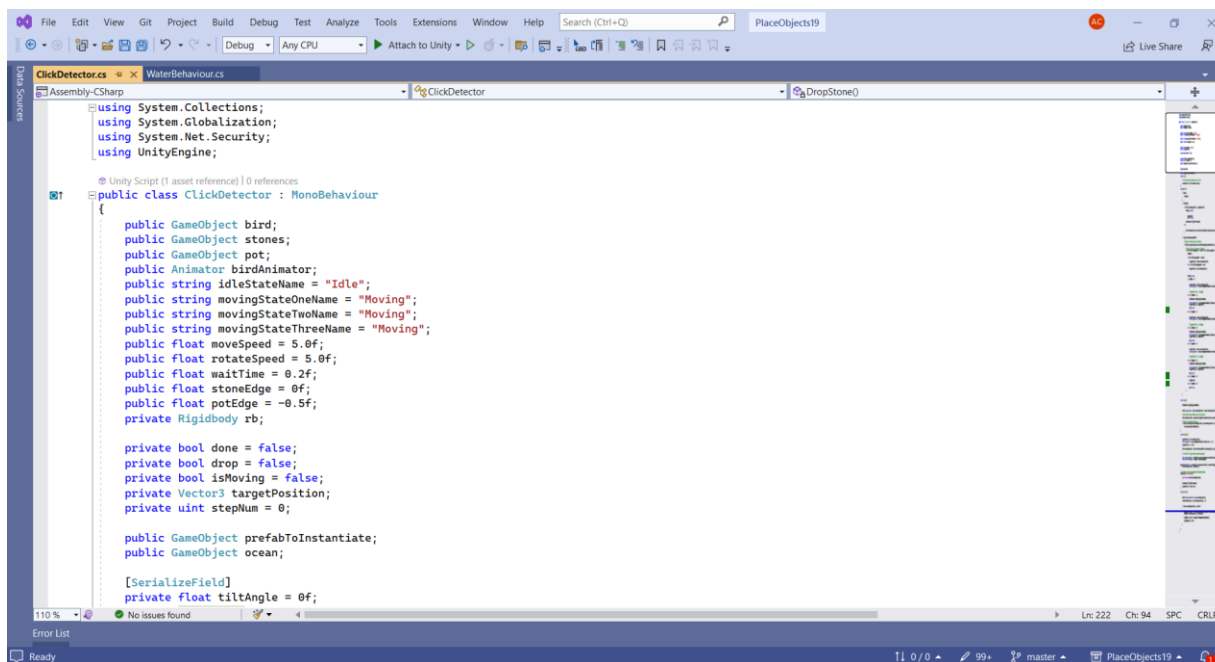


Figure 26. ClickDetector Script in Visual Studio [Screenshot]. Created by A. Chickanayakanahalli, 2023.

- This code defines a **ClickDetector class** in Unity that handles mouse clicks on a cube and a pot game object. When the cube is clicked, it moves a bird game object to the top of the cube. When the pot is clicked, it moves the bird game object to the top of the pot and drops a stone game object from the bird to the pot. If the water level of an ocean game object is below a certain level, the pot will also cause the water level to rise. Once the stone is dropped or the bird reaches the top of the pot without dropping the stone, the bird flies away.
- The **ClickDetector class** has several public variables that can be set in the Unity editor: bird, cube, pot, birdAnimator, idleStateName, movingStateOneName, movingStateTwoName, movingStateThreeName, moveSpeed, rotateSpeed, waitTime, prefabToInstantiate, and ocean.
- The **Start() method** sets the default animation state of the bird to idle and makes the pot slightly transparent.

- The **Update() method** checks for left mouse clicks and raycasts to detect which game object was clicked. If the cube or pot was clicked, it calls ClickCube() or ClickPot(), respectively. If the bird is currently moving, it calls MoveBird() to update its position and rotation.
- The **ClickCube()** and **ClickPot() methods** set the target position and rotation of the bird and start the moving animation. ClickPot() also sets isTimeToDropStone to true and saves the lastHit RaycastHit for use in DropStone().
- The **MoveBird() method** moves the bird towards its target position and rotates it towards its target rotation. If the bird reaches its target position, it stops moving, plays the idle animation, and calls DropStone() if isTimeToDropStone is true and the water needs to come up. If the bird is still moving, it waits for waitTime seconds before updating its position and rotation again.
- The **DropStone() method** creates a stone game object and drops it from the bird to the pot. If the water level of the ocean is below a certain level, it raises the water level and sets waterNeedsToComeUp to true. If the water level is already high enough, it calls FlyAway().
- The **FlyAway() method** plays the third moving animation of the bird and sets waterNeedsToComeUp to false.

Reflection/Evaluation.

What worked?

- The scene looks complete with the stones and pot and crow all in the tabletop scene.
- Crow model and animation is highly engaging.

What did not work?

- Currently the Crow is not a clickable object, but the prototype allows viewer to click and drag the crow around the detected surface.
- The crow is still not enabled with 'Rigidbody' and 'Physics' features and is able to go inside the other objects as the viewer moves it around.
- The learning curve for unity is too high (and is present in the forums as well).

New questions. N/A

New ideas.

- No matter where the user clicks, the crow should have the same steps of path.

Overall evaluation in general.

- Unity proved to be a good choice for prototyping mixed reality experiences. OpenAI's ChatGPT was extensively used for debugging code. Despite the noted challenges and limitations, the prototype demonstrated the potential of Unity for creating interactive mixed reality experiences.

5.5 Prototype 6.0



Figure 27. Prototype 5 in Unity Scene View [Screenshot]. Created by A. Chickanayakanahalli, 2023.

What is the idea/goal?

- A Mixed Reality Experience that captures 5 stones present around in the room along with the crow and the half-filled pot which holds water inaccessible to the crow needs to be created. The audience who is looking at this experience through their mobile device, needs to nudge the crow to see the rocks, which it shall carry to the pot. Once it can drop a few rocks in the pot, water comes up and crow can quench its thirst and fly away.

Design/development.

- **Link to Video:** <https://youtu.be/65yRqoiVAaM>
- **Link to Code:** [Appendix](#)
- **mirror Link:** <https://github.com/rewritablehere/intersections/blob/main/thirstycrow>

- Updated script controls the behaviour of game objects based on user input, and includes the following functionality:
- The script sets default animation states for a bird object and sets its starting rotation.
- When the user clicks on an object in the game (represented by a RaycastHit), the script detects which object was clicked on (either a "stones" object or a "pot" object) and sets a target position for the bird to move to.
- The script includes a series of conditional statements that determine how the bird should move and interact with the objects in the game, based on the order in which they are clicked. For example, the first time the user clicks on a "stones" object, the bird flies over to it, picks up a stone, and drops it in the pot object. This process repeats several times, with the bird picking up and dropping stones in the pot object in different ways each time.
- After the bird has completed its movements and interactions with the objects, it flies away from the pot and the game ends.
- The script also includes several methods that are called by the main Update method, including FlyAway(), DrinkWater(), WaitForNextMove(), and DropStone(). These methods contain specific instructions for how the bird should behave in certain circumstances.
- Overall, the script controls the behaviour of game objects based on user input, using conditional statements and specific methods to create a series of movements and interactions that make up a game-like scenario.

Reflection/Evaluation.

What worked?

- Crow model and animation is highly engaging.
- Using functions for keeping code cleaner helped.

What did not work?

- Users may try and press on the crow. Currently the Crow is not a clickable object, and the prototype doesn't detect clicks on the crow.
- When crow leaves the screen, they may panic. So, the Size of the device is small for the size of the installation/setup/experience.

- They will not know if the stone and pot are clickable.
- They may lose attention (may get tired in terms of their attention) if the number of stones to be picked and dropped is more than three.

New questions. N/A

New ideas.

- The stone should be visible when the crow is carrying it.

The pot used in the model is European style. This can be considered one of the limitations of this project, which includes getting to a functioning prototype of the idea becoming more significant than the details or specifics of the artefacts used in the story.

Overall evaluation in general.

- OpenAI's ChatGPT was used extensively for debugging code, and the prototype demonstrated progress in creating an engaging mixed reality experience, although there were still areas for improvement.

5.6 Summary

The prototyping section describes the development process of a Mixed Reality (MR) experience inspired by the story of the thirsty crow. Across six iterations, various tools and platforms were tested to create a user-friendly and engaging MR experience. These prototypes aimed to allow users to interact with a crow, stones, and a half-filled pot, nudging the crow to carry stones to the pot to raise the water level for the crow to drink.

- Prototype 1.0 explored using the Adobe Aero application for rapid prototyping but had limitations in creating a full MR experience.
- Prototype 2.0 utilized Mental Canvas but faced challenges with model importing and animation.
- Prototype 3.0 attempted to host the MR experience on a server using A-Frame, but the results were not sufficient to continue with this platform.
- Prototype 4.0 employed 8th Wall to create a tabletop MR experience, but the crow's animation was not readily available, leading to a decision to explore other tools.

- Prototype 5.0 used Unity, which allowed for a more complete scene and a highly engaging crow model, but the crow was not yet a clickable object.
- Prototype 6.0 built upon the previous Unity prototype, refining the experience by updating the script to control game object behaviours and interactions. However, some issues, such as the crow not being clickable and the small device size, persisted.

Throughout the process, OpenAI's ChatGPT was extensively used for debugging code. The prototypes progressed in creating an engaging MR experience but also revealed areas for improvement and limitations to address.

6.0 Evaluation & Results

6.1 Overview

During the evaluation, key areas to consider include identifying any disconnects within the Mixed Reality (MR) installation and addressing them, measuring engagement levels, capturing user reactions, and determining potential improvements for the installation, storytelling, and overall experience.

Self-reflection is essential for the project's success. To assess its effectiveness, consider the relevance of visuals, user interaction points, engagement levels, and immersion using a Likert-like scale. A survey with choices ranging from "1" to "5" will facilitate a robust evaluation. Self-assessment should also focus on whether the interactivity in the stories was meaningful and substantial. User feedback can guide decisions regarding the level of interactivity and content presentation in future prototypes—whether to prioritize simpler interactions or include more automated content for story completion.

Evaluating the effectiveness of location-based discovery will help determine the feasibility of using location services on devices to trigger specific web pages or applications for MR experiences. This assessment will contribute to refining the overall approach and enhancing the user experience.

6.2 Subjective Evaluation Process

The subjective evaluation of prototypes can be conducted using the following steps and criteria:

- **Preparing the prototypes:** Develop MR folktale experiences that include the different criteria to be evaluated.
- **Evaluation:** Interact with each prototype and evaluate them based on the frameworks referenced.
- **Gathering feedback/notes:** Record the feedback and comments for each prototype.
- **Analyzing the results:** Analyze the feedback and comments to identify the strengths and weaknesses of each prototype. A radar chart can be a powerful visualization tool for

displaying multiple evaluation criteria and comparing the performance of different prototypes.

- **Iterating and refining:** Use the feedback to refine and improve the prototypes and repeat the evaluation process until the desired level of quality is achieved.

6.3 Importance of Subjective Evaluation

Subjective evaluation in Research Through Design (RtD) refers to the assessment of a design artifact or process based on the personal experiences, opinions, and perspectives of the individuals involved, rather than relying solely on quantitative, objective measurements. Subjective evaluation can be valuable in understanding the nuances of user experiences, emotions, and preferences that might not be captured through purely objective methods. In the context of researching Mixed Reality (MR) Folktales through RtD, subjective evaluation can play a significant role in understanding the immersive and engaging nature of the MR experiences. By incorporating the personal opinions and experiences of users, researchers can gain insights into:

- **Emotional engagement:** How do users emotionally connect with the MR folktales? Are they more invested in the story and its characters due to the MR format?
- **Cultural relevance:** How do users perceive the cultural elements of the folktales in the MR environment? Do they feel a stronger sense of cultural connection or understanding?
- **Learning outcomes:** Are users better able to grasp the morals or wisdom of the folktales when presented in an MR format? How do their interpretations of the stories differ from traditional storytelling methods?
- **Usability and interaction:** How do users interact with the MR environment and navigate through the folktales? Are there any challenges or barriers they encounter during the experience?

By incorporating subjective evaluation, researchers can gain a deeper understanding of the impact of MR folktales on users and can iteratively refine the design to enhance the overall experience. This approach helps to create a more meaningful, culturally rich, and engaging MR folktale experience that caters to diverse user needs and preferences.

6.4 Evaluation Frameworks/Criteria

This following evaluation takes inspiration from the qualitative study of an interactive museum exhibit by Haywood and Cairns (2004) where they defined the criteria for evaluating children's engagement by participation, narrative and co-presence of others which arose from the data as being the main distinct concepts that underpin the engagement of the children with the exhibit.

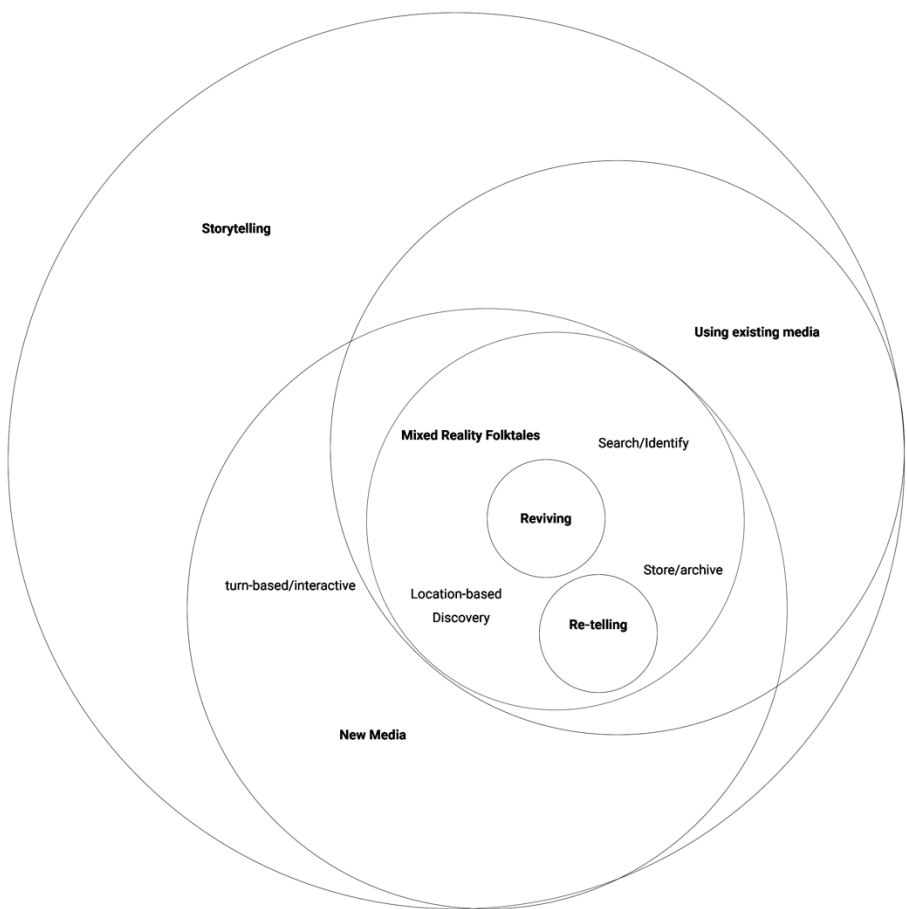


Figure 28. Venn Diagram showing overlap of Folktales and Mixed Reality [Diagram]. Created by A. Chickanayakanahalli, 2023.

The dynamic relationship between folktales and mixed reality represents a powerful synergy that revitalizes traditional storytelling and brings it into the digital age. Folktales, with their rich cultural heritage and timeless wisdom, provide a solid foundation for the immersive

and interactive experiences enabled by mixed reality technology. By intertwining these two domains, we create a novel form of storytelling that combines the depth and authenticity of folktales with the cutting-edge innovations of mixed reality.

This fusion enhances the overall experience for audiences, allowing them to engage with the stories in entirely new ways. Mixed reality brings the world of folktales to life, making them more tangible and emotionally resonant. It also allows for a greater degree of interactivity, giving users the opportunity to shape the narrative and explore various story paths. This interactive dimension not only makes the experience more engaging but also promotes a deeper understanding of the cultural context and the moral lessons embedded within these tales.

Furthermore, the combination of folktales and mixed reality has the potential to transcend geographical and cultural boundaries, enabling audiences worldwide to connect with these stories and appreciate their universal themes. By leveraging the power of mixed reality, we can preserve and promote the rich tapestry of human stories and ensure that they continue to inspire and educate future generations.

There are two frameworks possible for evaluating Mixed Reality Storytelling of 'The Thirsty Crow'. Key aspects of traditional storytelling are covered in the first framework to be considered as criteria for evaluation.

<i>Criteria</i>		<i>Applicability</i>
Oral Tradition and Human Connection	This includes assessing how mixed reality experiences engage users through immersive environments, interactivity, and meaningful storytelling elements that foster a sense of connection to the storyteller, the narrative, and the cultural context.	To examine how mixed reality experiences facilitate social interaction and discussion, promoting a shared understanding of the stories and strengthening bonds within the community is beyond the scope of this project.
Cultural Context	Incorporating immersive environments, interactivity,	This stretches the scope, will be helpful if time and

	<p>and meaningful storytelling elements that foster a sense of connection to the storyteller, narrative, and cultural context in mixed reality experiences is not easy for several reasons like technical challenges, balancing interactivity and storytelling, cultural sensitivity and accuracy, capturing the essence of oral tradition, diverse audience preferences and backgrounds & Evaluating success.</p>	<p>resources will permit, hence is ideal to be assessed in future work.</p>
<p>Intergenerational Transmission.</p>	<p>Intergenerational Transmission is essential because it plays a key role in preserving cultural knowledge, history, and values while fostering a sense of continuity and connection within communities. When evaluating mixed reality experiences, it is important to assess how these experiences can promote intergenerational engagement and sharing of cultural knowledge. Aspects like accessibility, collaborative experiences, cultural knowledge transfer,</p>	<p>All of these requires additional setup and an REB application to collect this information from the said demographic group will help and is out of scope of this project.</p>

	long-term engagement come into picture.	
Adaptability and Flexibility	This includes assessing the effectiveness of mixed reality experiences in capturing the dynamic and evolving nature of traditional oral storytelling and providing a more engaging and personalized experience for users. They are crucial because they allow stories to evolve based on the storyteller's interpretation or the audience's reactions. Oral storytelling thrives on this dynamic nature, which makes the stories more engaging and relevant.	When evaluating mixed reality experiences, it is essential to determine how the aspects like user-driven narratives, dynamic content, personalization and evolving Stories pan out however this is beyond the scope of this project because of limited time and resources.
Moral Lessons and Shared Values	They are essential because they reflect the cultural beliefs and practices of the community and guide individuals in their behavior and decision-making. When evaluating mixed reality experiences, it is necessary to assess how these experiences can accurately and effectively incorporate moral lessons and shared values from traditional folktales. Aspects like faithful	By considering Moral Lessons and Shared Values in the evaluation, we can assess the effectiveness of mixed reality experiences in preserving and conveying the cultural knowledge and significance of traditional folktales, ultimately guiding users in their everyday lives however stretches the scope of this project.

	representation, cultural relevance, user engagement and impact on behavior come into picture.	
Sense of Community.	Sense of Community is essential because traditional storytelling often brings people together, fostering a sense of belonging and shared identity. When evaluating mixed reality experiences, it is important to determine how these experiences can promote social connections and create a sense of community like that found in traditional storytelling contexts. Aspects like Social Interaction, Shared Experiences, Collaborative Learning & Community Building come into picture.	Assessing the effectiveness of mixed reality experiences in fostering social connections, promoting a sense of belonging, and preserving the communal aspects of traditional storytelling requires a broader runway for this project.

Table 1: Evaluation Framework 1

The second framework considers the unique design decisions that have led to the final prototypes as the criteria to evaluate the prototypes. This will enable viewing the entire research process across these touchpoints. The decisions were based on increasing discoverability, introducing interactivity, spatial storytelling, lesser number of story acts, having all the elements

of the act in a single spatial scene. The following criteria are closely tied to the prototypes and chosen for evaluating the work created in this research:-

<i>Criteria</i>		<i>Applicability</i>
Discoverability of stories	This criterion refers to how easily users can find and access the folktales in the MR format. It could involve considerations such as the use of location-based technologies, searchability, and accessibility across different devices and platforms. This helps us evaluate how a system is being accessed and what are the components to it.	Evaluates the ease of access and reach, ensuring wider audience engagement.
Interactivity of stories	This criterion relates to how engaging and interactive the MR folktale experiences are for users. It could include factors such as the use of haptic feedback, user-generated content, and adaptive narratives that respond to user actions. This adds the layers of personalization of narrative and additional dimensions to the story.	Assesses the level of personalization and engagement, enhancing user involvement.

<p>Spatial storytelling aspects (spread out in a space)</p>	<p>This criterion concerns how the MR folktale experience makes use of physical space to create immersive and interactive environments that enhance the storytelling. It could involve considerations such as the use of augmented reality overlays, 3D models, and spatial audio. This is the key aspect of mixed reality; the best of two worlds - user's reality and access to the virtual components.</p>	<p>Examines the effective use of physical and virtual space, creating a more immersive experience.</p>
<p>Lesser number of acts</p>	<p>This criterion relates to the structure of the MR folktale experience and how it adapts the traditional storytelling format to suit the MR medium. It could involve considerations such as the use of shorter or more condensed narratives, the integration of interactive elements, and the use of non-dialogue techniques for storytelling. The fact that something works for a simpler case can help future work build on it easily. Later prototypes can</p>	<p>Measures the simplicity and adaptability, providing a foundation for future expansion.</p>

	have bigger storyline, a greater number of acts, etc.	
Telling a full act's story in a single environment/scene	This criterion concerns how the MR folktale experience makes use of the visual and auditory elements of the environment to create a complete and immersive storytelling experience in a single scene. It could involve considerations such as the use of ambient sounds, lighting, and visual effects to enhance the narrative. The idea is to not have too many moving parts which fuels the fleeting of user's attention.	Gauges the ability to create immersive narratives in limited spaces, maintaining user focus.
Using non-dialogue techniques for storytelling	This criterion refers to how the MR folktale experience leverages other forms of communication beyond spoken or written language to convey the narrative. It could involve considerations such as the use of gestures, visual cues, and other nonverbal communication techniques. Reinforcing that if something works with bare bones, it can always be provided with	Analyzes the effectiveness of nonverbal communication, allowing for versatile and inclusive storytelling experiences.

	additions for more complex prototypes.	
--	--	--

Table 2: Evaluation Framework 2

The second framework is better suited for evaluation as it focuses on the unique characteristics of MR experiences that effectively recreate traditional storytelling aspects while acknowledging their potential to enhance and innovate storytelling. By addressing key elements of modern storytelling, such as accessibility, user engagement, and immersive experiences, your project can successfully adapt traditional folktales for contemporary audiences, preserving their cultural value and enhancing their relevance in the digital age. This comprehensive and targeted approach ensures the assessment of MR experiences is aligned with preserving and adapting traditional storytelling methods in a modern context, making it the ideal framework for evaluating the success of MR-based folktales.

6.5 Evaluation

Evaluation and self-reflection are crucial for the success of any project, and the MR storytelling project is no exception. To evaluate the MR folktale experiences, a Likert-like scale will be used, ranging from "1" to "5", to assess the relevance of visuals, user interaction points, engagement levels, and immersion. Key areas of evaluation include identifying any disconnects within the Mixed Reality (AR) installation, measuring engagement levels, capturing user reactions, and determining potential improvements for the installation, storytelling, and overall experience.

The evaluation criteria for this project were inspired by the qualitative study of an interactive museum exhibit by Haywood and Cairns (2004), which identified participation, narrative, and co-presence of others as the main concepts that underpin children's engagement with exhibits. The criteria for evaluating the MR folktale experiences in this project include discoverability of stories, interactivity of stories, spatial storytelling aspects (spread out in a space), lesser number of acts, telling a full act's story in a single environment/scene, and using non-dialogue techniques for storytelling.

The evaluation process involves developing MR folktale experiences that include the different criteria to be evaluated, interacting with each prototype, and evaluating them based on the evaluation criteria, gathering feedback and notes, analyzing the results, and refining the prototypes based on the feedback received.

Arriving at benchmarks (Likert scale; 1 - lowest, 5 - highest) from Related works: -

<i>Related Works</i>	<i>Le Petit Chef</i>	<i>MR Roller Coaster</i>	<i>Remembering</i>
Discoverability of stories	1 - need to go to a particular place, not free to access	2 - need to have an MR device, need to install an app	3 - need to have Disney+ subscription, need to install app
Interactivity of stories	1 - cannot move anything. Passive experience	5 - high interactivity with physics effects	1 - option selections from tv
Spatial storytelling aspects (spread out in a space)	4 - across table and objects	5 - across indoor space in all 3 dimensions	3 - across indoor in all 3 dimensions but directional (content faces away from tv)
Lesser number of acts	3 - many acts	5 - simplest, only two acts	2 - many acts
Telling a full act's story in a single environment/scene	5 - tabletop has the entire scenario playing out	5 - indoor space has the entire scenario playing out	3 - environment changes
Using nondialogue techniques for storytelling	5 - non-verbal, animated	5 - non-verbal, physics	4 - non-verbal, it is less of the story and extension of what is being shown in the TV
If there is a gap and why so?	The interaction is passive, with the viewer observing the	Focus is on physics and construction principles, with no	Is more focused on enhancing the movie-watching experience

	<p>projection mapping/ display of the animated chef and story elements on the dining table.</p>	<p>specific narrative or storyline.</p>	<p>through AR, with less direct user interaction however require the viewer to engage with the augmented reality elements. Remembering necessitates installing a Disney+ app, watching content on the Disney+ App on their TV, and scanning their physical location. It's essential to consider the simplicity and ease of onboarding steps to maintain user engagement and avoid frustration.</p>
<p>What was the takeaway from it (what was learnt from this approach)</p>	<p>Takes inspiration from the historical journey of Marco Polo, creating a culturally themed dining experience. Linear, guided, structured , immersive .Combines storytelling with the</p>	<p>Players manipulate virtual objects to create and modify roller coasters, with the objects behaving like physical ones, impacted by gravity and other physics principles. It also leverages AR, allowing players to</p>	<p>Extends the on-screen environment into the viewer's living room to create a more immersive movie- watching experience; enhances the movie- watching experience.</p>

	dining experience, creating a sense of wonder and curiosity as the projected animations blend with the actual food served to the guests.	interact with their digital creations in their physical space.	
--	--	--	--

Table 3: Assessment of Related Works - Part A

<i>Related Works</i>	<i>North Sumatran Folktales</i>	<i>Google Arts & Culture</i>	<i>Between Worlds</i>
Discoverability of stories	4 - need to have a mobile device, need to install app	5 - need to have a mobile device, free to access	3 - need to have the Book, need mobile device, need to install app
Interactivity of stories	2 - not interactive, passive experience	3 - passive experience	3 - passive experience
Spatial storytelling aspects (spread out in a space)	4 - across outdoor/indoor, all 3 dimensions	4 - across outdoor/indoor in all 3 dimensions	3 - limited to book's surface, directional
Lesser number of acts	3 - many acts	4 - simpler, less acts	4 - simpler, less acts
Telling a full act's story in a single environment/scene	3 - environment changes	3 - environment changes	5 - book leaf having the entire act playing out
Using nondialogue techniques for storytelling	2 - story with sounds and speech	4 - story with sounds	3 - The dialogue comes as text

If there is a gap and why so?	Komik App uses AR to create an interactive comic book experience.	Has an umbrella of experiences and interactive modules; hence N/A	N/A
What was the takeaway from it (what was learnt from this approach)	Presents illustrated comic stories that users can explore using AR markers, enabling them to engage with the content interactively; bringing illustrated comic stories to life. It helps ensure these stories remain relevant and accessible, fostering a connection between younger generations and their cultural roots.	Offers a variety of AR experiences that allow users to explore art and culture in new and interactive ways, enabling users worldwide to experience famous works of art and cultural landmarks without physically visiting the locations. Help fostering a deeper understanding and appreciation. Uses AR technology to digitize and safeguard art and culture, ensuring that these treasures are accessible to future generations.	Immerses users in a magical world that combines fantasy and reality, involves them in a narrative experience that responds to their actions. Pushes the boundaries of fantasy and reality to stimulate users' imagination. This interdisciplinary approach can lead to innovative ways of using technology to present and share cultural content, as well as foster cross-cultural exchange and understanding.

Table 4: Assessment of Related Works - Part B

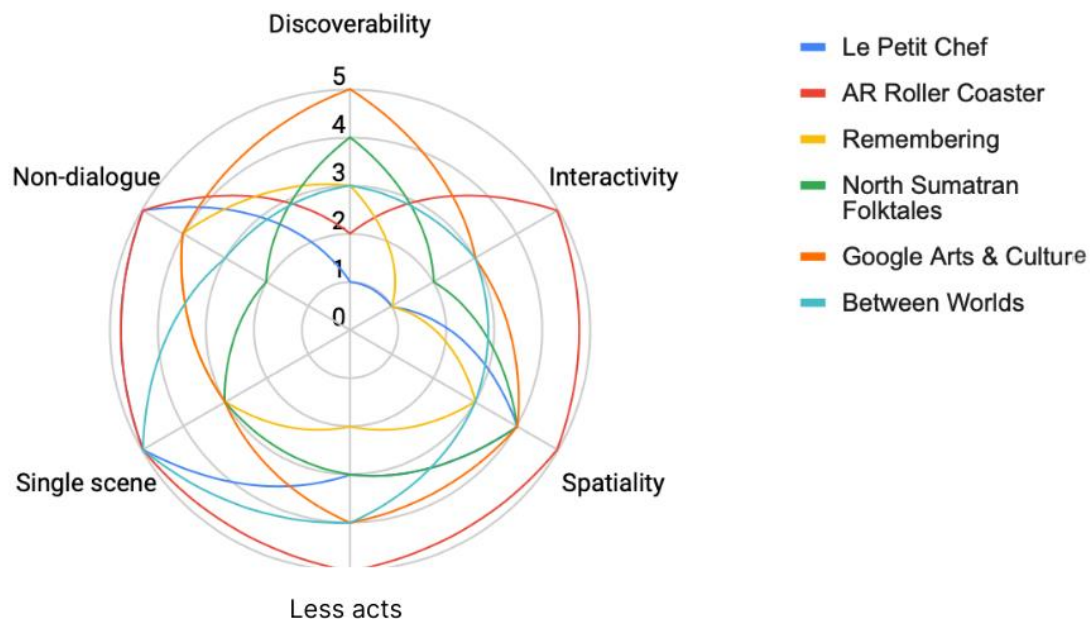


Figure 29. Radar Chart showing assessment of Related Works [Chart]. Created by A. Chickanayakanahalli, 2022.

AR Roller coaster seems to be the most well-suited Mixed Reality work that can be compared with final Prototype to see how well the exercise of research through design has contributed.

Comparing benchmarks (Likert scale; 1 - lowest, 5 - highest) with Final Prototype: -

<i>Related Works</i>	<i>MR Roller Coaster</i>	<i>Prototype 6.0</i>
Discoverability of stories	2 - need to have an MR device, need to install an app	4 - need to have mobile device and the app
Interactivity of stories	5 - high interactivity with physics effects	3 - Just triggers to continue the story
Spatial storytelling aspects (spread out in a space)	5 - across indoor space in all 3 dimensions	5 - across indoor space in all 3 dimensions
Lesser number of acts	5 - simplest, only two acts	4 - simpler, less acts
Telling a full act's story in a single environment/scene	5 - non-verbal, physics	5 - non-verbal, physics

Using nondialogue techniques for storytelling	5 - non-verbal, physics	3 - non-verbal, animated
If there is a gap and why so?	The narrative type here is experiential/simulation based and might not be as complex or character-driven as in other types of games, but the emphasis on user experience and interaction makes it an engaging and entertaining form of interactive storytelling. The emphasis is on creating a realistic and engaging environment for the user to explore and interact with, rather than focusing on a traditional, linear story with a defined plot and character development.	The thirsty crow experience has a clear storyline and follows a well-known fable with a moral lesson, while MR Roller Coaster is primarily focused on providing a thrilling roller coaster simulation.
What was the takeaway from it (what was learnt from this approach)	The game seems to prioritize delivering a thrilling and immersive roller coaster experience using the capabilities of VR and mixed reality technology. The objective is to give users the opportunity to experience different situations, activities, or sensations that may not be easily accessible or possible in real life.	Prototype 6.0 can become even better than it is currently if deployed fully onto a server and accessed directly instead of having to download an app. It can become more dynamic in story pacing (currently it is linear) as well as the path through which the story gets completed can be made more flexible. For example, the stones can be

		scattered across surfaces and space. The entire setup can become multi-player where each player brings/instructs the crew to pick up the stone.
--	--	---

Table 5: Assessment of MR Roller Coaster and Final Prototype

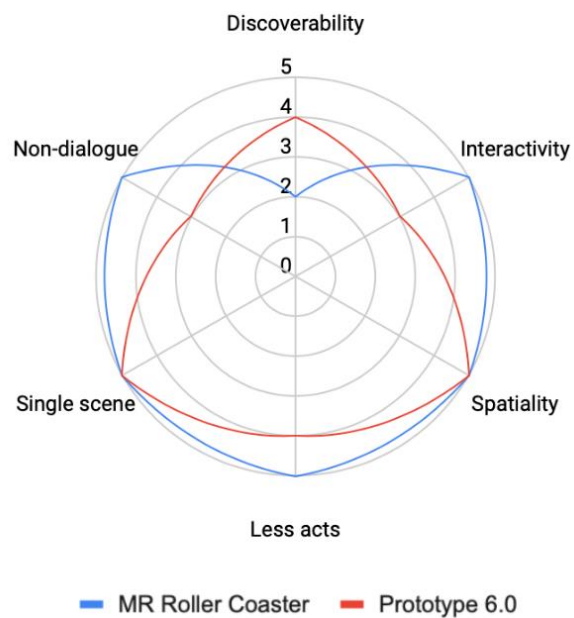


Figure 30. Radar Chart showing assessment of MR Roller Coaster and Prototype 6 [Chart].
Created by A. Chickanayakanahalli, 2022.

Again, AR Roller coaster seems to be the most well-suited Mixed Reality work, but it is not a folktale which possibly could have been even more insightful for us.

6.6 Exhibition

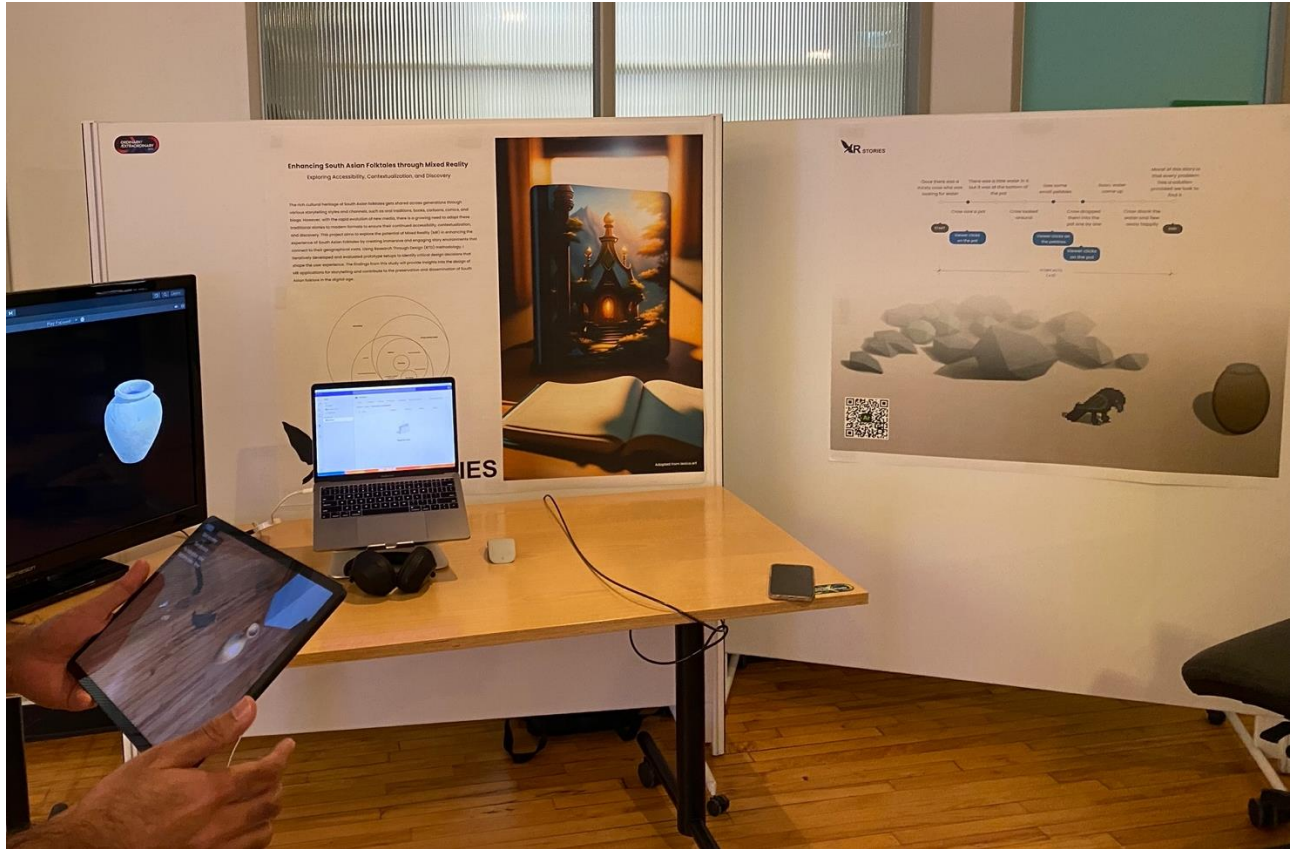


Figure 31. Ordinary Extraordinary 2023 - Digital Futures Thesis Exhibition [Photo]. Created by A. Chickanayakanahalli, 2023.

Some of the learnings from the exhibition are as follows:-

- The audience who interacted with the installation were enchanted. Many provided me a vote of confidence for working with different artists/folklorists for adapting this mode to folktales in different contexts and cultures as well.
- The messaging is missing for the final prototype and there is a slight learning curve for anyone who hasn't heard this story before to get the story started in device. That seems to be crucial for designing and deploying any kind of interactive digital experiences.

6.7 Summary

While both experiences provide interactive and immersive environments, the thirsty crow experience is more narrative-driven, with a clear storyline and moral lesson. In contrast, MR

Roller Coaster prioritizes delivering an exciting roller coaster simulation. The audience engagement and interaction differ accordingly, with the thirsty crow experience engaging users through the story and problem-solving, and MR Roller Coaster through the roller coaster experience itself.

- **Narrative Structure:** The thirsty crow experience has a linear narrative structure that follows the classic fable. The viewer participates in the story by helping the crow quench its thirst, providing a more guided and structured experience. In contrast, MR Roller Coaster is an experiential simulation that allows users to ride and manipulate roller coasters, with no specific narrative or storyline.
- **Interaction:** Both experiences offer interactivity, but they differ in the type of interaction. In the thirsty crow experience, the viewer interacts with the environment by selecting objects (the urn or stones) and guiding the crow to solve the problem. In MR Roller Coaster, the interaction is more focused on the physical experience of riding and controlling a roller coaster.
- **Learning and Moral Lessons:** The thirsty crow experience incorporates a moral lesson about resourcefulness and problem-solving, which is an essential aspect of traditional storytelling. MR Roller Coaster, on the other hand, is more focused on entertainment and does not have any specific moral or educational content.
- **Immersion:** Both experiences provide immersive environments, with the thirsty crow experience leveraging mixed reality (MR) to blend the virtual elements (crow, urn, stones) with the user's real-world surroundings. MR Roller Coaster uses virtual reality (VR) to create a fully immersive roller coaster experience.
- **Audience Engagement:** The thirsty crow experience engages the viewer in a familiar story, allowing them to actively participate and influence the outcome. MR Roller Coaster engages users through the thrill and excitement of riding roller coasters. The type of engagement differs, with the thirsty crow experience being more focused on the narrative, and MR Roller Coaster on the simulated experience.

7.0 Conclusion

7.1 Overview

In this thesis, the potential of mixed reality (MR) storytelling is explored as a means of adapting and preserving South Asian folktales. We have identified technical and creative challenges involved in developing MR experiences that are faithful to the cultural context of these tales while providing an engaging and immersive experience for the user. The story is meant to depict a moral. Through the process of designing and implementing a mixed reality prototype based on the folktale "The Thirsty Crow," the research has demonstrated the potential of MR as a medium for adapting and revitalizing cultural heritage as it brings in new visibility to it.

The prototypes offer a new way of experiencing the folktale, allowing users to engage with the story spatially and in an interactive manner. By blending the real and virtual worlds, the prototype provides a unique and immersive experience that enhances the storytelling and enables users to connect with the cultural significance (in this case being morality) of the tale.

By developing a framework for designing and implementing South Asian folktales in MR, this thesis offers a valuable resource for researchers and practitioners interested in leveraging MR technology for further re-imagining disappearing stories into newer platforms and newer modes of storytelling. Furthermore, this thesis underscores the cultural significance of South Asian folktales and highlights the importance of preserving and promoting this rich heritage for future generations.

7.2 Limitations

Despite the many strengths of this project, some limitations should be acknowledged. One limitation is the set of related works identified. This limits the generalizability of the findings. They were not all folktale based but were interactive, spatial storytelling examples that form a central theme in Mixed Reality Storytelling. Additionally, the scope of this project is limited to one specific folktale from South Asia, and easily possible that the results may differ for other types of folktales or cultural contexts.

Another area for improvement is the technical and financial resources required to develop a high-quality MR experience. The development of MR experiences requires specialized skills and equipment, which are inaccessible to individuals with limited resources. Additionally, creating a high-quality MR experience can be costly, which may limit the accessibility of this technology to specific audiences. This was a design choice to create a mobile device-based experience to be more accessible than specialized equipment for the MR experience.

Furthermore, this project focused primarily on the user experience and did not delve deeply into the cultural significance and interpretation of the folktale itself. Future research could explore these aspects in greater depth, including the role of folktales in preserving cultural heritage and their potential for promoting intercultural understanding.

Overall, while this project has demonstrated the potential of MR storytelling for adapting and preserving South Asian folktales, it is essential to recognize the limitations and the need for further research in this area. The challenges and constraints associated with using MR for the storytelling of folktales include technological barriers like hardware & software limitations, accessibility barriers like the digital divide and usability of tools, cultural context preservation like the authenticity of original stories and language barriers and lastly, user experience issues like motion sickness.

1. Hardware Limitations.

The quality of MR experiences largely depends on the hardware available. Unfortunately, high-quality headsets and devices can be expensive, and not all users may have access to them. Furthermore, the rapid pace of technological advancement may render current devices obsolete, impacting the longevity of MR folktale experiences.

2. Software Limitations.

Developing MR experiences requires specialized programming, 3D modelling, and animation skills. This can limit the number of people who can effectively create and adapt folktales in mixed reality. Additionally, compatibility issues may arise as MR technologies evolve, requiring developers to update their software and experiences continually.

3. Digital divide.

MR storytelling relies on technology that may not be accessible to all users, especially in underprivileged or remote areas. This digital divide could result in the exclusion of specific populations from experiencing folktales in mixed reality.

4. Usability.

Mixed reality experiences often require users to wear headsets or use handheld devices. Unfortunately, these interfaces may not be suitable for all users, such as those with disabilities, young children, or the elderly, limiting their ability to engage with MR folktales.

5. Authenticity & Traditionality of Folktales.

One of the challenges of adapting folktales to MR is preserving the cultural context and authenticity of the original stories. The immersive nature of MR may sometimes lead to oversimplification or distortion of the source material, which could impact the cultural significance of the folktale. In addition, by focusing on the interactive and immersive aspects of MR, some traditional storytelling elements, such as oral narration, audience participation, and the connection between the storyteller and the listener, may need to be recovered.

6. Language Barriers.

Translating folktales into MR experiences might result in the loss of linguistic nuances, idiomatic expressions, or regional dialects, all of which contribute to the richness of the storytelling experience.

7. Motion sickness.

Users (some) may experience discomfort or motion sickness while engaging with MR experiences, which could negatively impact their enjoyment of the folktale.

7.3 Future work

Jeff Marsilio (senior vice president of new media distribution at NBA) claims that even though not every technology will succeed, it is essential to start early and be prepared for when something succeeds and becomes widely used (Sprung, 2019). The following quote tells us the need to act early.

You are learning while these things are developing so that you are already mature with them when they are mature. If you wait until they are mature to begin learning, you are learning in front of all the fans engaged, and they might be disappointed in the experience. So, we want to get the experience, in immersive media, to the point where it is as good as it can be as this thing matures. (Sprung, 2019)

The takeaway is that if we benefit from folktales being reimagined in emerging media, we should do it sooner than later. This project attempts to retain the structure and quality of listening to a folktale while becoming immersed in folklore in a new way. As the Metaverse seems to be catching on, many more people are participating in virtual worlds. These folktales can be bridges between the real and virtual worlds. Going by the fact that in this format, location becomes immaterial, these approaches help anchor many contexts in these virtual worlds. This research paves the ground for the development of these context frameworks. These could be skeletons on top of which virtual worlds can be skinned, navigated, and connected. These stories will also give a sense of identity to different communities; the contemporary versions of the folktales will provide morals which continue to be timeless in an ever-changing world.

While this study provides a framework for designing and implementing South Asian folktales in Mixed Reality, future research could explore several areas. For example, one potential avenue for future work is to explore the impact of Mixed Reality storytelling on the retention of cultural heritage among South Asian communities. This could involve conducting user studies to assess the effectiveness of Mixed Reality in promoting cultural awareness and understanding among South Asian youth.

Another area of future research could focus on expanding the collection of South Asian folktales available in Mixed Reality. This would involve identifying and curating a broader range of traditional tales and stories from across the region and exploring the potential for user-generated content and community engagement in developing new Mixed Reality experiences. Additionally, further investigation into the technical aspects of Mixed Reality development could improve the overall quality and user experience of this format of storytelling. This could include exploring contrasting interaction models and modalities, improving the fidelity and realism of

virtual environments, and optimizing performance and accessibility for a broader range of devices and platforms.

Finally, the potential for cross-cultural collaborations and knowledge exchange could be a fruitful area for future exploration. By sharing and adapting storytelling techniques and technologies across different cultural contexts, it may be possible to create new and innovative forms of mixed-reality storytelling that draw on a wide range of cultural traditions and perspectives.

As technology advances, the future of MR storytelling for folktales promises to overcome current limitations (technological barriers, accessibility, cultural context preservation, and user experience, respecting cultural significances and ensuring a positive experience for users) and further enhance the way we experience these timeless stories. The future possibilities and trends for mixed reality storytelling of folktales could be greatly advantaged by upcoming technological advancements, accessibility & affordability of MR systems. By leveraging advancements in AI and natural language processing, future MR experiences may better capture linguistic nuances, idiomatic expressions, and regional dialects, enriching the storytelling experience. Collaboration with cultural experts (anthropologists and local communities) to ensure the authenticity and cultural integrity of MR folktales, resulting in more accurate and respectful representations of the source material. The future of MR storytelling could involve more advanced multi-sensory experiences, including haptic feedback, olfactory stimulation, and spatial audio, further deepening users' connection to the folktale and its world. As MR technology advances, we may see more social and collaborative storytelling experiences, allowing users to share and engage with folktales, fostering community and preserving the oral storytelling tradition.

7.4 Final Remarks

This thesis project explores the potential of using Mixed Reality (MR) technology to preserve and promote South Asian folktales by providing immersive, interactive, and culturally rich storytelling experiences that bridge the physical and virtual worlds. It is a laborious task bringing stories into mixed reality. The learning curve is steep initially if one needs to select a good tool; it requires much expertise in development and debugging if one wants custom interactions other than the out-of-the-box ones.

Although not necessarily in this project prototypes but its ability to create multi-sensory experiences, potential to personalize the story for everyone (based on their pace of interacting with the experience), and promote cultural heritage, mixed reality storytelling can revolutionize how traditional stories are experienced and shared. The future of mixed-reality storytelling for folktales holds immense promise. With technological advancements, increased accessibility, cultural preservation, and enhanced user experiences shaping the way we engage with these timeless narratives, mixed reality has the potential to become a powerful medium for preserving, adapting, and sharing folktales in a way that honours their cultural significance and offers engaging, immersive experiences for audiences worldwide.

8.0 References

- Appleton, N. (2015, October 25). *Jātaka*.
Obo. <https://www.oxfordbibliographies.com/display/document/obo-9780195393521/obo-9780195393521-0020.xml>
- Azuma, R. (2015). *Location-Based mixed and Augmented Reality storytelling*.
- Bruchac, J. (2017, September 20). The lasting power of oral traditions. The Guardian.
<https://www.theguardian.com/commentisfree/2010/jul/29/lasting-power-oral-tradition>
- Carroll, T. (2019, March 25). *Why We Keep Telling the Same Stories*. Electric Literature.
<https://electricliterature.com/why-we-keep-telling-the-same-stories/>
- Chaturvedi, H. (n.d.). *Thirsty Crow - moral story books*. Flipkart.com. Retrieved March 14, 2023, from <https://www.flipkart.com/thirsty-crow-moral-story-books/p/itm4d7ygpqqtnu>
- Cairns, P., & Haywood, N. (2015, December 3). Engagement with an interactive museum exhibit. York.
https://www.academia.edu/2846992/Engagement_with_an_interactive_museum_exhibit
- Chickanayakanahalli, A. (2023, March 20). Google Arts & Culture Play [Screenshot of webpage]. Google Arts & Culture. <https://artsandculture.google.com/play>
- DALL·E 2. (n.d.). <https://openai.com/product/dall-e-2>
- David W. Sime on LinkedIn. (2023, February 26). David W. Sime on LinkedIn: #Constructionplanning #InteriorDesign #AugmentedReality. Retrieved February 26, 2023, from https://www.linkedin.com/posts/davidsime_constructionplanning-interiordesign-augmentedreality-activity-7035572097078689792-Cm7f
- Dubai Future Foundation. (n.d.). Retrieved February 16, 2023
- Editors of Encyclopaedia Britannica. (n.d.). Sumer. Encyclopædia Britannica. Retrieved April 29, 2023, from <https://www.britannica.com/biography/Sumer>
- Encyclopedia Britannica. (n.d.). Jataka. In Encyclopedia Britannica. Retrieved March 14, 2023, from <https://www.britannica.com/topic/Jataka>.
- Frayne, A. (2016, March 3). The decline of print does not mean the death of publishing. The Guardian. <https://www.theguardian.com/info/2016/mar/03/the-decline-of-print-does-not-mean-the-death-of-publishing>
- Forristal, L. (2022, September 8). TechCrunch is part of the Yahoo family of brands.

- FutureLearn. (n.d.). Transmedia storytelling: Creating a world of stories. Retrieved from <https://www.futurelearn.com/info/courses/transmedia-storytelling/0/steps/27345>
- Gaver, W. (2012, May). What should we expect from research through design?. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 937-946).
- Gilmore. (2010). Theatre in a crowded fire ritual and spirituality at Burning Man. University of California Press. <https://doi.org/10.1525/9780520945531>
- Google Arts & Culture. (n.d.). Explore the world from home. Retrieved March 22, 2023, from <https://artsandculture.google.com/>
- Gupta, Y. (2017). Mapping India's Folk Arts. In MeMeraki.com. <https://www.memeraki.com/blogs/news/mapping-indias-folk-art>
- Homer. (1996). The Odyssey (R. Fagles, Trans.). Penguin Classics. (Original work written c. 800 BCE)
- Ibn Sayed, S. (n.d.). *Top AR, and VR Prototyping tools*. LinkedIn. https://www.linkedin.com/posts/saadibnsayed_unity3d-unrealengine-sketchfab-activity-7037743221745094656-Wtpo?utm_source=share&utm_medium=member_ios
- Ioannides, M., Magnenat-Thalmann, N., & Papagiannakis, G. (Eds.). (2017). *Mixed Reality and Gamification for Cultural Heritage*. Springer.
- Kinnally, C. N. (2019, January 25). Oral Culture: Literacy, Religion, Performance. Oxford Research Encyclopedias. <https://doi.org/10.1093/acrefore/9780190201098.013.437>
- Le Petit Chef. (2021). Der kleinste Koch der Welt ab sofort in Ingolstadt! @Ingolstadt. Twitter. https://twitter.com/LePetitChef_/status/1415256632083222528?s=20
- Lewis, J. E., Arista, N., Pechawis, A., & Kite, S. (2018). Making Kin with the Machines. *Journal of Design and Science*. <https://doi.org/10.21428/bfafd97b>
- Lewis, M. Paul, Gary F. Simons, and Charles D. Fennig (eds.). (2021). *Ethnologue: Languages of the World* (24th ed.). SIL International. Retrieved from <https://www.ethnologue.com/language/kan>
- Muñoz. (2023, February 18). The NBA's Impressive Virtual Reality Streaming Experience Allows You to Be Any Player. MARCA. Retrieved February 20, 2023
- McKelvey, F., & Hunt, R. (2019). Discoverability: Toward a Definition of Content Discovery Through Platforms. *Social Media + Society*, 5(1).
- Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995). Augmented reality: A class of displays on the reality-virtuality continuum. In Proceedings of SPIE - The International

- Society for Optical Engineering (Vol. 2351, pp. 282-292).
<https://doi.org/10.1117/12.197321>
- Miyazaki, K., Nagai, Y., & Nakatsu, R. (2007). Concept and construction of an interactive folktale system. *Digital Interactive Media in Entertainment and Arts*. <https://doi.org/10.1145/1306813.1306835>
- Naithani, S. (2009). Book: In Quest of Indian Folktales.
- Naithani, S. (2006). Folktales from Northern India.
- Niantic Lightship*. (n.d.). <https://lightship.dev/>
- Norman, N. (2001, August 1). The Augmented Realist Manifesto.
- OpenAI. (2021). GPT-3.5 Language Model [Computer software]. <https://openai.com/gpt-3/Remembering>. (n.d.). Disney Movies. <https://movies.disney.com/remembering>
- Rodgers. (2012, July 13). Watch this: the interactive story of Ramayana in Google Chrome. The Verge.
- Sandars, N. K. (Trans.). (1960). The Epic of Gilgamesh. Penguin Classics.
- Sharma, A. (2021, May 24). Storytelling: From Caves To The Digital Age. Forbes. <https://www.forbes.com/sites/forbesbusinesscouncil/2021/05/24/storytelling-from-caves-to-the-digital-age/?sh=78d3da086048>
- Singh, T. (2023, January 9). Prototype Testing: A Step by Step Guide (2023). Qualaroo Blog - User Research and Customer Feedback Trends. <https://qualaroo.com/blog/step-by-step-testing-your-prototype/>
- Sprung, S. (2019, March 15). How The NBA Is Using Virtual Reality And Augmented Reality To Get Fans Closer To The Action.
- Stéphane Bura. 2008, Apr 23. Emotion Engineering in Videogames (n.d.).
- Topolpet on Instagram. (2022, December 17). Instagram. Retrieved February 20, 2023, from <https://www.instagram.com/reel/CmSZ-kftyF8/>
- The Editors of Encyclopaedia Britannica. (1998, July 20). *Jataka / Buddhist literature*. Encyclopedia Britannica. <https://www.britannica.com/topic/Jataka>
- The United Nations Declaration on the Rights of Indigenous Peoples: A Manual for National Human Rights Institutions. (2013).

Tuli, N. & Creila, & Mantri, A. (2015). Interaction Techniques: helping user manipulate AR virtual content.

The United Nations Declaration on the Rights of Indigenous Peoples: A Manual for National Human Rights Institutions. (2013).

UNESCO. (2013). Convention for the Safeguarding of the Intangible Cultural Heritage: Operational Directives for the Implementation of the Convention. Retrieved from <https://ich.unesco.org/doc/src/00075-EN.pdf>.

Yusof, M., Afif, M., & Masyarah, M. Z. (2021, June). Preserving Malaysian Folktales through Mobile AR Application: Sumpahan Ikan Tapah. *Journal of Computing Technologies and Creative Content (JTec)*.

Zipes, J. (2012). *The Irresistible Fairy Tale: The Cultural and Social History of a Genre*. Princeton University Press.

Z. (n.d.). *Zappar: World-leading Augmented Reality solutions since 2011*. Zappar. <https://www.zappar.com/>

9.0 Appendix

9.1 Source code of ClickDetector C# Script of final prototype 6.0

```
using System.Collections;
using System.Globalization;
using System.Net.Security;
using UnityEngine;

public class ClickDetector : MonoBehaviour
{
    public GameObject bird;
    public GameObject stones;
    public GameObject pot;
    public Animator birdAnimator;
    public string idleStateName = "Idle";
    public string movingStateOneName = "Moving";
    public string movingStateTwoName = "Moving";
    public string movingStateThreeName = "Moving";
    public float moveSpeed = 5.0f;
    public float rotateSpeed = 5.0f;
    public float waitTime = 0.2f;
    public float stoneEdge = 0f;
    public float potEdge = -0.5f;
    private Rigidbody rb;

    private bool done = false;
    private bool drop = false;
```

```
private bool isMoving = false;
private Vector3 targetPosition;
private uint stepNum = 0;

public GameObject prefabToInstantiate;
public GameObject ocean;

[SerializeField]
private float tiltAngle = 0f;
private Quaternion startRotation;

void Start()
{
    // Set the default animation state to idle
    birdAnimator.Play(idleStateName);
    startRotation = bird.transform.rotation;
}

void Update()
{
    if (done)
    {
        FlyAway();
        return;
    }

    if (isMoving)
```

```
{
    if (bird.transform.position == targetPosition)
    {
        isMoving = false;
        if (drop)
        {
            DropStone();
            drop = false;
        }
        birdAnimator.Play(idleStateName);
    }
    else
    {
        bird.transform.position = Vector3.MoveTowards(bird.transform.position,
targetPosition, moveSpeed * Time.deltaTime);

        bird.transform.rotation = Quaternion.Slerp(bird.transform.rotation,
Quaternion.LookRotation(targetPosition - bird.transform.position), rotateSpeed *
Time.deltaTime);
    }
}

if (Input.GetMouseButtonDown(0))
{
    // Raycast to detect objects clicked on
    RaycastHit hit;
    if (Physics.Raycast(Camera.main.ScreenPointToRay(Input.mousePosition), out
hit))
```



```

    {
        // Check if the cube or pot was clicked on
        if ((hit.collider.gameObject == stones || hit.collider.gameObject == pot) &&
!isMoving)
        {
            stepNum++;

            if (hit.collider.gameObject == stones)
            {
                targetPosition = stones.transform.position;
            }
            else if (hit.collider.gameObject == pot)
            {
                targetPosition = pot.transform.position;
            }

            isMoving = true;

            if (stepNum == 1)
            {
                birdAnimator.Play(movingStateOneName);
                targetPosition = stones.transform.position;
                float heightOffset = stones.GetComponent<Renderer>().bounds.size.y /
2.0f;

                targetPosition.y += heightOffset;
                drop = false;

```

```

        //targetPosition.x += stoneEdge;
    }
    else if (stepNum == 2)
    {
        birdAnimator.Play(movingStateTwoName);
        targetPosition = pot.transform.position;
        float heightOffset = pot.GetComponent<Renderer>().bounds.size.y / 1.0f;
        targetPosition.y += heightOffset;
        targetPosition.x += potEdge;
        drop = true;
    }
    else if (stepNum == 3)
    {
        birdAnimator.Play(movingStateOneName);
        targetPosition = stones.transform.position;
        float heightOffset = stones.GetComponent<Renderer>().bounds.size.y /
2.0f;
        targetPosition.y += heightOffset;
        drop = false;
        //targetPosition.x += stoneEdge;
    }
    else if (stepNum == 4)
    {
        birdAnimator.Play(movingStateTwoName);
        targetPosition = pot.transform.position;
        float heightOffset = pot.GetComponent<Renderer>().bounds.size.y / 1.0f;
        targetPosition.y += heightOffset;

```

```
        targetPosition.x += potEdge;
        drop = true;
    }
    else if (stepNum == 5)
    {
        birdAnimator.Play(movingStateOneName);
        targetPosition = stones.transform.position;
        float heightOffset = stones.GetComponent<Renderer>().bounds.size.y /
2.0f;

        targetPosition.y += heightOffset;
        drop = false;
        //targetPosition.x += stoneEdge;
    }
    else if (stepNum == 6)
    {
        birdAnimator.Play(movingStateTwoName);
        targetPosition = pot.transform.position;
        float heightOffset = pot.GetComponent<Renderer>().bounds.size.y / 1.0f;
        targetPosition.y += heightOffset;
        targetPosition.x += potEdge;
        drop = true;
    }
    else if (stepNum == 7)
    {
        DrinkWater();
    }
    else if (stepNum == 8)
```

```
        {
            done = true;
        }
    }
}
}
```

```
void FlyAway()
```

```
{
```

```
    birdAnimator.Play(movingStateOneName);
```

```
    // Get a direction away from the pot
```

```
    Vector3 awayDirection = (pot.transform.position -
stones.transform.position).normalized;
```

```
    // Move the bird away from the pot in that direction
```

```
    bird.transform.position += awayDirection * moveSpeed * Time.deltaTime;
```

```
    bird.transform.rotation = Quaternion.Slerp(bird.transform.rotation,
Quaternion.LookRotation(awayDirection), rotateSpeed * Time.deltaTime);
```

```
    // Check if the bird has flown away
```

```
    if (Vector3.Distance(bird.transform.position, pot.transform.position) > 50.0f)
```

```
    {
```

```
        StartCoroutine(WaitForNextMove());
```

```
    }
```

```

}

void DrinkWater()
{

    targetPosition = pot.transform.position;
    float heightOffset = pot.GetComponent<Renderer>().bounds.size.y / 1.1f;
    targetPosition.y += heightOffset;
    targetPosition.x += -0.55f;
    targetPosition.z += 0.25f;

    bird.transform.position = Vector3.MoveTowards(bird.transform.position,
targetPosition, moveSpeed * Time.deltaTime);
    birdAnimator.Play(idleStateName);

    // Calculate tilt angle based on animation progress
    //tiltAngle = 90f;
    float animationProgress =
birdAnimator.GetCurrentAnimatorStateInfo(0).normalizedTime % 1f;
    float currentTiltAngle = tiltAngle * animationProgress;

    // Tilt the object
    Quaternion newRotation = startRotation * Quaternion.Euler(25f, currentTiltAngle, -45f
);
    bird.transform.rotation = newRotation;

}

// Coroutine to add a delay between each movement update

```

```
IEnumerator WaitForNextMove()
{
    yield return new WaitForSeconds(waitTime);

    done = false;
    birdAnimator.Play(idleStateName);
    isMoving = false;
    targetPosition = Vector3.zero;
}

void DropStone()
{

    Vector3 instantiatePosition = pot.transform.position;
    instantiatePosition.x = pot.transform.position.x;
    instantiatePosition.y = pot.transform.position.y + 3f;

    if (ocean.transform.position.y <= 0.496f)
    {
        ocean.transform.position += new Vector3(0, 0.075f, 0);
        GameObject newObject = Instantiate(prefabToInstantiate, instantiatePosition,
Quaternion.identity);
        newObject.transform.parent = pot.transform;

        Rigidbody rigidbody = newObject.AddComponent<Rigidbody>();
        rigidbody.useGravity = true;
```

```
rigidbody.mass = 0.01f;
```

```
}
```

```
}
```

```
}
```