The Feeling of Immersion in Location-Based Augmented Reality Setting

Case: City Stories Helsinki

Eeva Jäntti

Master's Thesis

Media Management

2019

DEGREE THESIS	
Arcada	
Degree Programme:	Media Management
Identification number:	
Author:	Eeva Jäntti
Title:	The Feeling or Immersion in Location-Based Augmented Reality Setting
Supervisor (Arcada):	Owen Kelly
Commissioned by:	Media Industry Research Foundation of Finland

Abstract:

The market of virtual technologies (Augmented, Mixed and Virtual Reality) is anticipated to grow exponentially. Technological development and high-speed 5G mobile connections will accelerate the growth within the next few years. More content and concepts need to be created and tested for these technologies. One of those concepts is City Stories, a location-based Augmented Reality experience. A pilot of it is examined in this study. It was produced during spring and summer 2018 by the funding of Media Industry Research Foundation of Finland. This study is also part of the project. Virtual technologies are often referred to as immersive technologies. Immersion is mostly associated with a desirable state and something worth to go for. By designing immersive experiences to immersive technologies, high immersion levels should be achieved. This study examines how immersive Augmented Reality (AR) experiences can be designed, what immersion is, how it can be measured in a location-based AR setting and most importantly, how immersive is the City Stories pilot. The purpose of this study is to find out if this and similar concepts are worth developing further from the immersion point of view. In this study the early history of AR technology is summarized, the XR industry is analyzed briefly, previous research on immersion and AR design is examined. The level of immersion of the City Stories is measured with ARI (Augmented Reality Immersion) questionnaire that is designed for a location-based augmented reality setting. It is found that the level of feeling immersion was quite high according to the ARI questionnaire, and the conclusion is that City Stories and similar concepts are potentially viable concepts for further development. It is also concluded that the taxonomies of immersion and flow should be clarified and the instruments for measuring these should be tested more. Further studies with different methods on these topics are needed.

Keywords:	Augmented Reality, Immersion, Storytelling, Content design, Case study, Location-based
Number of pages:	54
Language:	English
Date of acceptance:	

CONTENTS

Figures

Tables

1 INTRODUCTION

1.1 Background

The global Virtual and Augmented Reality market is predicted to increase exponentially during the next few years. The development and increasing number of smart devices added to the progress of the high-speed 5G mobile network accelerates the virtual technologies business and opens up new opportunities for streaming media. (Orlosky *et al.* 2017 p. 133)

Along with the new emerging technology also new kinds of content and concepts can be created. City Stories is a concept adopted from traditional storytelling to the Augmented Reality setting. The concept was created by writer and director Heli Lekka and was inspired by The Moth, that is a well-known storytelling club and podcast where people tell their own true stories on stage.

With funding of the Media Industry Research Foundation of Finland, a pilot of the concept was produced during the spring and summer 2018. It contained five stories located around Helsinki. For over three months anyone could go to those locations and watch the stories with their own mobile devices. The storytellers appeared virtually at those locations that also were the original scenes of the stories. The stories were also the storytellers' own true stories, no actors or made up stories were used.

Virtual, Augmented and Mixed Reality are used to create immersive experiences, and they are also often called immersive technologies (Suh & Prophet 2018 p. 77; Georgiou & Kyza 2017, p. 24; Raptis *et al.* 2018 p. 79). The notion of immersion can be defined in many ways. It can be seen as technological qualities (Slater *et al.* 1996 p. 166) or as a psychological phenomenon that furthermore has many interpretations (Witmer & Singer 1998, p. 227; Jennett *et al.* 2008, p. 646-649; Georgiou & Kyza 2017, p. 25-26). This study emphasizes immersion as a psychological phenomenon, and more precisely as a gradual process of engagement that may lead to flow and/or presence (Georgiou & Kyza 2017, p. 26).

Immersion is mostly associated with being a desirable state that would increase consumer engagement on brands (Scholz & Smith 2016, p. 149) or with the enjoyment of playing a game (Jennett *et al.* 2008, p. 641). It has been associated with the success of games and virtual reality experiences (Reid *et al.* 2005, p. 1733). Therefore, immersion is often pursued, and this fact often justifies the use of immersive technologies.

To gain maximal engagement, AR experiences should be designed the way that it becomes as immersive as possible (Scholz & Smith 2016, p. 149). Found guidelines were followed as far as possible in the design process of City Stories in order to achieve an immersive experience.

1.2 Purpose of the Study

Previous research on Augmented Reality has concentrated on technology and is lacking research on user behavior and human experiences with digitally augmented environments (Harborth, David. 2017, p. 1; Kim 2013, p. 79). Especially in gaming and mobile augmented reality, user behavior is underrepresented (Harborth, David. 2017, p. 1). However, the research on immersive technologies is rapidly increasing, and 43% of all of the studies were published during 2016-2017. In that timeframe, the research of user experience and user performance have been the two main streams. (Suh & Prophet 2018 p. 80)

This study also concentrates on the user experience and more precisely on the level of the feeling of immersion the user is having during an augmented reality experience in a location-based setting. The study emphasizes the AR content rather than the technical solutions, and because of that it also explores what has been written about the design of AR experiences.

Through a case study of City Stories, it is examined how immersive AR experiences are designed and how the feeling of immersion can be measured. This research examines how immersive is the City Stories AR experience according to ARI (Augmented Reality Immersion) questionnaire, that is an instrument developed for measuring immersion in a location-based AR setting. The research concludes with whether City Stories and similar

concepts are worth developing further from the immersion point of view, and suggestions for further research.

Going through the previous research and systematic literature reviews there is a minimal emphasis on the actual content and its contribution to the user experience. Also, in the suggestions for future research, it is not mentioned. In this study, the design process is also reviewed, and research on content characteristics effects on user experience is suggested for further studies.

1.3 Research Question

The primary goal is to find out if the location-based Augmented Reality experience City Stories and similar concepts would be worth developing further mostly from the immersion point of view. If the level of immersion can be measured the findings should indicate if the concept is viable in this sense or not. Also, other information than immersion related can be gained at the same time.

This research also scratches the surface of the design questions of AR, again mainly from an immersion point of view.

RQ1: Are City Stories and other similar concepts worth developing further?
RQ2: How immersive is the City Stories pilot?
RQ3: How immersive AR experiences are designed?

1.4 Method

The research of immersion and how it can be measured originates from the game studies (Jennett *et al.* 2008). Based on that some instruments have been developed for AR too (Georgiou & Kyza 2017; Kim 2013; Witmer & Singer 1998). One of them is the ARI (Augmented Reality Immersion) questionnaire (Georgiou & Kyza 2017) that is designed explicitly for similar location-based Augmented Reality experiences as City Stories. In this study, the ARI questionnaire is used as an instrument for measuring the feeling of immersion.

In addition to the ARI questionnaire, two open-ended questions are added and also notes from observations of the users are analyzed. These provide more information about what kind of thoughts and actions the experience and the content are causing in the users.

There is very little research on the design process of Augmented Reality content, so in addition to the background study, the design process of City Stories is opened up specially from the Augmented Reality and immersion point of view.

2 WHAT IS AUGMENTED REALITY?

2.1 Traditional Definitions

The most predominant definition of Augmented Reality in literature is Ronald T. Azumas outlining from the year 1997. In his paper, A Survey of Augmented Reality, he grounded a starting point for Augmented Reality research and usage. (Azuma 1997 p. 355)

Azuma states that AR supplements the real world rather than replaces it entirely with a virtual environment. The virtual and real objects would ideally appear to the user as if they would coexist in the same space. When the virtual environment is completely synthetic, the user cannot see the real world, and telepresence is entirely real. AR is in between them allowing the user to see the real world and the superimposed virtual objects. (Azuma 1997 p. 355)

Azuma did not limit the definition of AR to Head-Mounted Displays (HMDs) and defined three essential components that the AR system should have:

a. Combines real and virtual
b. Interactive in real time
c. Registered in 3D

Defining AR with these characteristics also allows other technologies than HMDs but excludes films and 2D overlays. (Azuma 1997 p. 356)

Different hardware and software technologies are needed for creating and experiencing Augmented Reality. The history of AR goes back thousands of years from using mirrors, lenses and light sources for creating virtual images (Billinghurst et al. 2015 p. 85). The first patent of a modern Augmented Reality device can be traced back to the early 1900s. Telescope maker Sir Howard Grubb's invention was a device that helped aim projectile firing weapons. Since then, the military and aviation industry has been the development hub of the AR devices. When the aircrafts started to have more and more sensors, avionics systems, flight controls, and weapons the pilots' focus went to the different dials and displays instead of the view outside the cockpit. The first Heads-Up Displays (HUDs) were introduced in the 1950s. They were transparent displays in front of the pilot that

would enable the pilots' head to be in up-position. In the 1960s the South African Air Force developed the Helmet-Mounted Sight (HMS) to help the pilots to target the heat-seeking missiles. Some of the information from the HUD was moved to the pilot's helmets. (Aukstakalnis 2017 p. 2-7)

The AR technology has spread from the aviation industry to other fields, and commercially available products of different Smart Glasses and Augmenting Displays. There are Optical See-Through displays that overlay the real world with graphics and video, and Video See-Through displays where graphics and video are combined with a video of the real world and then displayed to the user. In addition to the head-mounted displays (HMDs), there are the Handheld Mobile AR Devices, most usually tablet computers and smartphones, that merge computer-generated graphics and video to the real-world scene. (Aukstakalnis 2017 p. 2-7)

The revolution of the mobile devices, phones, and tablets, has brought AR accessible for anyone in the developed countries (Nincarean et al. 2013 p. 659-660, Wafa & Hashim 2016 p. 763). The devices have cameras and sensors to provide input and screen for output, and computational power for the software that is needed to present Augmented Reality (Orlosky et al. 2016 p. 134).

Azuma gave multiple examples of how AR could be used. Doctors could utilize it in training and visualization, complex machinery could be assembled, maintained and repaired with manuals superimposed on the actual equipment. Public or privet information could be annotated to objects and environments, robots could be teleoperated through AR, the entertainment industry could use AR to reduce production costs, and the military industry will continue to develop AR applications to their needs. (Azuma 1997 p. 358-364)

Another grounding survey was done by Paul Milgram and Fumio Kishino in 1994. They formulated the taxonomy of Augmented Reality (AR), Virtual Reality (VR), Augmented Virtuality (AV) and Mixed Reality (MR), and placed them on the Reality-Virtuality Continuum (Figure 1.). VR is an entirely virtual environment and is placed on the other end of the continuum than Real Environment (RE). In AV real images and graphics are

superimposed on a virtual environment, when in AR virtual objects are superimposed on the real environment. (Milgram & Kishino 1994 p. 1-3)

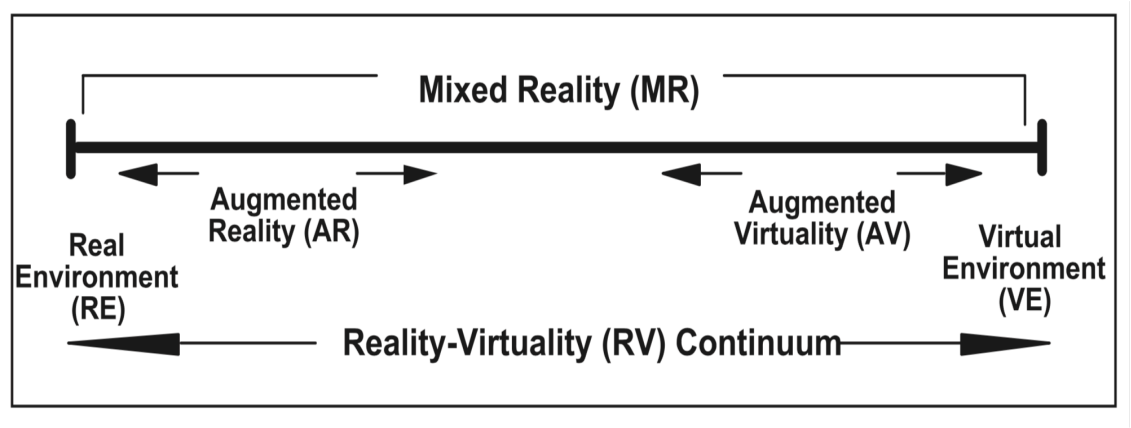


Figure 1. Mixed Reality and Reality-Virtuality Continuum (Milgram & Colquhoun 1999 p. 9)

The continuum presents that everything between the entirely real environment and completely virtual environment where real and virtual elements are presented in a single display at once is Mixed Reality; hence AR and AV are also part of the MR. The Reality-Virtuality Continuum also includes completely real environment and completely virtual environments. (Milgram & Colquhoun 1999 p. 9)

The terms AR and MR have been used interchangeably and inconsistently in the academic literature as well as in the professional fields. Flavián et al. conducted a literature review from four databases (ScienceDirect, Scopus, Web of Science, Google Scholar) and found out that clarification and standardization of the terminology were needed. Like many other researchers, they base their proposal of the new standard taxonomy of the virtual technologies on Milgram and Kishinos' work. They suggest that MR is an independent dimension of Pure Mixed Reality (PMR) that fall between AR and AV on the Reality-Virtuality Continuum (Figure 2.). (Flavián et al. 2018 p. 2-3)

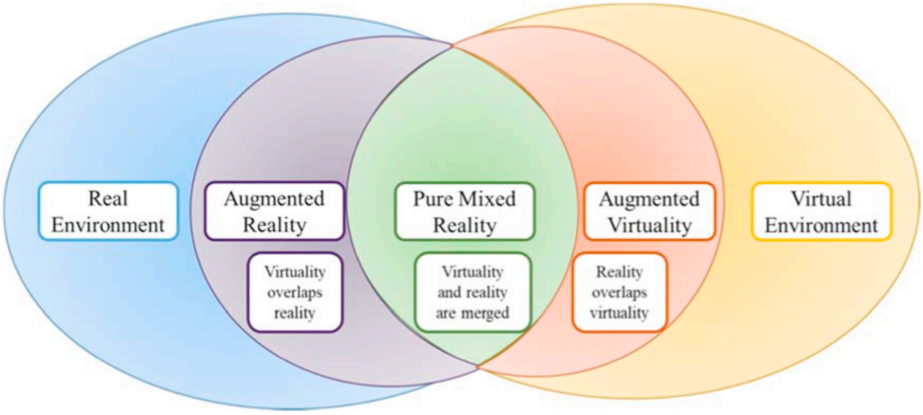


Figure 2. Reality-Virtuality Continuum proposed by Flavián et al. (Flavián et al. 2018 p. 3)

Flavián et al. propose that in PMR the virtual objects are rendered to be unobtrusive from the real world. The user can interact with the real and the virtual objects simultaneously and in real-time, and the real and virtual objects also interact with each other. In the PMR the virtual objects could be placed behind real objects, for example under a table, when in AR the virtual objects are superimposed on the real world. Devices that at the moment enable PMR are for example Microsoft Hololens and Magic Leap (Flavián et al. 2018 p. 3).

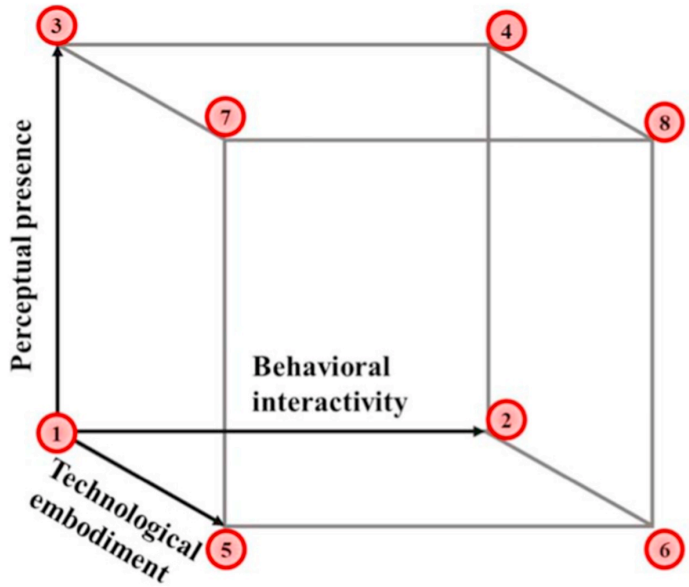
This research is using the taxonomy of Reality-Virtuality Continuum proposed by Flavián et al.

2.2 Extensions

Many researchers have created extended taxonomies based on Milgrim and Kishinos' Reality-Virtuality Continuum with taking into account different dimensions and technologies. In Mediated Reality different devices modify any human perception of the real world, and as a taxonomy, it is, therefore, more inclusive (Mann 2002). Amplified Reality contains the idea that an amplified object can control the information delivered. Visuo-Haptic Reality-Virtuality Continuum also contains a degree of virtuality in touch, and the real world and interactive virtual simulations are in the opposite ends of the continuum. (Flavián et al. 2018 p. 4)

The idea of the virtual technologies is also expanded to multisensory extensions of the human body that in the maximum level generates a human-technology symbiosis. Wearable computing is increasing the integrations between the body and the devices and therefore also in research the technological embodiment is examined. The degree of integration of the devices into the human body is presented in the Mobility Continuum. (Flavián et al. 2018 p. 4)

In addition to the new suggestion of Reality-Virtuality Continuum Flavián et al. proposes an EPI (Embodiment, Presence, and Interactivity) Cube (Figure 3.) that can be used to classify current and becoming technologies according to these different areas of the Human-Technology Interaction (HTI).



Vertex	Radical examples of technologies
1	Computer Web 1.0.
2	Website online simulators
3	Video Wall
4	Virtual Worlds (Second Life)
5	Augmented reality glasses
6	Mixed reality glasses (Holographic devices)
7	360-degree video HMD (fixed position)
8	Virtual reality HMD with haptic devices

Figure 3. The "EPI Cube" proposed by Flavián et al. (Flavián et al. 2018 p. 7)

The vertices of the EPI Cube shows the extremes of the features of the virtual technologies. Vertices 1-4 are devices that are unintegrated to the human body and vertices 5-8 are integrated into it. The even numbered vertices have high interactivity, whereas the uneven numbered vertices do not have. The vertices 3, 4, 7 and 8 represent technologies in which the perceptual presence is high, and the user may feel being somewhere else than in the actual location, whereas in the vertices 1, 2, 5 and 6 the actual surroundings of the user are visible. (Flavián et al. 2018 p. 6-7)

Dr. Helen Papagiannis thinks that Augmented Reality is about augmenting the human experience. In her book, “Augmented Human”, Dr. Papagiannis presents a wide range of different technologies and perceptions. She predicts that AR will become a super medium that will combine wearable computing sensors, the Internet of Things (IoT), machine learning, artificial intelligence, and other emerging technologies. (Papagiannis 2017)

Dr. Papagiannis defines the first phase of AR to the ”Overlay” where digital content is superimposed on the real environment. The next phase would be the ”Entryway”, where more immersive, integrated and interactive experiences would be designed. They would be more human-centered and in context to the user. (Papagiannis 2017 p. 4.-5)

In the entryway, the interaction with technology becomes more natural, and the experience is in the center. Augmented Reality is experienced with all of our senses. Haptics technology makes it possible to feel digital content, for example, the fur of a virtual pet. Smells can be added too, there already is a device that is plugged into smartphones audio jack, and it allows the user to send and receive smell messages. (Papagiannis 2017 p. 5-6). Another device creates virtual taste with electrical currents. The electric taste augmentation can be created with utensils designed for it, for example, a pair of chopsticks and a soup bowl that allows the user to apply different settings to make the food saltier or sour. These devices are already prototyped. (Ranasinghe et al. 2018 p.1-2) AR can also allow us to sense digital and electrochemical signals such as radio waves, X-rays and gamma rays (Papagiannis 2017 p. 5-6).

Dr. Papagiannis gives examples of how the next phase could impact on different fields of business in the near future. In the medical industry, real-life operations can soon be rehearsed with virtual brains. In education, facial expressions can be recognized, and a student that is struggling with a task or not paying attention can be identified. That can be useful especially in distance learning and also additional information or notifications can be sent to the students. In retail seeing the products at home or on the body are already in use, in the future, they can also be touched in addition to visualization. In the construction, industry distances are meaningless when architects and builders can fully interact at the job site. The entertainment industry will utilize AR headsets by creating a new type of

experiences starting from having a performer appearing at ones home and sing. (Papagiannis 2017 p. 7-9)

Later in the future, the second phase would highlight context and understanding of the surroundings. AR would become a transformation of reality. As artificial intelligence develops further, it would be possible to make avatars that would look like us and learn from our behavior. The avatars could replace us when we are not there, and they would be left for the next generations as a legacy. (Papagiannis 2017 p. 93-96) The concept of 4D printing could become real, and materials could grow and adapt to the environment or our needs (Papagiannis 2017 p. 101). Wearable technology would be in the core of the second wave of AR. The human body could be used as an interface, for instance, palm could be used as a touchscreen of a phone, or touching ears could give commands to adjust the volume. (Papagiannis 2017 p. 108-110) Responsive clothing could help in navigation, measure biometrics and coach to better performances, be used as an interface or reflect human mechanisms (Papagiannis 2017 p. 110-114). Technology can also be placed inside the human body as implants. They can measure biometrics, help blind to sense the environment and make magnetic fields sensible (Papagiannis 2017 p. 114-115). Brain-Computer Interfaces (BCIs) could help AR to achieve its full potential. Researchers already have succeeded in menu selection with using a brain-controlled software and recognizing subjects that evoke interest when they are red. (Papagiannis 2017 p. 117-120)

3 INDUSTRY REVIEW

The global XR market holds all the virtual, augmented and mixed reality hardware and software developers and content creators in the world. The hardware developers are making wearable technology such as virtual and augmented reality glasses and technology for mobile devices. The software developers are creating applications and tools that enable publishing content to the virtual space and watching it. And the content creators use these tools to create virtual experiences that are consumed through the hardware and software.

The whole market is anticipated to grow exponentially during the next few years (Figure 4.). In 2021 the market size is forecasted to be over 200 billion dollars for the whole XR industry when in 2016 it was only 6.1 billion dollars. (IDC, 2017)

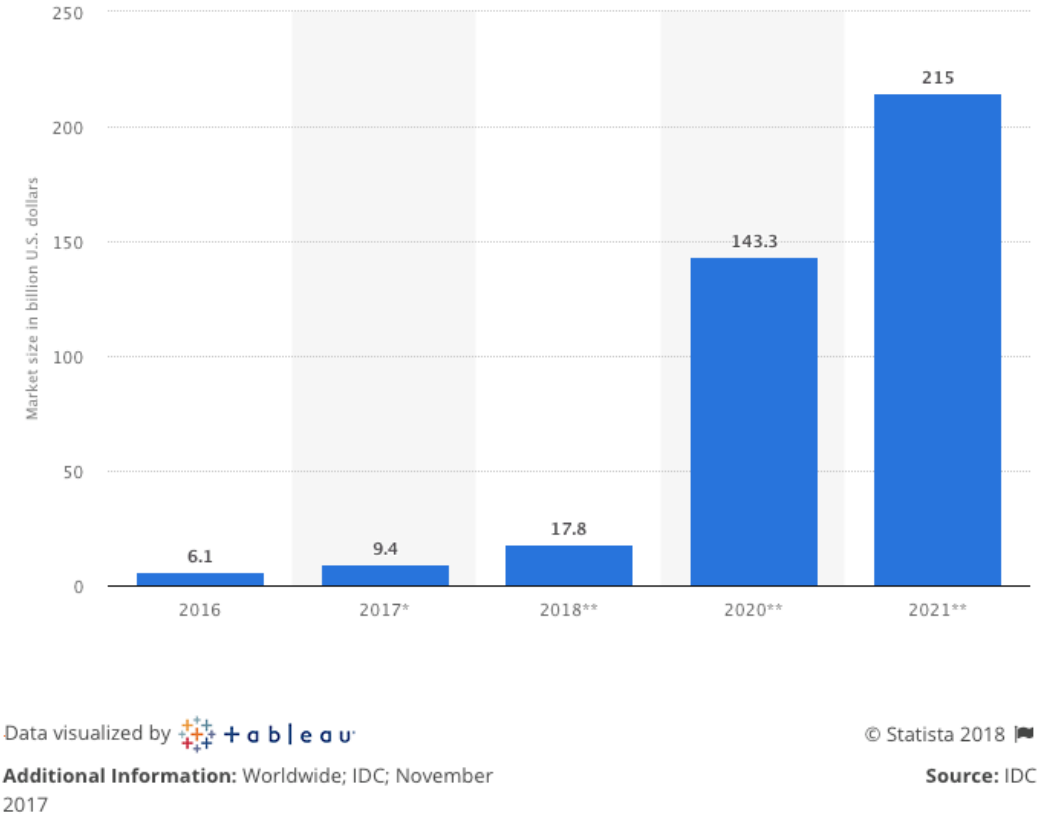


Figure 4. Global augmented and virtual reality market size forecast (https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/)

The revenue forecast (Figure 5.) shows that AR would have the lion's share of the whole market. Possibilities for AR are seen everywhere when the VR consumption is more limited. VR is perceived more for gaming purposes and AR for everything. About half of the

AR usage would also be gaming. After that the categories in order from the highest revenue to the lowest are forecasted to be: social, photo & video, navigation, entertainment, medical, education, lifestyle, travel & transport, music, business, sports, health & fitness, art & design, food & drinks, kids, reference, finance, news, books, catalogs, magazine & newspapers and utilities. Mobile AR is anticipated to be the driver because of its ubiquity, and many of us carry the needed device already. Moreover, as the replacement cycles for the mobile phones are short, the install base is going to expand in a short time. (Digi-Capital, 2018)

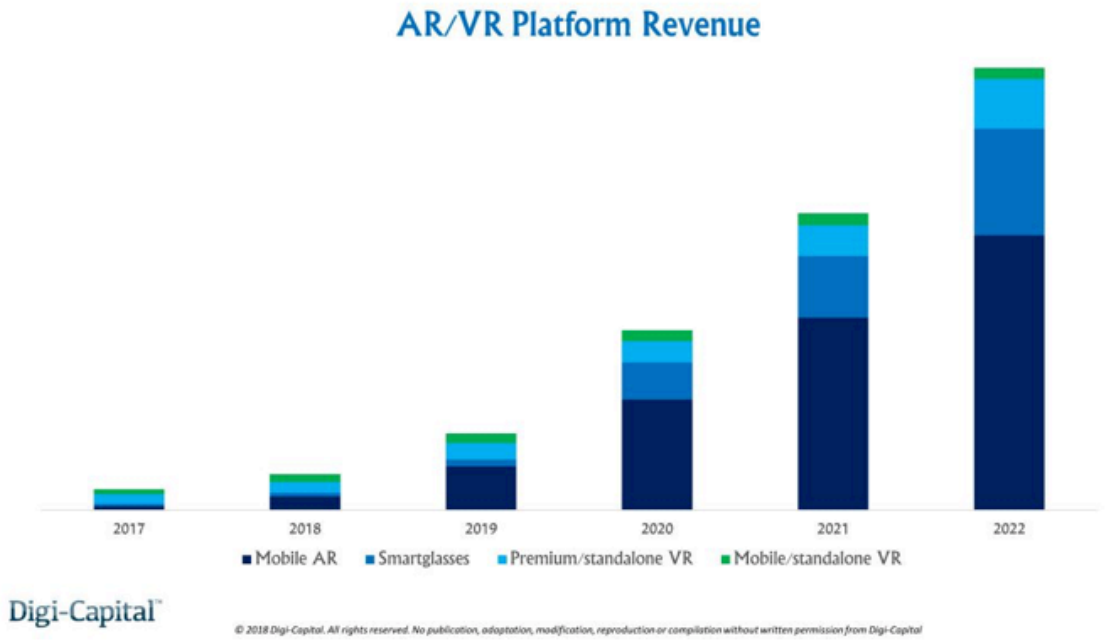


Figure 5. Augmented and Virtual Reality platform revenue share forecast (https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/#.Wo2vNmaB2lM)

Digi-Capital forecasts that Apple is going to launch smartphone tethered smartglasses in 2020 and that would spread the smart glass market from industry focus to the mass-consumers by 2022, but it would still play a minor role in the big picture as presented in Figure 6. (Digi-Capital, 2018)

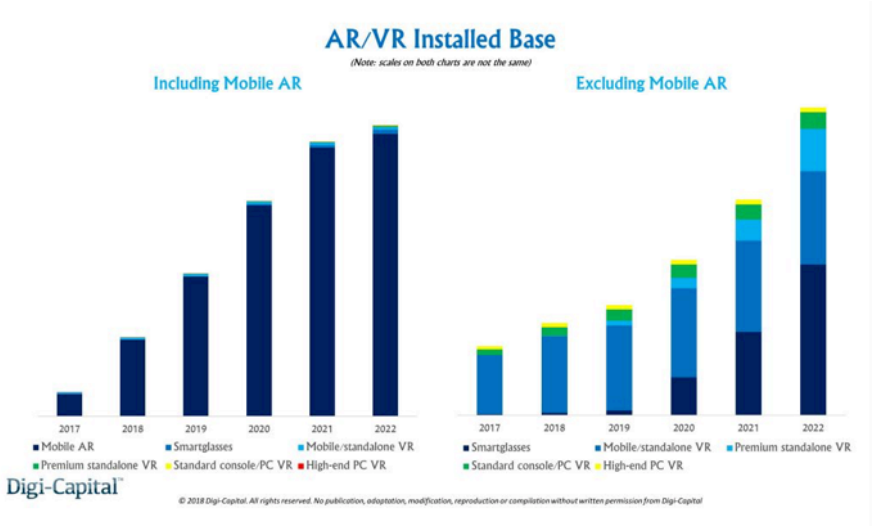


Figure 6. Install base forecast of AR and VR (https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/#.Wo2vNmaB2lM)

Geographically AR's distribution is seen similar to the smartphone and tablet distribution and VR's similar to the games market distribution. Asia is forecasted to hold almost half of the market. North America and Europe will be the second biggest markets (Figure 7.). (Digi-Capital, 2018)

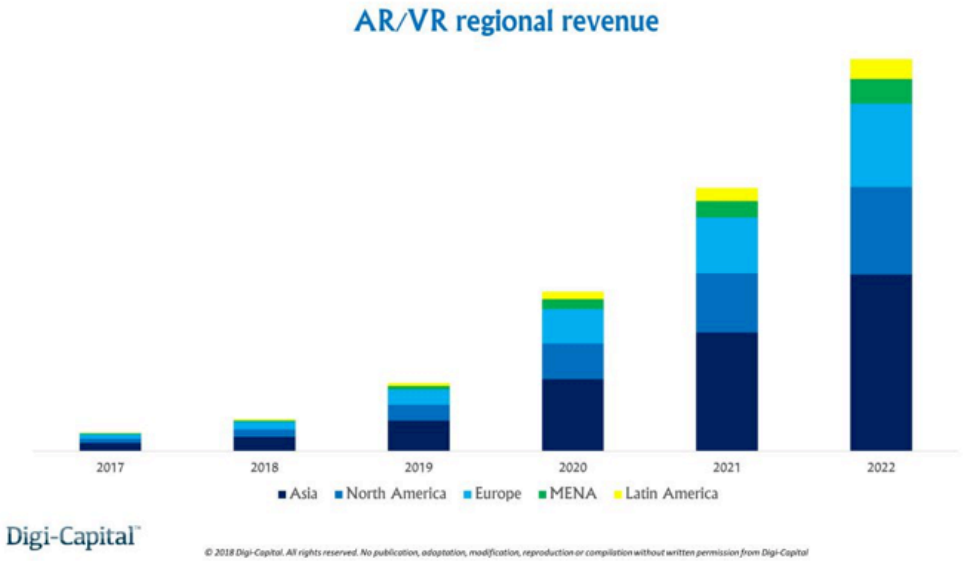


Figure 7. Regional AR/VR revenue forecast (https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/#.Wo2vNmaB2lM)

In the rapidly developing market, it is beneficial to identify concepts that work as soon as possible. Therefore, pilots like City Stories should be created and tested more.

4 DESIGNING IMMERSIVE AR EXPERIENCES

Marketing of consumer goods has been the showroom of Augmented Reality to the mass audiences. Many of the big brands such as Pepsi and Mc. Donalds have already years ago tested and used different AR apps and done their first AR campaigns introducing the technology to the consumers.

Typically, these have been augmentations of a print or packaging where the logo or a retailed image is scanned with an AR app, and the AR content pops up from a magazine, catalog or package. So-called bogus windows have also been tested in consumer campaigns. The existing space is augmented through screens that are installed to replace real glass windows. The screen is attached to a camera that films the scene outside the window, and the virtual content is combined with the scene. Bus shelters and tram stops are common places for the bogus windows. A classic example is the Pepsi Max's campaign in which tigers or UFO's approach the bus shelter.

Magic Mirrors and interactive screens use the same idea, but the user can see herself in the picture either as looking in the mirror or from a perspective of a third person. One example is the National Geographic Channels' campaign where the user could interact with the virtual wild animals. Virtual try-ons or virtual mirrors are also one form of "self-augmentation" where for instance glasses or makeup can be seen on your face as a virtual add-on. (Scholz & Smith 2016, p. 149-151, Javornik 2015, p.252-253)

Geo-Layer experiences augment the surrounding space as in the BOS Iced Tea campaign where the users plant virtual trees around the city (Scholz & Smith 2016, p. 151). Surrounding space can also be augmented with virtual elements, for example, a piece of furniture can be placed in the room or navigation can be made more accessible by adding information about the surrounding area to the screen of the mobile device (Javornik 2015, p. 254).

4.1 Framework for Successful AR

Joachim Scholz and Andrew N. Smith analyzed 50 AR experiences that were created for marketing purposes. They developed a framework that characterizes:

a. the ingredients of Augmented Reality
b. basic design decisions for developing compelling AR experiences
c. how marketers can optimize the dynamics of AR initiatives for increasing consumer engagement

AR experiences consist of active and passive ingredients (Figure 8.). Active ingredients are AR content, the user and the object that is augmented. Passive ingredients are non-participant witnesses, near located non-augmented objects and the background or ambient conditions. (Scholz & Smith 2016, p. 150)

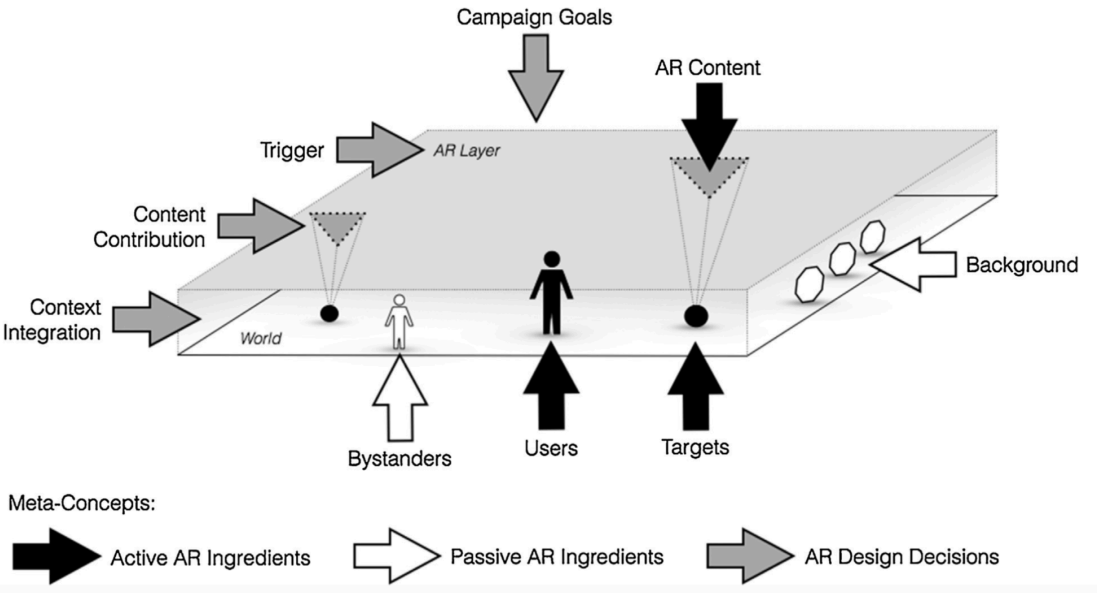


Figure 8. Augmented reality ingredients and design decisions (Scholz & Smith 2016 p.?)

Users experience the augmentation directly, bystanders observe the users actions and might affect the user's behavior. Targets are the objects that are augmented with the AR content. The physical environment that acts as the background of the experience shape the meaning of the AR content and is a vital part of the experience. These five ingredients

have to be considered first when making basic design decisions. (Scholz & Smith 2016, p. 151-153)

Scholz and Smith propose four steps for designing successful AR experiences:

1. Define the target audience and communication objectives (Campaign Goals)
2. Determine how the AR layer will be activated for users (Trigger)
3. Regulate how, and by whom, the AR layer will be furnished with targets and AR content (Content Contribution)
4. Establish how the AR layer will integrate with specific social and physical contexts (Context Integration) (Scholz & Smith 2016, p. 153)

The goal is to design immersive AR experiences that increase consumer engagement. Optimizing the dynamics between the active and passive AR ingredients are proposed to generate three types of consumer engagement:

1. User-brand engagement
2. User-user engagement
3. User-bystander engagement

With AR, users can interact with the brand in immersive experiences that increase user-brand engagement. Interactions between users in social AR experience is a strong way to add value to the experience. An easier way to increase consumer engagement would be exposing bystanders to the AR experience on the location or in social media. (Scholz & Smith 2016, p. 155-157)

Scholz and Smith recommend entangling digital AR content with the physical and social contexts of consumers' lives (Figure 9.). (Scholz & Smith 2016, p. 157)

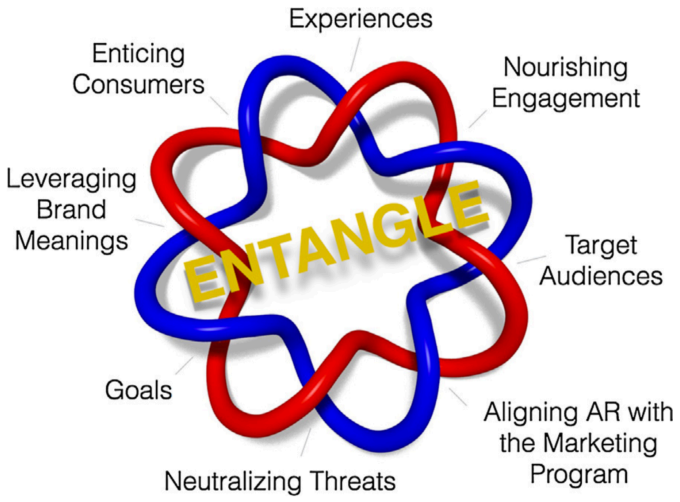


Figure 9. Entangling Augmented Reality (Scholz & Smith 2016, p. 157)

Instead of being driven by the technology the experiences should be consumer-experience driven. Focusing on consumer engagement should be the priority, and the target audience should include the early adopters and users who likely will share the experience in social media and spread word-of-mouth. AR should be integrated into the overall marketing program to maximize the coverage. Recognizing threats can save a lot; for example, protection of the brand image needs to be considered. Instead, AR experiences have an enormous potential to leverage brand meaning. The goals of the campaign should be clear and always kept in mind. Finally, the consumers should be enticed to try and re-visit the experience. (Scholz & Smith 2016, p. 157-159)

4.2 The Media Characteristics of the Interactive Technologies

Designing AR experiences can be disassembled from the perspective of the media characteristics of interactive technologies. It is proposed that these characteristics should be studied further with AR, that is considered as new interactive technology. The characteristics are interactivity, hypertextuality, modality, connectivity, location-specificity, mobility, and virtuality. (Javornik 2015, p. 255-258)

Interactivity is confirmed to lead to flow state that can improve learning and have other positive effects on the user experience, but also adverse effects such as distraction has been recognized. Hypertextuality and navigability also have positive effects. The richness

in visual, verbal, audio and video representations lead to positive attitudes and in augmented and virtual reality in addition to the positive effect of virtuality, narration, cause-effect, and storytelling have even more significant impact, although websites are better in creating a feeling of trust by offering information in better ways. Connectivity to social networks impacts positively on the user's flow and involvement. Location-specificity means the ability to use the geolocation for personalized content delivery. On the other hand, this leads to positive attitudes, but privacy is seen as a high concern. (Javornik 2015, p. 255-258)

4.3 Content Design

All of the research found was related to the technological characteristics and the user experience of AR, and in-depth research on the actual AR content design was not found. Perhaps it is considered that the traditional elements of storytelling and visual effects are adapted directly to the AR setting and no particular idiosyncrasies of how to create compelling AR does not exist. Alternatively, we are not yet in the phase of analyzing the content when the technology is so new.

Dr. Papagiannis states that AR is a new communication medium that extends the human condition. The creative evolution of AR is in its beginning, and there are no rules for the storytelling. We are now at the wet clay phase where we can try different designs before the language of the media becomes established. (Papagiannis 2017, p. 69)

5 DESIGNING CITY STORIES HELSINKI

The idea of City Stories was initially created in a writer's room where scriptwriters from different fields of entertainment were developing their first AR concepts. Naturally, the ideas sprang from the traditional entertainment formats. Scriptwriter and Director Heli Lekka was impressed by The Moth, a storytelling format where people tell their own true stories on stage, and the podcast recorded from it. Taking the stories to their scenes with AR was recognized as a possibly viable AR format.

With the funding of the Media Industry Research Foundation of Finland, a pilot of five stories was produced during spring 2018. First, the five storytellers were found through public search and personal contacts. The requirements were that the location had to be an essential part of the story and that a stand for watching the story could be placed to that location. In practice, the City could permit placing a stand and a chair to parks or open spaces.

The City of Helsinki partnered in the project. They published the casting call on their My Helsinki web site and ones the stories were published they also had a page for the City Stories AR experience with introduction and instructions. They also posted about it on their social media accounts.

5.1 Following the Framework for Successful AR

The four steps for designing AR experiences proposed by Scholz and Smith (section 5.) can be extracted from the design process of City Stories. Even that the steps are drawn for brand marketers, they are reasonable, though not exhaustive planning tool for any AR experience.

The target audience was defined to be the citizens who were interested in their surroundings and exploring it in new digital ways. The budget did not allow language versions, so tourists were dropped out. Age limitation was quite comprehensive from 15 to 50 years with a focus on the early adopters whose acceptance of new technology is high. The goal was to deliver the story to the users in a way that feels genuine, and the meaning of the

location is highlighted. The user would get an emotional experience and an augmentation of the location she might pass every day on her way to work.

We wanted the experience to be accessible for anyone to get as much knowledge as possible. We also wanted to test how virtual objects would work in the real environment and learn from that. It meant that in the same time we needed to technically execute the experience in a way that anyone could use it with their own devices and that would simulate a Pure Mixed Reality (PMR) environment where virtual objects would be blended to the real environment. We ended up using ARKit (iOS) and ARCore (Android) technologies that are based on recognition of flat surfaces. The user shows the environment to the device's camera, and if a flat surface is detected, the AR content can be placed there. It enabled us to get the virtual storyteller standing on the ground, and the user could freely move the device without interrupting the content.

We also wanted the user to be facing a particular direction to see a specific view essential to the story so we designed a story stand that included a chair so that the user could sit down and watch the story aligned automatically to the right direction. The stories had to be around five minutes long, so the chair was also needed to help the user to be comfortable and able to concentrate more.

We pondered what kind of virtual elements other than the storyteller could be added to the scene. It would have been nice to point out from the environment the spots related to the stories and bring out graphical elements to make the story more visual. As the PMR technology is not yet available in consumer devices, the virtual elements could not be attached to the environment properly, so we decided to only simulate it in one of the stories. For that, the content had to be placed carefully in the right position to get the content in place. The solution for this was to design the base of the stand in the way that it had a shape that was repeated in the AR content. When the shapes were on top of each other and in the same position, the content was on place. The user experience of this was not very good, but in the future, we hope that our devices can detect the environment so accurately that the user only needs to show the environment to the camera, and it places the content automatically.

Another issue with the technology was that ARCore and ARKit are not available in all devices, so we decided to offer a sound-only version to those whose devices did not support the technology.

At step two in the design process (Scholz & Smith 2016 p. 153) we determined the AR to be activated for the users through their own devices at the story stand. The user could go there whenever she liked and place the content in front of her, or listen to the story if the visual version was not available on her device. The user would make a deliberate action to get the experience, and the user would also be in control when to do it. That is found to make the user feel positive about the AR content (Scholz & Smith 2016 p. 155). The story stand would also attract by-passers to go and see what it is about.

Originally the concept included the opportunity for the users to add their own stories to their locations, but we decided to cut that off from the pilot as it would have taken too many resources and we wanted to concentrate on the content instead. In the pilot, we as content creators would be in control of whit what the AR experience is furnished. However, in the future, if we would get funding for the full experience, also the users could add their own stories.

The fourth step, the integration of the passive ingredients (Scholz & Smith 2016 p. 154) was mostly automatically dictated by the concept as it is so context bound. The story stands (Figure 10.) were placed the way that the experience would be as pleasant as possible, but the scene of the story should also be visible. The stand would catch the attention of the bypassers, but it might also be that some users would think that sitting on the stands chair would point too much attention on them and what they are doing. In the future, if the PMR technology is available for everyone the experience can be executed without the stand. On the other hand, that would eliminate the marketing value of the visible stands on the locations.

Figure 10. The story stand of the City Stories

The active ingredients of the City Stories are the user, the story stand and partly the surroundings, and the AR stories themselves. The passive ingredients are the by-passers and the ambient surroundings that are not part of the story. In this case, user-brand engagement is occurring when the user watches the story, and thereby the user is a passive receiver. The ability to point the device to different parts of the scene that are part of the story and see something there that is essential would increase the affordance level. With this concept, when the stories are linear true stories, increasing the interaction level would be difficult in other ways.

User-user engagement could be increased by the feature of letting people create their own stories and attach them to the locations. That way the user-bystander engagement would probably increase too when those who have published their own story would also post about it in their social media networks.

5.2 Following the Media Characteristics of the Interactive Technologies

Reflecting the media characteristics of the interactive technologies (Javornik 2015, p. 254-255) reviewed in section 4.2, the City Stories pilot takes advantage of all of the possibilities as far as it is possible within the limits of the concept and the pilot resources.

Direct interactivity in the stories is not possible as they are linear true stories. However, for example, the user could have been asked to go and take a closer look at the spots that were related to the stories. If a PMR setting had been available, these spots could have been highlighted and some additional information could have been represented there.

Also, more stories could have been on the same location, and the user could have had the control to choose which story she will see. That would have increased the interactivity and hypertextuality. With soundscape and graphical elements, the modality was increased to achieve a more rich experience. Location-specificity could be increased by sending a notification to the by-passers who have already downloaded the app, but this was not added as it was not a desired feature for the app (Arilyn) in general at that time. In this experience, mobility is deficient as the stories are bound to their locations. The virtuality of the experience is very high.

5.3 Content Design

In the actual AR content, the design decisions were made based on our knowledge on other audiovisual media production, starting with the cast to be diverse and exciting with an urban culture celebrity among it. In addition to the location specificity, the stories should contain a deeper level that the user can relate to. Enough details were needed to describe the circumstances and to add some humor and lightness too. However, the stories would have to feel as real as possible so too much writing and practicing would have killed them. On the other hand, the whole story needed to be filmed with one shot as cutting in AR is complicated or not possible. Finding the balance in how much to rehearse was a question that was often pondered.

Adding soundscape to the stories felt natural from the beginning of the design process. Sound can create the right atmosphere and make the story more alive. The same audio file was used in the sound only version of the experience. In the instructions, it was highlighted that using headphones would make the experience complete.

It was often questioned if it is enough that there is only the virtual storyteller or should there be other elements too. We decided to add some animated graphics to illustrate the

stories a little and to give variance and rhythm. In one of the stories we even created an utterly virtual surrounding and made a rough reconstruction.

The storyteller was designed to appear quite close to the viewer but far enough to fit the storyteller completely to the sight of the mobile phone. The appearing of the storyteller was done with visual and sound effects that draw attention in the right direction.

PMR setting was simulated in the story that is examined in this study and from which the level of immersion was measured. We placed drawn characters to the spots that the story was telling about at that moment. The problem was how to inform the user that there was content in the surroundings. An arrow was added next to the virtual storyteller to indicate that there was something in that direction to look at.

6 IMMERSION

The concept of immersion has been widely discussed in the research of emerging technologies, games, and storytelling. It has two central notions: quality of technology and psychological phenomenon. The latter also has different theories of what exactly is immersion.

6.1 Quality of Technology

The early research of virtual environments suggests that immersion is an objective, quantifiable characterization of a technology. The measured qualities are how "extensive, surrounding, inclusive, vivid and matching" the displays are. The more there are sensors, the more extensive the system is. The quality of surrounding means that the user can receive virtual information from any direction and can turn towards it. When the whole external physical world is shut off entirely the system is totally inclusive. Resolution and other qualities of the displays, and abundance of the sensory information generate vividness. Tracking the user's body movements and matching the virtual environment to it is also a measurable feature that defines how immersive the technology is. (Slater *et al.* 1996 p. 166)

6.2 Psychological Phenomenon

The psychological approach sees immersion as a subjective experience. Witmer and Singer suggested that immersion is a psychological state reached when technology of virtual environments is used, and virtual environments are experienced. The elements that affect the level of immersion are isolation level from the real world, perception of self-inclusion and -movement, the naturalness of interaction and control. The state of immersion requires a virtual environment that provides a flow of stimuli and experiences, and the user is interacting, included and enveloped by it. (Witmer & Singer 1998, p. 227)

Also, this early approach has been questioned, and many researchers have argued that immersion is a natural human state that is not dependent on technology. It can be gained by reading a book, listening to a story or other engrossing activity. It means to be involved

physically, mentally and emotionally. The game research has recognized immersion as a characteristic of a successful digital game and has studied the phenomena widely. (Georgiou & Kyza 2017, p. 25-26)

"Presence" and "flow" are often interpreted to be the same as immersion, but digital games researchers highlight that they are optimum stages of engagement, and immersion is a sub-optimal process of becoming engaged in the experience (Jennett et al. 2008, p. 646-649). "Comparing presence, flow, and immersion, Jennett et al. (2008) argued that while presence and flow are often considered as optimal "states of mind", immersion can be viewed as a gradated psychological process of engagement that may provoke flow and/or presence. " (Georgiou & Kyza 2017, p.25). In a flow state, people are so absorbed in the activity that everything else is cut off. Immersion is the precursor of flow, and they are overlapping. However, immersion does not necessarily lead to flow, and game experiences can be very immersive without meeting the criteria of flow. Presence has various definitions, many of them are quite extensive and therefore are partly synonymous with immersion. The notion of Cognitive Absorption (CA) is also close to immersion. It is a state of deep involvement with the software but is more about the attitude towards technology, when immersion is the experience of playing a game. (Jennett et al. 2008, p. 646-649)

Lack of consensus on the notion of immersion drove Brown and Cairns to study it further. Through the grounded theory methodology they developed a robust concept of immersion based on the interviews of gamers. Immersion had been often used in game reviews, and gaming literature and the gamers recognized it well. They were asked about experiences in different levels of engagement with the game and the research resulted that the gamers use the notion of immersion to describe the degree of involvement with a game. Three levels were outlined:

1. Engagement, the first stage of immersion, that occurs before others and is the lowest level of involvement. Time, effort and attention are invested in entering the game.
2. Engrossment, the second stage of immersion, that is entered when the gamers emotions are affected by the game. It becomes the most important thing to the gamer, and everything else is irrelevant.

3. Total immersion, feeling of being in the game. The game is all that matters, and all of the gamer's attention is in it.

Brown and Cairns also identified barriers like the gamer's interests, the game quality and distraction from the environment that keep from entering the immersion levels. (Brown & Cairns 2004, p. 1297-1300) Total immersion was found to be a fleeting experience, and not something that would last when Engagement and Engrossment were found to be more long-lasting experiences (Brown & Cairns 2004, p. 1299-1300).

Brown and Cairns' definition has been very influential, and many researchers have grounded their studies to it. Jennet et al. developed and validated the Immersive Experience Questionnaire (IEQ) that also included aspects of flow, cognitive absorbing and presence to find out if immersion can be measured. The questionnaire was tested in three different experiments, and it was found that immersion can be measured subjectively and objectively. (Jennett et al. 2008, p. 641-661)

Cheng et al. also based their Game Immersion Questionnaire (GIQ) to the Brown and Cairns' theory. Their purpose was to develop an instrument that could be used for measuring immersion in game-based virtual worlds. They suggested that there is multidimensionality in each of the immersion levels. They broke down the Brown and Cairns' model to different constructs:

1. Engagement
    a. attraction
    b. time investment
    c. usability
2. Engrossment
    a. emotional attachment
    b. decreased perception of the surrounding environment
3. Total immersion
    a. presence
    b. empathy

(Cheng et al. 2015)

7 METHOD

Georgiou and Kyza thought that the Cheg et al.'s Game Immersion Questionnaire (GIQ) was "the most well-structured and reliable instrument of all identified published questionnaires on immersion" and that the work of Cheng et al. "not only provided a validated instrument for measuring immersion in the context of game-based virtual worlds but, at the same time, provided a sound theoretical explanation of their model of immersion". (Georgiou & Kyza 2017, p. 27)

Georgiou and Kyza based their development and validation of the Augmented Reality Immersion (ARI) Questionnaire to the work of Cheng et al. They modified the model to meet better the qualities of location-aware AR setting from game-based virtual worlds. (Georgiou & Kyza 2017, p. 27)

Table 1. The multi-level construct of immersion in the ARI questionnaire (Georgiou & Kyza, p. 28)

Immersion levels	Scales	Measures
Engagement	Interest	Interest for the activity
	Time investment	Time investment in the activity
	Usability	Perceptions about the app's usability
Engrossment	Emotional attachment	Emotional attachment to the activity
	Focus of attention	Focus during the activity
Total Immersion	Presence	Sense of feeling surrounded by a blended, yet realistic physical/virtual environment
	Flow	Full absorption in the activity

In the validation process, Georgiou and Kyza tested both the Brown and Cairns global three-level model and the Cheng et al.'s higher order hierarchical multi-leveled model (Table 1.) to be sure that their hypothesis would hold. In the validation process, the reliability of the proposed hierarchical structure was confirmed. (Georgiou & Kyza 2017, p. 27-32)

Georgiou & Kyza resulted in the 21 items questionnaire that measures each level and scale of the model. Each level has different factors that they are composed of; "Engagement" is composed of "Interest" and "Usability", "Engrossment" is composed of "Focus of attention" and "Emotional attachment" and "Total Immersion" is composed of "Flow" and "Presence". (Georgiou & Kyza 2017, p. 27-32)

The questionnaire is answered with seven Likert scales where one is "totally disagree" and 7 "totally agree". From Table 2., it can be seen which questions are used to measure immersion on different levels.

Table 2. ARI questionnaire that resulted in the validation process (Georgiou & Kyza 2017, p. 33)

Factors	Items
Engagement	
Interest	A2: I liked the activity because it was novel
	A3: I liked the type of the activity
	A8: I wanted to spend the time to complete the activity successfully
	A9: I wanted to spend time to participate in the activity
Usability	A13: It was easy for me to use the AR application
	A14: I found the AR application confusing*
	A17: The AR application was unnecessarily complex*
	A18: I did not have difficulties in controlling the AR application
Engrossment	
Emotional attachment	B2: I was curious about how the activity would progress
	B3: I was often excited since I felt as being part of the activity
	B4: I often felt suspense by the activity
Focus of attention	B6: If interrupted, I looked forward to returning to the activity
	B9: Everyday thoughts and concerns faded out during the activity
	B10: I was more focused on the activity rather on any external distraction
Total immersion	
Presence	C4: The activity felt so authentic that it made me think that the virtual characters/objects existed for real
	C6: I felt that what I was experiencing was something real, instead of a fictional activity
	C7: I was so involved in the activity, that in some cases I wanted to interact with the virtual characters/ objects directly
	C8: I so was involved, that I felt that my actions could affect the activity
Flow	C9: I didn't have any irrelevant thoughts or external distractions during the activity
	C10: The activity became the unique and only thought occupying my mind
	C11: I lost track of time, as if everything just stopped, and the only thing that I could think about was the activity

In the validation process, the ARI questionnaire was first tested with a location-aware AR learning environment called "Mysterious Absences", and the final questionnaire was tested with a similar learning environment called "Mystery at the Lake". Both of the AR experiences were bond to locations, and the user was asked to investigate the surroundings of the location to find answers to the given questions. (Georgiou & Kyza 2017, p.

28) In the Mystery at the Lake, the high-school students moved around the location with a tablet running the AR application. An interactive map was displayed with an indication of hotspots. At the hotspots, video-based characters gave information and instructions. (Georgiou & Kyza 2018, p. 176)

8 RESEARCH DESIGN

This study uses the ARI questionnaire to measure the feeling of immersion among the viewers of the City Stories pilot. Two open-ended questions were added to gain more qualitative data from the viewers (Reid et al. 2010, p. 56). These questions are not concerning immersion and are aimed to help understand how the concept should be developed further.

The questionnaire was first translated into Finnish as the AR content was also in that language. Different options for the translations were pondered carefully so that the meaning of the questions would correlate to the English questionnaire as well as possible.

The target group of the City Stories is the citizens who are interested in exploring their environment in new digital ways. Anyone who passes by the locations or goes actively to seek for the story stands. The participants for the research were randomly recruited from the street. Most of the AR research has been done with student samples (Suh & Prophet 2018, p. 80). This research aims to use the sample from the real target group.

A story with a strong connection to the location was chosen for the examination. The story of Renaz is located at Hakaniemi, John Stenberg's bank and is about one day when she finally dared to skate down the hill, but then almost crashed to a couple and the skate went over the edge to the canal. That summer Renaz had lost her dad who always encouraged her to be brave and never to give up. So Renaz went to the canal and got her skate back despite the staring by-passers, and skated home with wet clothes. The story contains Renaz telling her story, drawn figures appearing to the places the story is telling about and soundscape that supports the story.

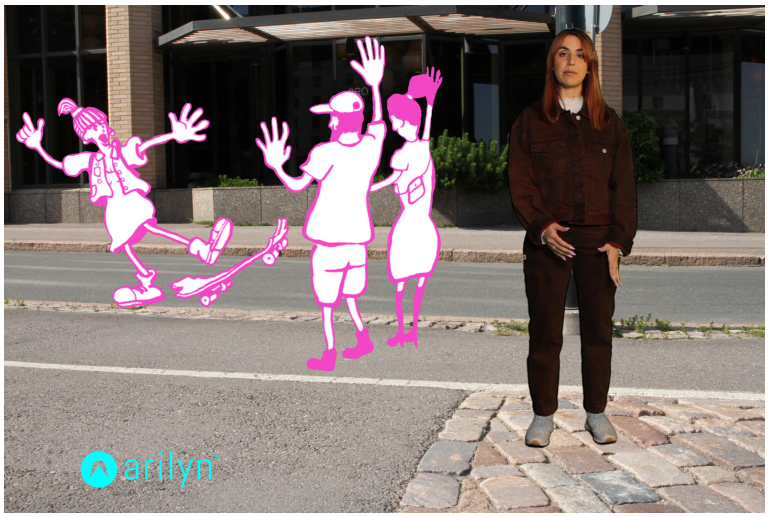


Figure 11. Renaz telling her story with the illustrations in AR

The equipment, smartphone, and Bluetooth headphones were provided for the participants, and also the AR content was set up for them. This study emphasizes the content and the experience and not that much the technology and acceptance of it. It was recognized that for the first timers problems in setting up the AR content to the environment might appear as the technology used was so new. When people start to understand more how markerless AR works and they have more experience, and more tools for setting up the content is developed, it will become more intuitive and less challenging. For this study we wanted people to concentrate on the content as in the future the technical challenges will probably be smaller. After the AR content was placed for them, they watched the story independently, and the researcher stayed at a distance for not to disturb the experience.

After the experience, the participants filled in the ARI questionnaire supplemented with two open-ended questions: “What did you like the most in the experience?” and “What did you like the least in the experience?”. Qualitative data about what kind of thoughts the participants had could be gained with those questions for analyzing how the concept could be developed further. (Reid et al. 2010, p. 56)

The questionnaire was filled in in Google Forms by 11 participants who watched the story in AR. After analyzing those results, it was decided that the same test would also be run to participants who would only listen to the story at the location. Seven participants

listened to the story and filled in the same questionnaire. It was not told to them that it had anything to do with AR. They were just told to listen to the story at the location. The questions that concerned the application were left out as there was not any application that they were using. The story was listened to from a sound file.

The researcher was also able to observe the participants from a distance and notice how the participants behave in both versions.

9 FINDINGS

9.1 Analysis of the ARI Questionnaire Answers

9.1.1 Visual Version

The first eight questions measure the level of "Engagement", four of them points to "Interest" and other four to "Usability". The results of watching the story in AR clearly show that all of the participants wanted to invest their time to participate to the activity and even more strongly they wanted to invest their time to complete the activity. They also clearly liked the activity, and they also liked it because it was novel. In the Usability part, there was more dispersion. Most of the participants did not find the application confusing, but two of them thought it was quite confusing, and two was in the middle ground. The clear majority did not think the application was unnecessarily complicated, but two was again in the middle ground. Most did not have difficulties with the application, but three did have some. The clear majority thought that the application was easy to use.

The "Engrossment" level consists of three questions measuring "Emotional attachment" and three "Focus of attention". All of the participants wanted to know how the activity would progress, but only half of them was often excited since feeling as being part of the story. Three of the participants did not feel any excitement, and two was in the middle ground. Also, fewer clearly felt suspense by the activity, but most did feel some. In "Focus of attention" about half looked forward returning to the activity if there were interruptions and five was in the middle ground. There were not many interruptions, so this probably explains that there were not that much clear answers. Everyday thoughts and concerns were faded out during the activity clearly for about half, and the other half felt that too but not that strongly. Most of the participants were more focused on the activity than to the external distractions, but two did not feel so and were a little more focused on the external distractions.

In "Total Immersion" four questions are about "Presence" and three about "Flow". Most of the participants thought that the activity felt so authentic that it made them think the virtual characters existed for real. However, three of the participants did not feel so. Most

also felt that what they experienced was something real, not fictional. Nobody gave the highest rating to "I was so involved in the activity, that in some cases I wanted to interact with the virtual characters/objects directly.", but the majority felt so to some extent. Two did not agree, and two was in the middle. The values for being so involved that they felt they could affect the activity were very evenly dispersed, and no one gave the highest rate.

Questions focused on "Flow" showed that the majority did not have any irrelevant thoughts or external distractions during the activity, but three of the participants did to some extent. Only one participant gave the highest rate, but five gave the second highest rate for the activity becoming the unique and only thought to occupy their mind. The last question got high dispersion. Two lost track of time entirely, and the activity was the only thing they could think about. Two gave the second highest and two the third highest rate. One was in the middle, and four disagreed to some extent. Nobody gave the lowest rate.

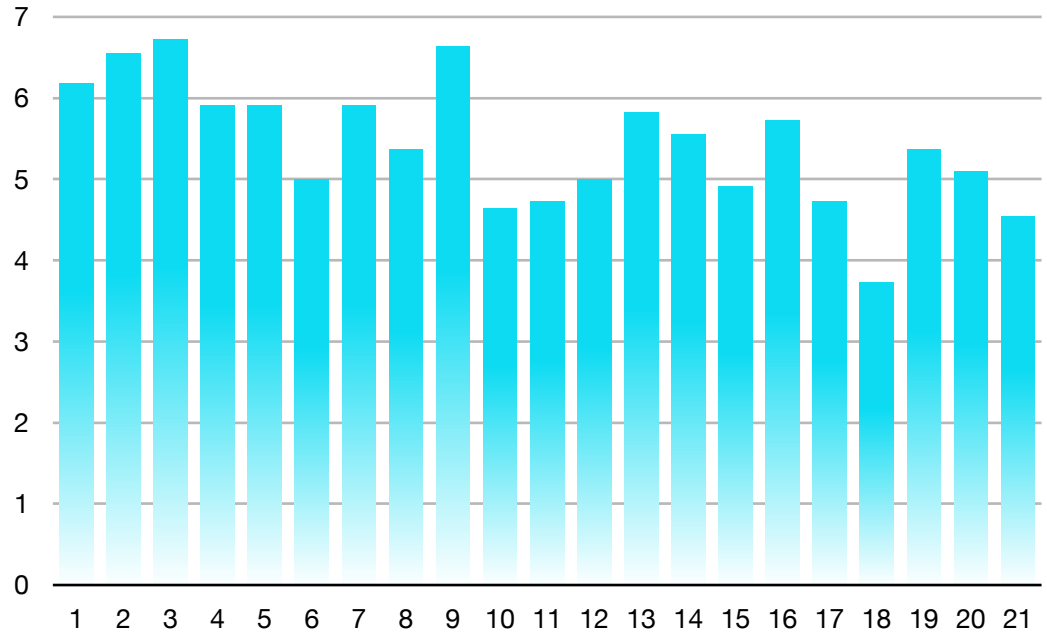


Figure 12. Averages of the answers to the ARI questionnaire for the City Stories AR experience with visual elements

The average values of the answers (Figure 12.) show that the values are in general descendent towards the total immersion level. For the graph the values of usability questions (6 and 7) have been turned over to be comparable with the other values as the setting of the questions was reversed.

9.1.2 Audio Version

In the answers of the visual version, two participants were wondering if the AR elements brought anything to the experience and if it would have worked better with audio only. Therefore, it was decided to run the same questionnaire to participants that would only listen to the story at the location. The seven participants were not told that it is augmented reality to make sure that knowing they are using new technology would not impact on the results.

The results were in general similar to the results of the visual version. The graph of averages (Figure 13.) is very similar, and values are decreasing from engagement to engrossment and total immersion.

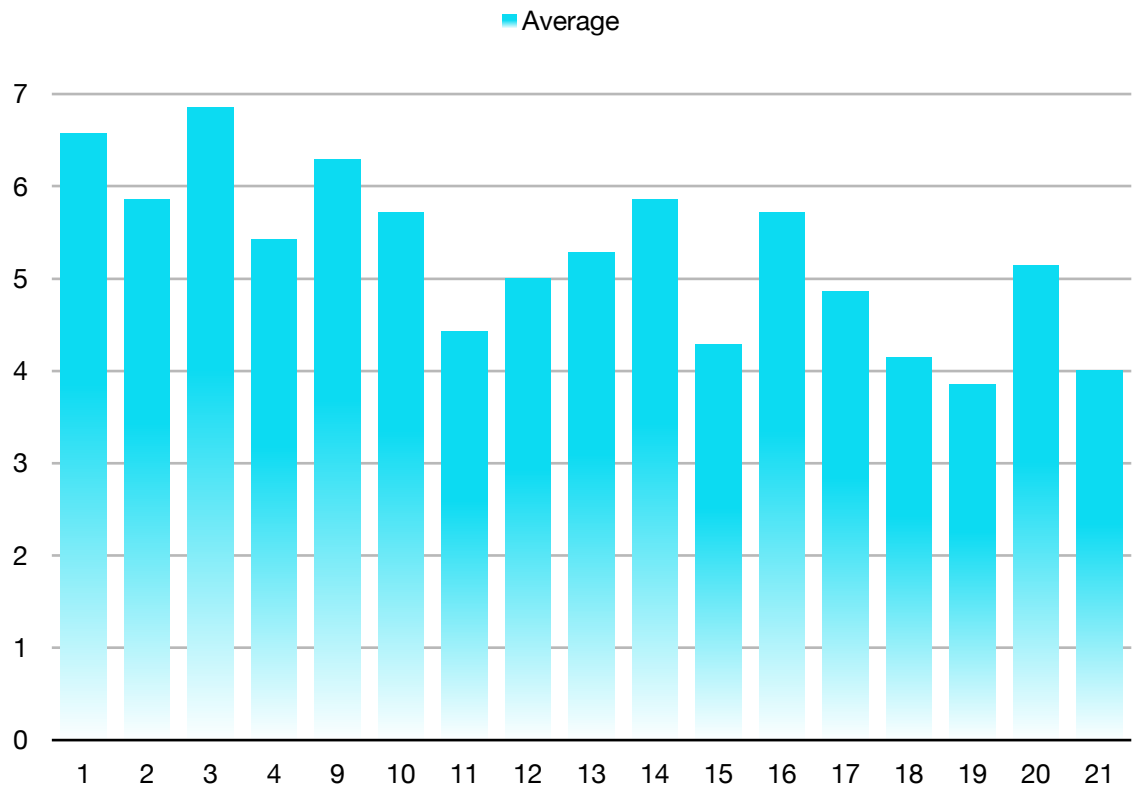


Figure 13. Averages of the answers to the ARI questionnaire for the City Stories AR experience with only audio elements

Some differences are found. To the question 10: "I was often excited since I felt as being part of the activity" six of the seven participants who only listened gave the second highest value when the participants who had the visual experience also gave high ratings but

also lower ratings. The average in the visual experience was 4,6, but in the audio version, it was 5,7. The highest difference in the averages is found from question 19: “I did not have any irrelevant thoughts or external distractions during the activity”. The average of the answers in the visual version was 5,4 when in the sound only version it was 3,9. Four of the eleven participants in the visual version gave the highest rate, and three of them gave the second highest when in the sound only version most of the participants gave the middle value.

9.2 Results of the Open-Ended Questions and Observation

9.2.1 Visual Version

The open-ended questions contained more information about what the participants were thinking of. In the answers to the question “What did you like the most?” seven answers mentioned the character and the story. The characters attitude and the way of telling the story was liked, and also the story itself and the message of it was mentioned. Six of the answers mentioned things that the technology enables, for example: “There was simultaneously something dreamlike, and on the other hand it felt genuine”, “The movement of the real world on the background of the story” and “I liked the intensity and personal remark that the app formed. It felt like we shared the same space with the storyteller.”.

The other open question asked what they liked the least. Five of the participants did not answer anything, and one answered there was not anything she disliked. Four of the six comments concerned the visual elements of the story. It was debated if the visual elements could have been different or needed at all. For example, “Drawn pictures. The idea that you move the device towards the point the story tells about was nice, but I think it would have been better with photos or video, or even without the pictures. The story was so detailed that it would be fine with your own imagination” and “Couple of times it crossed my mind that the story could have worked without the AR elements. Seeing the storyteller live and the drawn characters did not bring so much added value. The location and story were more in the leading role. (Maybe the AR things improved concentration to the story)”.

The location was also mentioned in the answers of what was liked the best: “New idea. I felt that I wanted to go and see how deep the see is on this spot and how high the story-teller needed to climb to get back to the dry land. The story was sympathetic!”. One answer in the least likings was that does the by-passers wonder what he is doing.

The observation of the participants showed that some were so focused on the storyteller that they did not even notice that there were any other objects. Then again one of the participants started to look around the location to find more content. It could be read from most of the participants face that the story woke joy in the part where the storyteller was getting her skate back. Some of them even laughed out loud. Also, in the end, they were emotionally touched.

9.2.2 Audio Version

The participants who only listened were also sitting down on a chair, and all of them closed their eyes for the whole time. It probably made them concentrate more and isolated them from external distraction.

In the open questions, the participants who only listened liked the story most, the story-teller, that they were at the location where the story had happened and the soundscape. Also, the realness of the story was highlighted in three of the answers: “The location of the story made the story real.”, “You could imagine the incident to the location. The story was very real.” and “It really felt real.”.

Three of them did not find anything that they did not like, one mentioned only sound problems at first, but the headphones caused it. One said that one detail of the story was clichéd, one said that soundscape could have been louder, and more feeling of a boiling day should have been highlighted, and one said that the reader should have empathized more.

10 CONCLUSIONS

10.1 Immersion

From the results of measuring immersion, it can be inferred that the immersion level in the story of Renaz was according to the ARI questionnaire high on the level of engagement, pretty high on the level of engrossment and quite high on the level of total immersion. The same conclusion can be made from both versions; the visual version and the audio-only version, as it can be seen from Figures 12. and 13. that show the average values. The ratings drop pretty consistently from level to level, but none of the levels averages is below the middle in both cases. In conclusion, the City Stories concept and similar are worth developing further in the sense of immersion as a multileveled hierarchical construct.

In the answers of open-ended questions, the meaning of the location was highlighted in both versions. It would have been interesting to run the same questionnaire to participants who would watch the story from a regular video at home or listened to it where ever to find out if the location was the main factor to the feeling of immersion, or is the story, how it is told and the storyteller, the key to the immersion. This extension did not fit to the scope of this thesis, but it would have provided information about how important the location is in terms of the feeling of immersion that the ARI questionnaire tries to measure. If the results were similar to the ones in this research, it would mean that the story combined with the location is not causing the immersion.

The most interesting finding when comparing the results of the two groups was that the ones who had the visual version had very little irrelevant thoughts or external distractions when in the audio-only version they had clearly more. Even the audio-only versions participants closed their eyes to concentrate more and to block visual stimulus.

10.2 Conclusions Based on the Qualitative Data

Taking into account the answers of the open questions it can be put together that the concept of the City Stories and other similar AR concepts are worth creating and

developing further also in other sense than immersion. It was encouraging that the answers of both versions, with visual elements and sound only, were so positive.

The fact that the user is at the location where the story had happened seems to matter according to the answers of both settings. The audio-only version of the story could be produced with lower expenses than the one with the visual storyteller. On the other hand, in over half of the answers to what the participants liked most in the visual version were the things that the technology enables visually.

Based on the observation, the participants in these two different settings acted quite differently. With the visual version, the participants were more active and showed their emotions more openly, when in the audio version they blocked the world around them by shutting their eyes. It evokes a question of to what extent can these experiences be compared.

One of the answers was pondering if the visual elements were needed at all but suggested that the visual elements might make the user concentrate more. That with the highest difference in the questionnaire answers, the question of irrelevant thoughts and distractions, might indicate that the visual objects help the user concentrate.

10.3 Suggestions for Further Research

Even that the City Stories pilot was designed the way that it would be as immersive as possible following the guidelines found from previous research, it cannot be inferred that those design decisions lead to high immersion. This connection should be one of the focuses in the future research.

Clear and widely acknowledged definitions of immersion, flow, and presence would clarify the field for further studies. Michailidis et al. have already challenged the prevalent definition of immersion and flow as separate to each other, that also this research is based on. They suggest that further behavioral and neurophysiological evidence is needed to show if these can be separated and measured individually. (Michailidis et al. 2018 p. 4-5)

After clarifying the taxonomy, the questionnaire should be revised based on it. The questionnaire should be tested with various AR experiences to result with an instrument that works for a wide range of executions possibly including any XR experiences, and not limited to location-based experiences as the questionnaire does not contain anything that points to location-specificness.

Also, the solid proof is needed to confirm that the feeling of immersion, flow and/or presence is something worth to aim for. If this is the conclusion, then we get to the point where we can start to map out characteristics and design decisions that would increase this feeling.

More research on the strengths and weaknesses of the visual version and the audio-only version would be needed to say if either of them would be more viable than the other. For example, does the visual objects make the user concentrate more, or would people who have different learning styles (auditory, visual, tactile or kinesthetic) prefer the other. It has been recognized that individual differences in visual information processing have an effect on users' behavior and immersion in mixed reality gameplay. Further studies on cognitive differences are already suggested to gather evidence about added the value of personalized content according to cognitive styles on immersive technologies (Raptis et al. 2018 p. 79, 75, 77).

A good question is also if these two versions can even be compared. The other one is close to radio drama or document and the other to a video, or if PMR technology were in use, it would be close to a VR experience. The participants who watched the story also acted pretty differently than those who only listened to it.

10.4 Conclusions on Developing the City Stories

Even if the two psychological phenomena: immersion and flow, could not be separated or the ARI questionnaire would not be a reliable instrument for measuring immersion, from the answers to the questionnaire it can still be concluded that both versions of the experiences woke positive feelings. The participants liked the activity and wanted to

invest their time to it and see how the activity would evolve and end. If they were interrupted, they wanted to continue. Other thoughts than the activity were faded out. The same conclusion can also be made from the answers of the open-ended questions, with hints to which direction the experience could be developed to.

Whether this is a result of a good story or the way how it is presented, or combination of these two, it fulfills the ultimate purpose of this study to find out if the City Stories and other similar concepts should be developed.

Future research for the City Stories at this point would be focus groups to get more data on to which direction the format should be developed. Technological improvements enable new possibilities and improvements for the experience as a whole. These would be evaluated at the next phase.

10.5 Limitations

The research was done with the target group that the AR experience was pointed at and therefore required recruiting the respondents from the street. The sample size is very small but represents well the group that would use the experience.

The ARI questionnaire was originally validated with a somewhat different location-based AR experience than the City Stories, and in this study, the same questionnaire is used to measure the feeling of immersion also in the audio-only version. No other researches that are done by other than the researchers who validated the questionnaire were found, so the instrument has not been very widely used. However, the instrument is rather new, and researches using it are probably on their way.

The Finnish translation of the questionnaire did not go through a validation process.

As the virtual technologies are relatively new research topics, there is no consensus on the taxonomies and notions or concepts related to them. For example, immersion can be seen as a technological quality or a psychological phenomenon, or it might not even be

defined at all in some researches. It in addition to limited access to literature made the theory base not as robust as it would be in topics on more mature research areas.

Virtual Technologies are at the moment a hot topic, and new research is published frequently. During this research new significant information was found after most of the work was done.

The researcher also works as an Augmented Reality Producer in a company called Arilyn and also produced the City Stories pilot examined in this paper. The researcher has been as objective as possible and studied the topic critically.

REFERENCES

Aukstakalnis, Steve. 2017, *Practical augmented reality: a guide to the technologies, applications, and human factors for AR and VR.* Boston: Addison-Weslay Professional, first edition, 448 pages.

Azuma, Ronald T. 1997, A Survey of Augmented Reality. *Presence: Teleoperators & Virtual Environments,* Vol. 6, No. 4, pp. 355-385.

Billinghurst, Mark; Clark, Adrian & Lee, Gun. 2015, A Survey of Augmented Reality. *Foundations and Trends in Human-Computer Interaction,* Vol. 8, No. 2-3, pp. 73-272.

Brown, Emily & Cairns, Paul. 2004, A Grounded Investigation of Game Immersion. *Extended Abstracts on Human Factors in Computing Systems,* pp. 1294-1300.

Cheng; Meng-Tzu, Shet; H.-C. & Annetta; L.A. 2015, Game immersion experience: its hierarchical structure and impact on game-based science learning, *Journal of Computer Assisted Learning,* Vol. 31, pp. 232-253.

Digi-Capital, 2018, Augmented/Virtual Reality Report and Database Q1 2018, Available from: https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/#.WpRhFWaB2YV Accessed 24.2.2018

Flavián, Carlos; Ibáñez-Sánchez, Sergio & Orús, Carlos. 2018, The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research,* pp. 1-14.

Georgiou, Yiannis & Kyza, Eleni. 2018, Relations between student motivation, immersion and learning outcomes in location-based augmented reality settings. *Computers in Human Behaviour,* Vol. 89, pp. 173-181.

Georgiou, Yiannis & Kyza, Eleni. 2017, The development and validation of the ARI questionnaire: An instrument for measuring immersion in location-based augmented reality settings. *International Journal of Human-Computer Studies,* Vol. 98, pp. 24-37.

Harborth, David. 2017, Augmented Reality in Information Systems Research: A Systematic Literature Review. *Twenty-third Americas Conference on Information Systems. Advances in management information systems research (general track),* pp. 1-10.

IDC, 2017, Worldwide Semiannual Augmented and Virtual Reality Spending Guide, Available from: https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/

Javornik, Ana. 2015, Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behavior. *Journal of Retailing and Consumer Services,* Vol 30, pp. 252-261.

Jennett, Charlene; Cox, Anna; Cairns, Paul; Dhoparee, Samira; Epps, Andrew; Tijs, Tim & Walton, Alison. 2008, Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies,* Vol. 66, No. 9, pp. 641-661.

Kim, Mi Jeong. 2013, A framework for context immersion in mobile augmented reality, *Automation in Construction,* Vol. 33, pp. 79-85.

Mann, Steve. 2002, Mediated reality with implementations for everyday life, *Presence connect,* Available from: http://wearcam.org/presence_connect/

Michailidis, Lazaros; Balaquer_Ballester, Emil & He, Xun. 2018, Flow and Immersion in Video Games: The Aftermath of a Conceptual Challenge. *Frontiers in psychology,* Vol. 9, pp. 1-8. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6134042/

Milgram, Paul & Colquhoun, Herman Jr. 1999, *A Taxonomy of Real and Virtual World Display Integration,* 26 pages.

Milgram, Paul & Kishino, Fumio 1994, A Taxonomy of Mixed Reality Visual Displays. *IEICE TRANSACTIONS on Information and Systems,* Vol. E77-D, No. 12, pp. 1321-1329.

Nincarean, Danakorn; Balai Ali, Mohamad, Abdul Halim, Noor Dayana; Abdul Rahman, Mohd Hishamuddin. 2013, Mobile Augmented Reality: the potential for education, *Procedia – Social and Behavioral Sciences,* Vol. 110, pp. 657-664.

Orlosky, Jason; Kiyokawa, Kiyoshi & Takemura, Hauro. 2017, Virtual and Augmented Reality on the 5G Highway. *Journal of Information Processing*, Vol. 25, pp. 133-141.

Papagiannis, Helen. 2017, *Augmented Human: How Technology Is Shaping the New Reality,* 1st edition., California: O'Reilly Media, Inc.,139 pages.

Ranasinghe, Nimesha; Tolley, David; Nguyen, Thi Ngoc Tram; Yan, Liangkun; Chew, Barry & Do, Ellen Yi-Luen. 2018, Augmented Flavours: Modulation of Flavour Experiences Through Electric Taste Augmentation. *Food Research International,* in the press, 9 pages.

Raptis, George; Fidas, Christos & Avouris, Nikolaos. 2018, Effects of mixed-reality on players' behavior and immersion in a cultural tourism game: A cognitive processing perspective. *International Journal of Human-Computer Studies,* Vol. 114, pp. 69-79.

Reid, Josephina; Hull, Richard; Clayton, Ben; Melamed, Tom & Stenton, Phil. 2010, A research methodology for evaluating location aware experiences. *Personal and Ubiquitous Computing,* Vol. 12, No. 1, pp. 53-60.

Reid, Josphina; Geelhoed, Erik; Hull, Richard; Carter, Kirsten & Clayton, Ben. 2005, Parallel worlds: immersion in location-based experiences. *Conference: Extended Abstracts on Human Factors in Computing Systems,* pp.1733-1736

Scholz, Joachim & Smith, Andrew. 2016, Augmented reality: Designing immersive experiences that maximize consumer engagement. *Business Horizons,* Vol. 59, No. 2, pp. 149-161.

Slater, Mel; Linakis, Vasilis; Ushoh, Martin & Kooper, Rob. 1996, Immersion, Presence, and Performation in Virtual Environments: An Experiment with Tri-Dimensional Chess. *ACM Virtual Reality Software and Technology,* pp. 163-172.

Suh, Ayoung & Prophet, Jane. 2018, The state of immersive technology research: A literature analysis. *Computers in Human Behaviour,* Vol. 86, pp 77-90.

Witmer, Bob & Singer, Michael. 1998, Measuring Presence in Virtual Environments: A Presence Questionnaire. *Presence,* Vol. 7, No. 3, pp. 225-240