AUGMENTING UNDERWATER EXPERIENCE:
DESIGN OF A DIVING MASK

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September 2019

AUGMENTING UNDERWATER EXPERIENCE:

DESIGN OF A DIVING MASK

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF SOCIAL SCIENCES

OF

IZMIR UNIVERSITY OF ECONOMICS

BY

NERMİN SENA ÖZGER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF DESIGN

IN

THE GRADUATE SCHOOL OF SOCIAL SCIENCES

SEPTEMBER 2019

Approval of the Graduate School

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ABSTRACT

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DESIGN OF A DIVING MASK

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Master of Design Studies

Graduate School of Social Science

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This thesis investigates the relationship between diving, underwater as an immersive environment, psychological restoration for enhancing the diving experience from a designerly perspective. In this context, it applies the tools for measuring the impacts of underwater ambiance, built environment and immersion on the diver through psychological restorativeness tools. An underwater ambiance has been created in shallow water. The tests measure the differences between experiencing a built underwater area and a naturally vacant area. The results show that diving into the designed area has a more positive effect on psychological restoration. Based on these results, and regarding the research questions, this study provides an initial design proposal for an augmented reality embedded diving mask design.

ÖZET

SUALTI DENEYİMİNİ ARTTIRMAK:

DALIŞ MASKESİ TASARIMI

Özger, Nermin Sena

Tasarım Çalışmaları Yüksek Lisans Programı

Sosyal Bilimler Enstitüsü

Danışman: Doç. Dr. Güzden Varinlioğlu

Eylül 2019

Bu tez, dalış deneyimi tasarımını geliştirmek için kuşatıcı bir ortam olan sualtı ile psikolojik yenilenme arasındaki ilişkiyi incelemektedir. Bu bağlamda su altı ortamı inşa edilmiş, çevre ve dalışın etkilerini psikolojik yenilenme araçları ile ölçme yöntemleri uygulanmıştır. Bunun için bir yapay sualtı ortamı yaratılmıştır. Testler, inşa edilmiş bu sualtı alanının ve doğal olarak boş bir alanı deneyimlemenin arasındaki farkları ölçer. Sonuçlar, tasarlanan alana dalışın psikolojik yenilenme üzerinde daha olumlu bir etkisinin olduğunu göstermektedir. Elde edilen sonuçlar doğrultusunda ve araştırma sorularına da dayanarak, bu çalışma arttırılmış gerçeklikle birleştirilmiş bir dalış maskesinin tasarımı için ilk tasarım önerisini sunar.

To all the ocean stories that kept my heart warm,

and my curiosity continuous.

ACKNOWLEDGEMENT

I would like to thank my supervisor Assoc. Prof. Dr. Güzden Varinlioğlu for her constant guidance, encouragement and infinite patience through this process. I thank her very much for all the inspiration she gave me. This work was greatly enhanced by her presence. I feel privileged to be an advisee of her.

I also would like to thank Asst. Prof. Dr. Gökhan Mura, for the mind-opening conversations. They helped me to seek for a wider perspective in subjects. His dedication to his job has always inspired me and encouraged me to pursue my goals.

I would like to thank my committee members Assoc. Prof Sema Alaçam and Assoc. Prof. Zeynep Arda. Especially, for being understanding, and a great role model for a mind searching for more.

I would like to express my deepest appreciation to my Visual Communication Design family, for all the support and tolerance but mostly for becoming a family for me. I would like to thank Ali Matay and Ali Kızmaz for their support during the semester. Their contribution is definitely unforgettable. Without Asst. Prof. Burak Erdeniz, this work would be missing the core piece of the study. I cannot thank him enough for his support and endless understanding. I wish him all the best in the world.

I would like to thank everyone whose path crossed mine during this work; Diving instructors Cengiz Arslan, Erkan Ayvazoğlu, Burak Bambul whose support during the preparation and implementation is highly appreciated. For providing underwater photography and help, I thank sincerely Çağrı Güven, Ali Ege Çelebi, Volkan Cingöz.

My sincere thanks for Taner Yılmaz and Ertan Saruhan and Asst. Prof. Can Özcan for introducing us goes without saying for their donation to prepare an underwater test area.

Zahit Yüksel and Barış Özbaykal, my dearest biker gurus, I want to thank them for all of the times that they‘ve been with me. Zahit Yüksel is a great photographer, a moment-capturer who captured not only the beautiful moments of the set-up process in Karaburun but also never let the dynamism fade away when he is around. Barış Özbaykal is one of my good friends whom I have great confidence in his prevision.

Sometimes life brings you a basket full of friends as a gift to remind you how lucky and valuable you are. I want to thank Selin Yalçın for being a great friend that comes along with that basket. She is full of life, a wild spirit, caring, and supportive figure in my life. Selin deserves all the happiness in the world.

I would like to thank Arda Yılmaz, for saving a spot for me to study and helping me during my darkest hours. I am very thankful Funda Yeşilyurt, and Friday Longwe for reading what I tried to write down even when I couldn’t read. I cannot express my gratitude enough.

I would like to thank my family, my mother Zülal Özger, my father İhsan Özger and my brother Selçuk Özger for their unconditional support in my life even when times get rough. I would like to thank Gönül Gümüş. Her support and existence in my life cannot be described in few words. I know that I am just lucky to have such an upfront, encouraged and reasonable, loving friend. I am thankful that our paths have crossed.

This thesis would have been difficult if I did not have Gözde Damla Turhan in my life. One could only be so lucky to be her friend. I look forward to witnessing all the success she will achieve in her life.

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LIST OF ABBREVIATIONS

AR- Augmented Reality

ART- Attention Restoration Theory

AV- Augmented Virtuality

BCD- Buoyancy Compensator Device

HTI- Human-Technology Interaction

PR- Psychological Restorativeness

PRE- Psychological Restorativeness Environment

PRT- Psychological Restorativeness Test

RE- Real Environment

SCUBA- Self Contained Underwater Breathing Apparatus

SET- Stroop Effect Test

SRPRT- Self Rating Psychological Restorativeness Test

VE- Virtual Environment

VR-Virtual Reality

XR- Mixed Reality

1. Introduction

While discussing the relationship between humanity and experiencing the environment, the elaborations usually refer to the human's relationships with the Earth's surface. Less attention has been given to underwater environments. Therefore, underwater is a relatively underexplored research area at the intersection of immersive experience design and psychology. It is a physically immersive environment with both physical and psychological aspects. Immersion is to the act of completely immersing the user into another world. The world refers to an artificially generated world (Bockholt, 2017). Based on this definition, one's surrounding appears altered entirely in an immersive environment. Today, altered worlds are generated through digital tools, thus, the term "immersiveness" is commonly studied together with digital tools and the experience they offer to its users. The concept of immersion stands close to the digital dimension since the invention of virtual reality helmets in the early '60s (Art of Corner, 2017). The common ground of physical and digital immersiveness focuses on proposing a design system for both virtually and physically immersive underwater experience. The final step for this is the design of the Augmented Reality (AR) diving mask.

This thesis includes an interdisciplinary approach by using psychological experiments through a designerly way of thinking referring to Cross (2001). This study also shows the initial findings of the experiments conducted on divers, for designing AR tools to capture the immersiveness of the underwater environment for more effective learning and awareness (Bruno et al., 2019). The aim is to enhance the immersiveness and psychological restorativeness by the integration of AR tools without harming the natural environment. Prior to proceeding further, problem definition has been discussed in the first chapter. The thesis discusses the research questions around the three main topics including diving, psychology, and technology.

Based on the growing interest in exploring extreme environments, underwater has become a popular field for recreational diving activities. Also, it is also known to provide psychological restoration as an immersive experience that stimulates the senses. By being immersive, diving is also associated with digital technologies such as virtual applications (Davies, 1998). The position of design and digital technologies such as AR within the relationship of diving and psychological restoration is questioned in this thesis. By doing so, the study proposes a design system for an augmented diving experience.

The term psychological restoration, borrowed from psychology, is the recovery of depleted resources which can be either a combination of the phenomena: psychological, physiological. Psychological phenomenon includes attention and emotions. Physiological sources can show signs of stress (Hartig, 2011). The restoration can be done by interacting with a restorative environment to change negative space to positive space. The underwater ambiance was used for the psychological restorativeness in this study. According to Kaplan's attention restoration theory (ART), psychological restoration requires a dramatic change in one's physical environment (Kaplan et al., 1989). On the other hand, Hartig et al. (1997) also discuss that this change can be virtual since stimulation of senses also has the prospect of coming from virtual experiences (Erdeniz et al., 2016). Diving as an immersive experience also provides the required spatial change for the divers. How their psychology is affected by the experience is measured in this study.

Underwater AR technology merges physical and digital immersion into one for the enhanced diving experience. Technological aspects of this combination are reviewed in this study. AR systems create an augmented ambiance experience instead of replacing the real environment. How system design starts and works are also reviewed within the scope of this thesis.

1.1. Scope

Diving is a profound physical activity that provides both physically and mentally an immersive user experience, yet potentially questioned if it contributes to the improvement of psychological restorativeness (Dimmock, 2008). In terms of physical impacts, it can take place in natural reefs, as well as artificial environments created by deploying ships, planes, and other large scale structures. By large scale structures, the underwater formations for going in and around, moving freely in between the components, such as underwater museums, are referred. These wrecks become tourist attractions, however, artificial reefs are likely to damage the sensitive ecosystems as seen especially in the Mediterranean and the Red Sea when inappropriate procedures on deploying metal wrecks are applied (Fabi et al., 2015).

It has been a curiosity for the thesis to dive into what are the earnings of diving as an immersive experience for the divers, especially for novice divers, in terms of the features of the environment and the impact of the ambiance. It has also been questioned what novice divers feel when they dive underwater based on the features of the environment, and how the diving equipment can enhance the quality of diving while triggering the learning activity without harming the underwater ecology. Prior to going into detail about understanding the point of view of novice divers, diving should be defined as an experience for various levels of experience. The education level for Self-Contained Underwater Breathing Apparatus (SCUBA) starts from the beginner level to the instructor level (PADI, 2019). Novice divers are the divers who have never been to diving before and thus, they are exceptional from the education levels. Their equipment, underwater adjustments are done by the dive instructor or the dive guide. The novice divers have been chosen for this study since they lack the idea of what should be expected when diving. Hence, their opinion about diving is unique and fresh. The dive guides or instructors are responsible for adjusting the equipment and their buoyancy underwater. All risks are taken by the instructors. Novice divers are not responsible for doing anything underwater except for breathing and enjoying the view.

1.2. Statement of the Thesis

During the course of history, humanity has intuitively explored various environments for living. Underwater habitats are one of the environments where today's technology is promising to extend the ability of humanity to adapt itself to extreme conditions. Previous studies allow users to experience the immersive environment through virtuality tools (Davies, 1995; Jain et al., 2016). However, these attempts happened by recreating a virtual environment in the 3D platform rather than using the actual environment itself. Thus, although there are existing studies, the ambiance of underwater experience design and its effects on users are still subject to being explored through alternative methods because of the amount of complexity involved in the underwater environments.

By being both an immersive activity by its nature, being underwater and losing the sense of gravity that we are used to having on the earth, in addition to being a defenseless field that can be over-exploited by harming the ecosystem if a contribution is not made, it is questioned what design can add to diving experience.

Hence, in contrast to the findings in the literature, the use of the real environment by enhancing its immersiveness by designing 3D artifacts is proposed.

This thesis gathers results from a comparative experiment that measures the psychological restorativeness and cognitive abilities in relation to underwater ambiance experience design. The experiment reveals findings on the psychological impacts on the divers for researching a product design equipped with digital technology tools. Prior to the findings, the study raises questions to convey information for the divers to experience underwater in a digital augmented way without disturbing the underwater environment through their experience. The structure of the study starts by analyzing diving that takes place as a recreational activity in a physically immersive ambiance. This physical activity is usually coupled with the enjoyment of learning and experiencing the underwater world. However, usually, the informative aspects of diving are neglected because of the complexity of the psychological analysis.

Thus, the structure of the study includes tests for psychological restorativeness, which can be enhanced by the diving activity to help learn more effectively. The evaluation process focuses on the underwater immersion and psychological restoration and develops the proposal of an AR diving experience through the help of digital tools. Second, an AR embedded diving mask design proposal to convey information about the environment is planned. Lastly, the initial system design for an AR diving mask is proposed.

1.4. Research Questions

The research questions are:

1. "How physically immersive experience and virtual immersiveness can work together?"

2. "How can we create an underwater ambiance that is enhanced with augmented reality?"

3. "How can we reduce human interference with the underwater environment through design while still encouraging underwater activities such as artificial or natural reef diving?"

4. "How do Augmented Reality devices work underwater?"

The first question is explored by research through the definition of reality and virtuality. What is real and what are virtual environment and their relation to each other, In order to understand the dynamics between reality and virtuality, and the relation of VR, AR, and XR to the reality and virtuality, a continuum was proposed by Milgram and Kishino (1994). According to Flavian et al (2018), this Reality-Virtuality Continuum has been accepted as the starting point to classify the wide variety of realities in terms of Human-Technology Interaction (HTI). The initial classification ranges from real to virtual environments at the extremes of the continuum. To define a position for the environment that is experienced, the terms Real Environment (RE) and Virtual Environment (VE) should be defined. Real Environments (RE) signifies the reality itself. The RE consists of real objects. This includes direct or indirect views of a real scene. Virtual Environments (VE) are completely computer-generated where objects that do not actually exist are displayed on a device and users interact in real-time through an interface.

When the interaction between the user and device that provides virtuality of the experience is studied within the scope of HTI, the continuum lacks the detailed positioning of the environment as it is a one-dimensional classification tool. Thus for a more accurate approach on RE and VE, the EPI Cube was proposed by Flavian et al. (2018). Instead of having a one-dimensional continuum, reality and virtuality are classified according to three terms: technological embodiment, behavioral activity, and perceptual presence in a cubic classification tool. Based on this initial research, the proposal of a mixed reality experience includes merging the immersiveness of the underwater ambiance with digital tools. In other words, to augment the underwater experience, AR tools and its system are brought together.

The second question is a literature review on AR tools. The focus is on underwater AR experiences. The types of tools based on their features are also reviewed. These features are related to EPICube and technology. The research showed that the most common types of AR tools for underwater experience are handheld, or attached to the body examples. The third question is answered after research on underwater parks, archaeoparks, and museums. It is seen that users feel more comfortable in built environments where human interaction tends to go in and around, moving freely in between the components of underwater formations. Furthermore, museum-like experiences encourage learning more. These findings encourage the study to propose an ambiance design. However; in order to minimize the physical interference, digital tools should be used both as information boards, and the structures of the built environment. The built environment is envisioned to provide the museum-like experience (Bruno et al., 2019).

The fourth question has revealed that the design idea of an underwater AR mask and the environment has several aspects such as technological possibilities and constraints. In order to find the optimized solutions, in addition to the possibilities and constraints of AR, the challenges of the underwater should be taken into consideration. The challenges can be evaluated as underwater light refraction, visibility, current, the water temperature that also affects vision. For instance, GPS is challenged underwater because of the density of the water, and this constraint requires an alternative solution for the positioning of the real and virtual artifacts for divers to wander around.

1.5. Methodology

The structure of the study is shaped around the comparative experiment and its analysis between the results of experiencing a naturally vacant and a built area. First, the underwater environment was used as in situ. It is vacant and far away from the artifacts placed far from this dive site intentionally. This part is the control area of the experiment. For the test area, a small-scale underwater archeopark was built. The tests were conducted with 30 novice divers who have never been to dive before. Since the group was formed by novice divers, the experiment was conducted in shallow waters around five meters of depth. The decision about which group will dive where was made randomly by the instructors who took the divers underwater. The experiment had two sets: One set is for the control group, the second set is for the experiment group. Each set had the same process starting with pre-dive tests that measure cognitive abilities, underwater experience then post-dive tests that measures psychological restoration and cognitive abilities.

To evaluate, the thesis asked, “How can we use the user’s opinion to turn into data and improve the underwater experience?” The question investigates translating qualitative data into quantitative data. In order to answer the question, the methodology used two types of psychological restoration tests. The first type of test focused on the changes in cognitive abilities. It is called the Stroop Effect Test (SET). It measures how the cognitive abilities of divers improved after the dive. These cognitive abilities include reading correctly, differentiating colors from the text. The number of errors for each participant was recorded for pre and post-dive comparisons. The second type of test is a self-rating psychological restorativeness test (SRPRT). The SRPRTs are based on two scales that focus on the psychological, physiological, emotional and physical reactions of one's in an environment. Divers who took the test answered questions about what they felt during their first time underwater experience. The SRPRTs of the experiment was adopted from psychology and adapted for measuring the psychological impacts of design on the users (McDowell, 2006). Results were compared to evaluate the differences between the two groups.

The experiment explores two types of main data. First, it investigates the changes in pre and post-dive cognitive abilities. Cognitive abilities refer to participants' learning abilities. Second, it evaluates the physical, psychological, emotional and physical reactions of the subjects towards the diving experience. The cognitive abilities are evaluated through the Stroop Effect test (SET). This test was applied before and after the try dive. The participants who took this test also completed SRPRTs after the dive. This part of the experiment collected data on the four types of reactions of the subjects.

The methodology for designing the AR embedded diving mask develops a multi-tasking study method. The parts of the design are the product and system design. At the end of the design process, the user's outcomes from experiencing the design are measured. Thus, the design also includes psychological tests. The product design focuses on ergonomics, optical issues. This part of the design answers questions such as what the product looks like, what type of device is designed for navigating underwater with ease. The system design part focuses on solving the technical aspects of an underwater diving system. How the artifacts will work as markers underwater, how visibility, illumination affect the reading process. The visual is the common concern of product and system design. The envisioned view is an artificial museum. Thus, once the related research is done, the artifacts will be prepared as 3D objects and the real artifacts will be made of appropriate materials.

2. Underwater and Virtual Immersion for Psychological Restoration

This chapter presents a literature review on three research fields; the underwater immersion, virtual immersion and psychological tests for augmenting the underwater experience design. The main topics are brought together from their disciplines that are diving, digital technologies, and psychology.

Underwater immersion can be experienced in various ways such as self-contained underwater breathing apparatus (SCUBA), free diving, and immersion through underwater vessels (Figure 1). SCUBA is a type of underwater diving where the diver is independent of the surface (U.S. Navy, 2018). Freediving relies on the ability of one's breath-holding. Immersion through vessels, provide a sight of underwater ambiance while navigating inside the water. SCUBA, as underwater immersion, is also a restorative and recreational activity. It provides physical immersion for the divers by the change of environment of what humans experience on the surface where the air covers one. The underwater covers divers with the water along with increasing pressure.

Figure 1-Three types of underwater immersion

The virtual immersion is to interpret, perceive, and interact with one's immediate surroundings through digital tools. Although the physical surroundings remain the same, meaning the physical features of the environment do not change, digital immersion outcomes, as part of the experience, resemble the SCUBA mainly in terms of psychology. Additionally, this literature presents the technological factors, human dimension and behavioral factors of digital immersion. Based on these factors, embodiment, presence, and interactivity define the immersion level for an experience. The connection point of SCUBA and virtual immersion lies in the effects of immersiveness. Further in these studies, the psychological impacts of SCUBA and virtual immersion on the user revolve around this common ground.

Psychological tests reveal the impact of an underwater experience. The theory of attention restoration and how immersive experience affects psychological restoration is reviewed. The aim of this review is to be able to explain user studies and its scope. The self-rate questionnaires are specifically revised according to the ART and for that reason; the topic is an essential part of the literature review. The psychological experiences are challenging in terms of transferring the outcomes into quantitative data. For that reason, self-rating tests and their validation process and reliability are reviewed in this part.

This thesis reviews underwater immersion, virtual immersion and psychological restorativeness and the relation between them. Furthermore, it uses the data on psychological impacts to create the basis for the design proposal.

2.1. Underwater Immersion

Underwater, as a relatively less explored area, has intrigued attention for centuries. Starting from the ancient times, the literature reveals the preliminary attempts for underwater experience for reasons such as war, food, sea sponge trade and curiosity (Bachrach, 1998). The initial works to stay underwater for a longer period of time has led to today's technology known as SCUBA. SCUBA is a mode of underwater diving, which is completely independent of surface supply, to breathe underwater (U.S. Navy, 2008). Hereinafter, SCUBA diving is referred to as diving.

In terms of purpose, diving activities divide into two: commercial and recreational diving (Figure 2). The first one is for the professional divers who work for underwater welding, search and rescue, underwater construction, underwater piping, cutting, marine services, and shipyard activities (Smith, 2019). The second one, the recreational diving, is a physical activity that takes place in natural and artificial dive sites such as reefs, shipwrecks, underwater museums and archaeoparks (Figure 3).

Figure 2-Two types of diving in terms of purpose.

Figure 3-Two types of reef diving activities.

The equipment used for SCUBA includes a diving mask for observing the environment, a regulator as breathing apparatus, an air tank as air source, Buoyancy Control Device (BCD) for hovering underwater, diving dress to protect the body from heat loss and fins to navigate. The mask creates an air gap for eyes to be able to see clearly. Otherwise, because of the density of the underwater environment, the eye cannot see as it does on the surface. The regulator is a device that is connected to the air tank and BCD to provide air from the tank for divers to breathe and inflate the BCD when it is necessary. BCD is the device that is both connected to the air tank and the regulator. It helps divers to hover in the middle of the water, and holds the air tank. The wetsuit is used as well as a dry suit, to prevent the diver from excessive heat loss. The suit is required since the density of the water speeds up the heat loss of the body 25 times faster than it is on earth. Fins are also required since after putting on the equipment, the weight of the divers increases dramatically and to navigate underwater, divers need fins to ease navigation underwater. The equipment of the divers has also positive buoyancy which means they tend to float on the surface instead of sinking down. For that reason, a weight belt is used to submerge the divers. Depending on the type of the dive, supportive accessories are used such as torch, dive computer, underwater compass. In terms of the equipment used, commercial diving might use SCUBA equipment as well as other surface-supplied diving equipment, in which case diver’s breathing gas is supplied from the shore or a diving support vessel or indirectly via a diving bell (U.S. Navy, 2008). In this case, the diver is not immersed underwater as there are possible scenarios that the diver can be at the bottom of the water column.

Every year 1.7 million people join the diving community which makes diving a popular activity around the globe (ISO24801-2, 2014; PADI, 2013). In order to become a certified diver, there is a training system. The training system guides the diver from beginner’s level to advance. The upgrade of a divers’ certificate requires experience and skill and for each level of certificate, additional training is required. The training levels of recreational diving can be listed as Novice divers, also known as try divers are inexperienced and uncertified divers. They can only dive with a dive instructor or a dive guide. Their guide adjusts their equipment and buoyancy underwater. They are not responsible for other divers. They are only asked to breathe in/out and enjoy the view. Mostly, they are kept very close to their supervisors throughout the dive. In order not to disturb the divers' view, guides hold the air tank of the novice divers. Their diving depth limit is 5 meters. Open water divers are the beginners that can prepare their SCUBA equipment. However, they cannot dive without the supervision of an instructor or a divemaster. The dive limit for beginners is 18-meter depth. Advanced divers are more experienced than beginners. However, they are not equipped to supervise a novice diver. Their dive limit is 30-meter depth and this is the limit for all levels of divers. Rescue divers are trained to help other divers in case of an emergency and they can participate in search and rescue works as a part of an authorized team. Diving instructors are trained to train divers from beginner level to upper levels.

It should be noted that none of the divers, regardless of their level of experience or education, can dive without supervision. However, as the diver gains more experience and the ability to hover in the water, being able to adjust their buoyancy improves. Thus, their need for physical support decreases. In this thesis, the chosen test group who are the novice divers dive with divemasters or instructor divers. The novice divers depend on the experienced ones. Still, it is worth mentioning that technical divers, experienced divers who can be both commercial and recreational divers are not within the scope of this thesis.

2.1.1. History of Diving

Starting from free-diving as an ancient activity, -as ancient as humanity itself, more than any other sport, it is based on old subconscious reflexes in human beings as for the first nine months of our lives, they exist in an aquatic environment similar to seawater. Famous oceanographer Jack Cousteau said, “From birth, man carries the weight of gravity on his shoulders. He is bolted to earth. But man has only to sink beneath the surface and he is free" (Time Magazine, 1960). This is a definition of the impacts of the immersive experience related to the underwater. Immersiveness provides man freedom from all their weight on land. The positive psychological impacts of diving can also be understood from the current number of certified divers.

Along with the developments in the activity itself, the development of diving equipment to explore underwater can be scaled from a spatial practice to product design throughout history. 332 BC, Alexander the Great ordered a glass barrel to dive into the sea (Ross, 1970). Although this was only a legend, the first tangible examples were revealed in Greece dating back to circa 300 BC These glass barrels are diving bell examples that were brought down under the sea while the pressure was being equalized through pressurizing the air inside. This principle allowed divers to breathe under the surface. In 1828, John Deane and his brother designed an alternative diving system by modifying the dress that was made for firefighters to enter smoke-filled buildings (Bevan, 1996). This dress consists of a copper helmet that would cover a diver's head, attached to a cloth bodysuit to protect from cold water, and weighted shoes to counteract the positive buoyancy created by the air in the suit. The air is supplied through an air pump on the surface. But one of the problems of the system is that the helmet wasn't sealed so it floods when the head is turned at an angle. During the 1830s Augustus Seibe modified the diving dress by sealing the helmet to the suit to prevent flooding away. Due to the lack of technology to compress air into a container, and on-demand regulator as the fundamental equipment, SCUBA could not be developed until 1943, when Cousteau disconnected the demand of air. It is the invention of the first aqualung regulator.

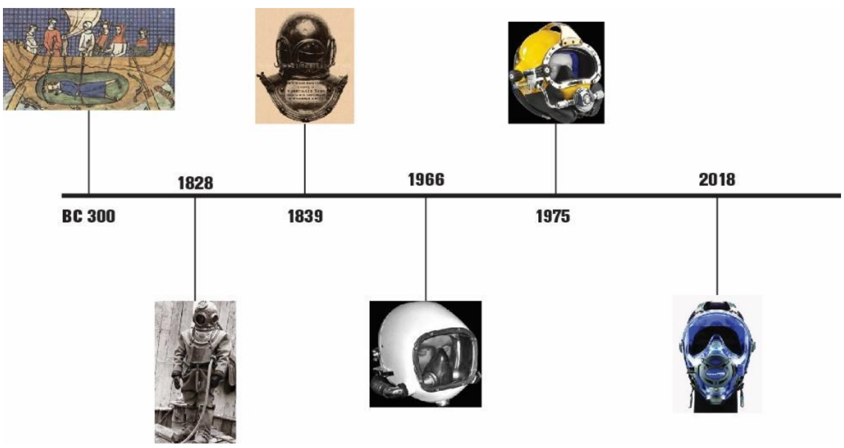


Figure 4-Development of the diving equipment throughout history.

The underwater explorations started with attempts to create a space through glass barrels, diving dress, and SCUBA. Furthermore, since Cousteau's design of Aqua-Lung (Than, 2010), the innovative approach and developments in technology also led to new product designs (Figure 4). The interaction between the user and the product both in material and non-material sense has been evolving. The designs mostly serve a recreational purpose yet some of them are also used by the professionals as well. All of the early attempts led humanity to be present for a long time under the sea while observing marine life without any need to reach the surface.

2.1.2. Underwater Environment

The development of the equipment has led to diversify the types of diving as well as the locations of diving. From commercial to recreational diving types, as the diver's ability to stay underwater increased, it started attracting more people, resulting in an increase in tourism activities. The thrill of exploring attractive dive sites such as natural reefs that are underwater caves and artificial reefs that are shipwrecks started to attract people. The interest in visiting attractive dive sites has helped recreational diving tourism to evolve resulting in building artificial reefs, promoting artificially sunken wrecks. Artificially created dive sites do not only consist of wrecks, but they can also be underwater museums, underwater parks, or archaeoparks. On the other hand, there are also artificial reefs that are built for commercial purposes such as fishery.

Figure 4-Artificial reefs for recreational diving.

Overall, there are 5 types of artificial reefs. They are protection, production, recreational, restoration, and multipurpose (FAOUN, 2015). Within the scope of this thesis, recreational artificial reefs are referred to as artificial reefs. These artificial reefs create dive sites for recreational diving. The main purposes of these artificial reefs are to attract tourists in areas where natural rocky habitats are lacking; to reduce the human pressure on natural and sensitive habitats. The tendency is to deploy shipwrecks for artificial reefs (Figure 5). Although shipwreck diving is popular, the high structural complexity inside the wreck increases the safety risks for a diver. (Ange, 2006). To prevent risks, not only shipwrecks are used but also structures are built to attract and host underwater habitat so the divers can navigate safely while enjoying their dive with inside the habitat.

The studies on recreational diving show diving attract increased numbers of tourists on a global scale. The trend of attractive dive sites tends to be on open water reef diving or wreck diving (Hawkins et al., 1991). The dive sites of wreck diving and reef diving can be naturally formed or artificially created by deploying ships, planes, and other large-scale structures (Lucrezi et al., 2017). When the wrecks form a habitat underwater, they become attraction sites for touristic purposes. The most common reasons to choose artificial reefs are to attract tourists into sites that lack natural rocky habitats; to control the human pressure on natural, and sensitive habitats; (Şensurat et al., 2016). Because the sensitive habitats suffer from the overwhelming interest from the beginner level divers who cannot adjust their buoyancy underwater and harm the habitat by stepping or sitting on the living fragile residents such as corals. Finally, following vessel deployment, artificial reefs provide ecological benefits to the surrounding natural reefs.

There are also downsides to artificial reef implementation. The first one is the required time for the artificial reefs to become appropriate to use. They generally take up to twenty years to reach the growth in popularity of artificial reef wrecks. Second, the faulty decision about the site location for artificial reef deployment can harm the environment and aquatic habitat. The decision on the location is critical to their ecological, physical and economic success. Third, the location chosen for the reef's placement is important because natural reef habitat can provide an important source of transient fishes and juvenile fish to the recruitment of artificial reefs. Finally, and most importantly, the cleanup standards for the sinking process are still not well defined worldwide. (Şensurat et al., 2016; Magson, 2016). There should be environmentally safe, and repeatable and quantifiable methods implemented especially in vulnerable ecosystems such as the Mediterranean. However, artificial reefs are conflicting with the sensitive ecosystems as in the Mediterranean and the Red Sea, when the procedures on deploying metal wrecks are not applied properly (FAOUN, 2015; Şensurat et al., 2016). Moreover, there are not adequate and well-applied regulations so far on creating such recreational diving destinations. At this point, the integration of immersive media tools to design underwater ambiance is advised to enhance the user experience while decreasing the environmental concerns.

Artificial reefs can be placed onto the seabed such as a shipwreck or as a group of an installation. The installations are planned to attract divers to navigate through the site while it transfers a message to the divers. Important notification on artificial reefs is that they are not always placed deliberately. Because of a marine accident or a natural phenomenon, the artifacts may sink and create the artificial reef site. These reefs are called archeoparks because they are considered to be cultural heritage (Varinlioğlu, in press).

The major types of artificial dive sites are underwater museums, underwater parks, and archeoparks when they offer a museum-like experience to the divers (Varinlioglu, 2011). Oftentimes, these terms are used interchangeably. They are evaluated based on whether they have historical value, or simply historical looking artifacts which were created artificially, or just art objects. When the artifacts are found underwater and their location is open to visiting by divers underwater, it is called underwater museums of underwater parks. The examples of underwater museums vary from wrecks to various types of artifacts. For instance, the Baia Underwater Museum in Italy is a sunken city that is submerged in the 8th century (Osci, 2007). Additionally, Florida has the historical shipwreck trail which consists of wrecks from the 1730s to the 1980s. The Art Museum of Underwater (MUSA) in Mexico is actually an artificially created underwater park. MUSA is a pioneer in its field by being the largest artificial designed underwater park for recreational diving (MUSA, 2019).

The third term archeopark is used for thematic underwater parks. They can also be archeological with a historical value or artificially created in order to give divers information through an immersive experience. According to the UNESCO 2001 Convention (UNESCO, 2001), cultural heritage means “all traces of human existence having a cultural, historical or archaeological character which have been partially or totally underwater, periodically or continuously, for at least 100 years”. The cultural heritage includes sites, artifacts, and wrecks, human remains together with their archeological and natural context. As it can be seen, not all archeoparks have historical value; however historical, ancient artifacts underwater are called archaeoparks. The existing examples of applications for recreational diving consist of physical objects whether they are designed to be underwater or decided to be sunken after they claim their life cycle on land. Regardless of their building process, the design and the experience have the attention of divers. That means an underwater environment that is suitable for recreational diving can be natural or artificial. Either type requires a set of tools. This set of tools varies according to the purpose of the dive. The thrilling features of the underwater environment can be observed and experienced with the use of this equipment.

2.1.3. Diving Equipment

Diving can only be done with a combination of tools and equipment (Figure 6). Diving equipment can be examined into three groups; ABC, and SCUBA, and supportive equipment. The first group, ABC includes the mask, snorkel, and fins. They are not only for diving but also other water sports activities such as swimming, and free-diving. The second group, SCUBA is an acronym that signifies the equipment to explore underwater. It consists of four components. They are the regulator, BCD, the air tank, and weight (Boyd, 2016). Additionally, there is supportive equipment to enhance and ease the diving experience for divers such as dive computers, torches, dive booties, underwater cameras.

Figure 5-SCUBA equipment

Diving mask is essential equipment because, if the human eye is in direct contact with water as opposed to air, light entering the eye is refracted by a different angle and the eye is unable to focus the light on the retina. The eye is only able to focus nearly normally when air space is provided in front of the eyes. The shape of the air space in the mask slightly affects the ability to focus (Chen et al., 2000). Corrective lenses can be fitted to the inside surface of the viewport or contact lenses may be worn inside the mask to allow normal vision for people with focusing defects. A snorkel is a device used for breathing air from above the surface when the wearer's head is facing downwards in the water with the mouth and nose submerged. Diving fins are used to be able to navigate underwater. A regulator is a pressure regulator that reduces pressurized breathing gas in the air tank to ambient pressure and to deliver it to the divers. The gas may be air composition or one of a variety of special mixture of breathing gases. A gas pressure regulator has one or more valves in series which reduce pressure from the source and use the downstream pressure as feedback to control the rate of flow and thereby the delivered pressure, lowering the pressure at each stage. There are 3 main parts of a regulator; the first one is the main air source of the diver, alternate air source is for other divers in case of an emergency, and pressure gauge that shows how much air is left in the tank. Buoyancy Compensator (BC) is a piece of diving equipment with an inflatable bladder which is worn by divers to hover underwater neutrally and for positive buoyancy on the surface. The buoyancy is controlled by adjusting the volume of air in the bladder inside BC. The bladder is filled with ambient pressure gas from the diver's primary breathing air cylinder. The air cylinder is used by scuba divers to hold air and other breathing gases at high pressure underwater. The body loses body temperature 25 times faster underwater. The suits that are used for SCUBA have two types. The wetsuits are more suitable for warm waters. Drysuits are used for cold water and ice diving. Apart from the fundamental equipment above, there are also supportive equipment of diving such as dive computer, underwater torches, diving boots for types of fins, and underwater cameras (U.S. Navy, 2008)

Figure 6-Four types of the diving mask;
a- full face, b- double glass, c- single
glass, d- AR masks.

The thesis mainly focuses on the diving mask in terms of the sense of vision for the underwater experience to be further developed. The human eye is incapable of focusing underwater because the water is denser than air, and refraction is greater. In order to have a clear vision, there must be air between the eye and the object. Diving masks provide this air gap so that the eye can focus and see. For that reason, the mask is one of the three fundamental equipment of diving. Stimulation of the sense of vision can be enriched by an innovative mask design.

Currently, there are four types of mask designs (Figure 7). They are full-face, double glass, single glass, and digitally enhanced masks. The full-face mask is used mostly for commercial diving. It has functions such as allowing the diver to see clearly underwater while providing protection for the diver's face from cold and polluted water and from stings such as jellyfish or coral. Finally, it increases breathing security and provides a space for equipment that lets the diver communicate with the surface support team. Double glass masks are common for the divers who have eyesight problems and have to use prescribed glasses. The glass can be converted into prescribed glasses. The single glass masks are the regular mask that is commonly used. In terms of function, single and double glass masks are similar to each other. Digitally enhanced masks for recreational diving remain conceptual. Commercial divers use AR diving masks to rehearse their tasks before their actual dive (Morales et al., 2009).

AR diving masks are becoming more popular as the glass is also used as a display for showing informative graphics for the divers. These graphics may show to the air left in the tank, navigational information, in addition to information about the dive site (Bellarbi et al., 2013)

All the equipment listed in this thesis allows the human body to hover in the middle of the water for the sense of full immersion. On the other hand, they have not been challenged enough in terms of the integration of digital technologies for the purpose of enhancing the underwater experience. The design of them as a product and a way of being submerged into the immersive environment has to change to stimulate the emotional, psychological and physiological reactions of the divers. This thesis focuses on the visual aspects to alter the context of the environment. For that reason, the mask is the focal point of the design proposal to provide an augmented underwater visual experience.

2.1.4. Diving as an Immersive Experience

According to the Cambridge Dictionary, the word "immersive" is noting or relating to digital technology or images that actively engage one's senses and may create an altered mental state. In other words, the immersive experience can provide information or stimulation for a number of senses, which causes a change in the perception of surroundings. The surroundings of one can be altered in two ways. One is to change the perception virtually by the use of digital technologies such as VR and AR (Milgram et al., 1994). Second is to interfere with the physical surroundings such as diving. Diving provides changes in terms of atmospheric and hydrostatic pressure, temperature, sound. The changes affect the perception of the surroundings and offer an immersiveness experience.

Referring to the aspects of immersiveness, diving is a physically immersive experience that stimulates the senses by the changes in physiological features of diving underwater. In order to evaluate the features and the perception the immersiveness, first, the physical features of underwater and physiological features of humans should be mentioned. What changes for the diver physiologically is immersed underwater can be listed as the changes in blood circulation, fluid balance, and work of breathing.

The speed of the sound on the surface under normal conditions is 340 m/min. The sound would reach the ears separately. Thus the brain can recognize where the sound is coming from. Underwater the sound travel 4.5 faster. For that reason, it is hard to detect where the sound is coming from. It sounds as if the sound is coming from every direction. The only feature that can be detected is whether the sound is close or far based on the volume.

The water temperature may change rapidly. The changes can be detected within very close points underwater and the difference can go up to 10-15 C, additionally, water conducts heat 25 times faster than air. Unless there is an insulator such as a wetsuit, the diver would be in danger of serious illnesses such as hypothermia.

Light is also affected by the change of environment as well as the change in depth. The density of light refracts with a greater angle than it does in air. For that reason, eyes cannot focus properly. With the use of a mask, a clear vision is provided. However, because of the refraction, objects appear 33% times bigger and 25% times closer. In addition to the visual challenges, colors start fading at 5 m with Red color disappearing and it is followed by orange fading at 8 m, yellow at 11 m, green at 19 m. After 23 m, blue is also gone and all of the colors look shadows of grey unless an underwater torch is used.

The physical and virtual changes in one's surroundings stimulate the senses and evoke the perception of immersion. This is where the physical and virtual immersiveness can be gathered under the immersiveness. Today, technology has evolved providing opportunities for a virtually immersive experience to the user. In that sense, what both virtual and underwater experiences have in common is that these experiences have similar outcomes in terms of implementation. For example, advances in the field of mobile devices allow us to use them for applications to see in real-time what cannot be seen in the real world, and through the screens of smartphones or tablets, it is possible to visualize in three-dimensions how buildings looked hundreds or thousands of years ago (Vlahakis et al., 2002, Panou et al., 2018, Edney et al., 2015), and underwater, users can see a wreck or a museum even if they do not belong underwater. In conclusion, both experiences change the perception of surroundings; display an alternative environment that one is not used to being surrounded with.

2.2. Virtual Immersiveness

Immersion is described mostly related to technology. It describes the extensions of what technological displays are capable of providing to the user. The outcome of immersive experience is an inclusive, extensive, surrounding, and vivid interpretation or augmentation of reality. The initial literature refers to the displays of computers; however, today the technology offers displays such as AR contact lenses. For that reason, interpretation and augmentation are both used for the description (Durlach et al., 2000). The connection between the surroundings and the immersiveness is what users perceive. The perception of the environment is a phenomenon that is achieved by stimulating one's senses and evoking their emotions.

Stimulation of the senses refers to evoking emotions by intense changes in one's conditions both physically and virtually. By these changes, as the perception evolves to an alternative state of mind, the user's emotional state also changes (Lukka, 2014). The literature has been reviewed starting with the classification of the tools examining the relationship between reality and virtuality beginning with the fundamentals such as reality-virtuality continuum and EPI cube.

2.2.1. Reality-Virtuality Continuum

In the early 1990s, the virtual experiences were limited to the use of displays rather than an intense interaction between the user and the equipment. The relation between reality and virtuality depends on how real or virtual an experience was. The classification of the dynamics between reality and virtuality, and the relation of VR and AR to the reality and virtuality, a continuum was proposed in 1994. The Reality-Virtuality Continuum designed by Milgram et al (1994), has been fundamental to classify the wide variety of realities (Figure 8). This classification ranges from real to virtual environments at the extremes of the continuum. Real Environments (RE) signifies the reality itself. This includes direct or indirect views of a real scene. Virtual Environments (VE) are computer-generated where objects that do not actually exist. These objects are displayed on a device and users interact in real-time through an interface.

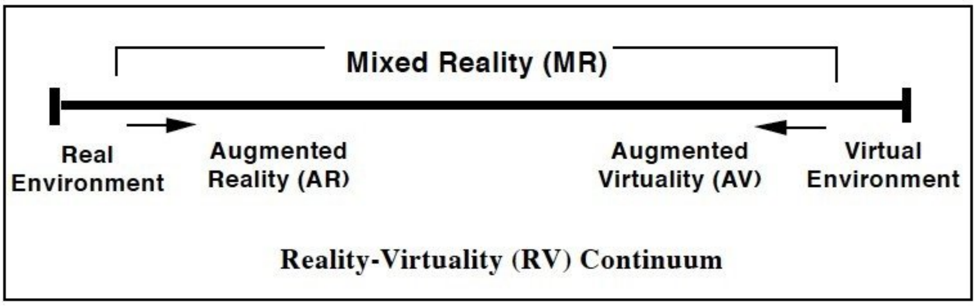


Figure 7-Reality Virtuality Continuum.

As technology develops tools that interact with users through more than displays such as computers, the continuum requires additions such to describe how virtual or real an experience refers to the three factors. The factors are technological, human dimension, and behavioral factors. Thus, the addition has to present three further dimensions related to Human-Technology Interaction (HTI). According to these factors to classify all the existing technologies are discussed as embodiment, presence, interactivity in the same order. In his theory of human-technology mediation, Ihde (2011) regarded embodiment as situations in which technological devices mediate the users' experience and concluded that technology is an extension of the human body that helps to interpret, perceive and interact with one's immediate surroundings. A combination of the three aspects of HTI into one continuum to read at a glance is challenging for a reader. Thus, a wide variety of existing technologies is placed on and inside the different faces of the cube, in accordance with their positions relative to the corresponding factors. As a result, this cube is called an embodiment-presence-interaction cube (EPI cube) (Flavian et al., 2018).

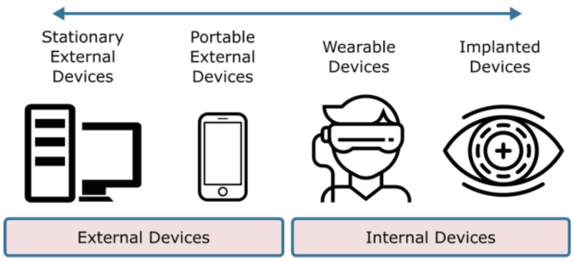


Figure 8-Embodiment Continuum of EPICube.

Presence is defined as the user's sensation of being transported to a distinct environment outside one's body (Biocca, 1996). Presence can be triggered easily. It happens by reading a book, listening to a song, watching a movie or playing a video game (Coelho et al., 2009). Even though the medium is relevant in inducing presence, the user's psychological interpretation of what is in front of him/her is key to developing a sense of presence (Baños et al., 2004). Presence is also related to transportation in the sense that consciousness of the users is being transported to an alternative place, completely different from where they actually are, and they feel and act as if they were in a real place (Figure 10) (Biocca, 1996, Sanchez-Vives et al., 2005).

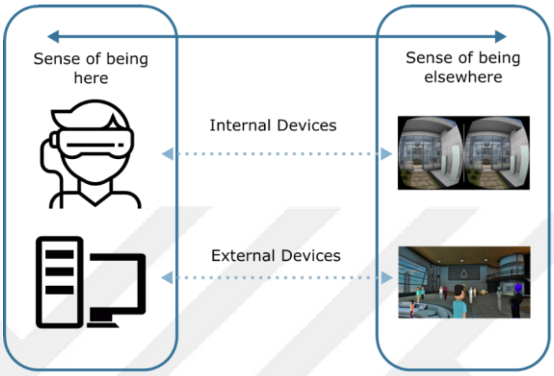


Figure 9-Sense of Presence Continuum of EPICube.

Interactivity is defined as the users' capacity to modify and receive feedback to their actions in the reality where the experience takes place (Carrozzino et al., 2010; Muhanna, 2015). There is a continuum ranging from low behavioral interactivity such as navigation control to high interactivity such as the capacity to control and modify the environment (Figure 11) (Bowman et al., 1999; Muhanna, 2015).

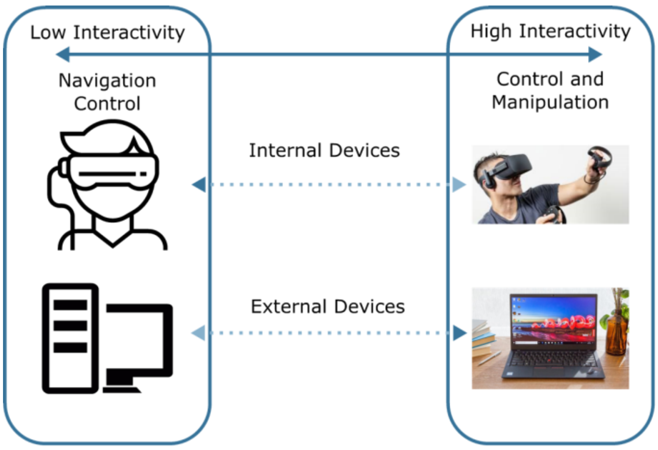
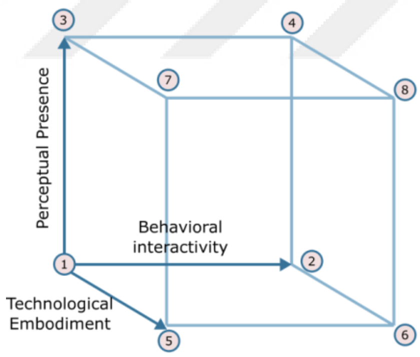


Figure 10-Interactivity Continuum of EPICube.

The EPI Cube provides a 3D understanding for exploring the extremes of RE and VE. Vertices of the EPI Cube represent examples of technologies in their situation (Figure 12). External devices are in vertices 1 to 4. In vertex 1, computer 1.0 websites and traditional media are examples, where users feel themselves in their actual location and they can only control the content display. They are not allowed to modify it. Vertex 2 resembles vertex 1, only, users can manipulate the environment. Vertex 3 shows external devices of a low degree of behavioral interactivity. They can control only displayed content and through which users may feel they are in a place other than where they actually are. This factor triggers high levels of presence. Video Wall or 3D cinema can be considered as radical examples of these technologies. Finally, vertex 4 offers high levels of behavioral interactivity, where users can also manipulate the content. Examples of this are video games and virtual worlds and platforms such as Second Life, where users can freely manipulate the virtual environment and the content is engaging enough to make them forget their actual, immediate surroundings (Takatalo et al., 2008)



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
7	360-degree video HMD (fixed position)
8	Virtual reality HMD with haptic devices

Figure 11-Representation of the EPICube.

2.2.2. Virtual Reality (VR)

Virtual reality (VR) is simply defined as an experience generator (Bailenson et al., 2008). Since it is a digital medium, anything that one can imagine seeing or hearing can be easily generated in a VR environment. Typically, VR uses combinations of computer hardware and software to represent different aspects of the physical world to an individual in real-time. A key design goal for virtual reality is to include a feeling of psychologically presence, or the illusion of being immersed in the environment, as opposed to viewing the environment from an outside perspective (Claman, 2015).

VR allows individuals to experience distant or inaccessible places which would be expensive or impossible for them in the real world. One's perception of a place is enhanced by their senses. VR is mainly a visual recreation that can only stimulate visual sense. Additionally, an advanced computational requirement for a virtual rendering of a place limits the lifelike recreation. Therefore, VR's user experience is limited due to the limited stimulation of senses and lifelike visualization of the environment.

VR allows the user to move around in a VE as they would in RE. By doing so, visual senses are used as well as bodily movements. The VR can sense the users' movements, changes in physical conditions. What will be used to wander around depends on the system designed. While displays are used for visual senses, there are also hand-held tools to help the user navigate inside the VE. The hand-held tools are used for users to interact with their surroundings. They are programmed to detect the changes in the current state and respond to the user's interventions. In general, the VR tools are categorized into two groups. The first group is standalone devices such as mobile mounts and all-in-one devices. Second is Tethered VR which is PC-based, and PlayStation VR (Blueocean, 2019).

In conclusion, VR is only limited to a computer-generated artifact where the user and the tools are the only real component of the environment.

2.2.3. Augmented Reality (AR)

As Flavian et al. mentioned, the reality-virtuality continuum by Kishino & Milgram moves towards the right side of the continuum from reality to virtuality. Hence, a mixed reality (XR) can be conceived as the different points of the continuum at which real and virtual objects are merged. Thus, Augmented Reality (AR) and Augmented Virtuality (AV) are parts of Mixed Reality (XR). However, amongst the two, AR has gained more popularity with the release of video games (Pokemon Go, 2018), when they revealed the potential for memorable experiences for the user (Jung at al., 2015). On the other hand, AV stays less explored with its characteristics of superimposing real-world elements on virtual ones (Collins at al., 2017).

The AR, provided by (Azuma et al., 1999), is a system that combines real and virtual content, provides a real-time interactive environment, and registers in 3D. Additionally, (Azuma et al., 1999) extends the concept of AR to systems with the potential to remove objects from a real environment using graphic overlays. In discussing AR tools, the visual aspect of the interaction with the imposition of three-dimensional computer graphics is often central to discussions; however, any media within a synthetic space, provided by, for instance, sound or haptic features can increase the sense of reality for the user for various explorations (Shute, 2009).

2.3. Immersive Experience and Psychology

An immersive experience is accepted with two phenomena. The first one is changing one's surrounding environment. The changes can be both physical and virtual. The second phenomenon is the stimulation of the senses related to the environmental changes in one's surroundings. These phenomena also cause changes in terms of emotions which are studied by psychology in terms of psychological restoration (PR) within the framework of ART. In this chapter PR and ART and their relation to restorative environments are reviewed.

Through the literature, previous research on restorative environments shows the precise outcomes for the experience of nature generally by comparing an attractive nature scene to the less attractive built environment. These studies refer mainly to stimulating a sense of vision without changing the physical features of the ambiance dramatically (Erdeniz et al., 2017). Along with the inclusion of the technology the variety of the methods are also evolved by offering VE experience along with RE experience. Another method used is to provide attractive and unattractive scenes to the participant through VR tools. The results of these experiences are focused on the impacts of implementation and the use of tools of the user's psychology. Moreover, psychological tests are commonly conducted within the framework of user experience design, especially for underwater studies, even though they are critical to measuring the level of changes in psychological restorativeness since the physical changes that stimulate the senses are slightly more. Erdeniz et al. conducted a study where the participants were subjected to a virtually created nature and urban scenes. All of the participants have been in the VR environment as the first person. They were asked the answer PR test to measure their psychological reactions after spending five minutes in natural and urban environments. The object of the study was to evaluate restorative qualities of computer-generated virtual environments, through behavioral, self-report and pulse-rate measures. Though several previous studies have investigated the impacts of restoration in simulated urban and natural environments (Berto, 2005), in contrast to previous works, the user studies in this thesis compared the psychological effects of built underwater ambiance and vacant underwater ambiance with the aim of identifying whether design has a critical role in the level of psychological restorativeness in terms of immersive ambiance experience. According to studies (Erdeniz et al., 2018), there are factors affecting the restorativeness of real and virtual nature environments, and it is unclear which of these better accounts for the observed changes in attention, or how best to understand the influence that a variety of environmental covariates may have on individuals such as bird sounds. Understanding the underlying mechanisms on how virtual environments influence restorativeness is a crucial direction for future research. A period of only 5 minutes of interactions with a virtual environment was found sufficient to produce a remarkable increase in executive attention in the study of Erdeniz et al. (2018). In the future, more advanced virtual environments may be able to create the same effects as being outdoors in nature.

2.3.1. Attention Restoration Theory (ART)

Daily routines typically demand our direct attention. This capacity may weaken over time by causing direct attention to fatigue. It can also result in negative emotions, irritability or decreased sensitivity to interpersonal issues (Hartig et al., 1997). Resting in natural environments can reduce mental fatigue and also can restore directed attention (Kaplan, 1995). Thus, natural environments provide psychological restoration. Restorative characteristics of nature have emotional, physiological, and cognitive impacts on humans evaluated by the psychological restorativeness scales that measure the relationship between the user and ambiance design (Hartig et al., 1997; Han, 2003).

There are four common indicators of restorative experience settings: Being away, extent, fascination, and compatibility (Figure 13). They are the characteristics of both the imagined/mental domain and the actual/physical domain (Han, 2003). Directed attention is important for human information processing. Therefore, direct attention fatigue has far-reaching consequences. ART provides an analysis of the kinds of experiences that lead to recovery from such fatigue. Natural environments turn out to be particularly rich in the characteristics necessary for restorative experiences. In order to understand the ART clearly, Kaplan (1989) has pointed out the significance of four restorative properties of nature in promoting positive outcomes (Figure 13).

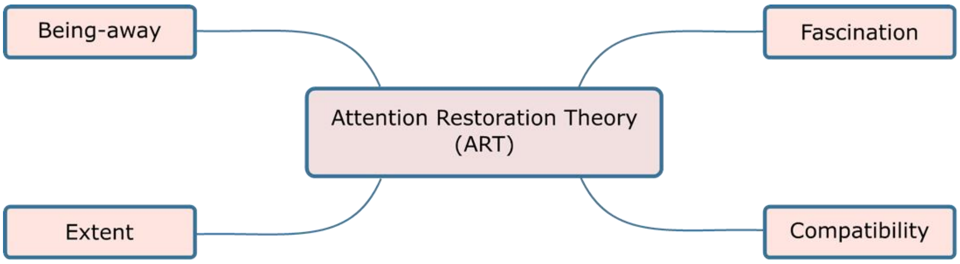


Figure 12-Four components of ART.

The first component of ART is being away. It indicates the sense of being separate and apart from usual thoughts and concerns, daily routines. To detach present worries and demands that are draining attention and energy, being away helps restored attention (Daniel, 2014). The second component is fascination. Fascination helps attention to be held without having to focus or direct it a certain way. The third component is the extent and it refers to the quality of the environment that encourages one to feel totally immersed and engaged with their surroundings (Kaplan, 2001). It can also be an environment that one feels comfortable and at ease. According to an extent, an environment should be familiar. The familiarity should not be exactly that one has been before but similar enough not to feel uncomfortable, confused or out-of-place (Ackerman, 2018). The last component is compatibility. It is about feeling enjoyment and congruence in the environment. Compatibility is higher when engaged activity is familiar to the person such as learning a new skill (Daniel, 2014).

2.3.2. Psychologically Restorative Environments

People inevitably deplete physical and psychological resources as they meet the self and externally imposed demands within changing environments. Failure to reestablish vital capabilities for effective action can harm health through multiple pathways such as stress, and mental fatigue (Hartig, 2004). Psychological restoration refers to the capacity of natural environments to replenish cognitive resources depleted by everyday activities and to reduce stress levels, according to the ART (Scopelliti et al., 2019).

As the ongoing debate in the literature as to whether simulated natural environments have equal restorative properties compared to real natural environments

(Villani et al., 2008; Valtchanov et al., 2010) continues, previous study by Valtchanov and Ellard (Valtchanov et al., 2010; Valtchanov et al., 2010) showed that users who experienced virtual natural environments have increased positive effect and decreased negative effect measured by Zuckerman Inventory of Personal Reactions (ZIPERS) (Zuckerman and Gerbasi, 1977). However, the results regarding the cognitive benefits of natural environments, such as attention and memory, are more controversial (Valtchanov et al., 2010; Bratman et al., 2015). It was speculated that, as simulated environments are inherently less detailed than natural environments, they may require more directed attention, requiring more effortful fascination (Villani and Riva, 2008; Valtchanov et al., 2010), thus they fail to promote increased executive attention performance (Erdeniz et al., 2018).

2.4. Discussion

The underwater experience, psychological restoration within ART, and virtuality are discussed in this thesis since the background of the design proposal requires interdisciplinary collaboration. There are three different perspectives to the main objective of the study, and the need of the user in terms of restorative experiences and the design requirements for design along with the technological advancement can bring these disciplines together. Ultimately the objective of the UX is to enhance the user's interaction with the design in all aspects.

Underwater immersion has common grounds in terms of the necessity for the use of specific equipment. In order to build a connection between underwater immersion and virtual immersion, this thesis uses touchpoints to show the resemblance between two experiences. Physically they use equipment to present their context. Diving uses SCUBA equipment to separate the user from land, similarly, VR also uses equipment to create an environment that diverts the user from the land.

Digitization of the ambiance for the built-up environment has the potential to provide alternative solutions to a wider spread of knowledge and experience. Additionally, the use of immersive reality tools could further facilitate the experience in a more appealing and innovative way. Through this research, users will be able to experience a completely innovative underwater ambiance, which reduces the harm to the natural environment by the built-up environment, caused by current applications.

3. Methodology

The study was built to find answers to these research questions:

- "How physically immersive experience and virtual immersiveness can work together?"

- "How can we create an underwater ambiance that is enhanced with augmented reality?"

- "How can we reduce human interference with the underwater environment through design and still encourage underwater activities such as artificial/natural reef diving?"

- "How do Augmented Reality devices work underwater?"

To design an AR diving mask, the initial stage is to run experiments on the effects of the underwater environment on the divers. The effects that have been diagnosed here are psychological restorative effects that may have also had an effect on learning. The experiments are conducted at two setups, in the underwater natural environment without any intervention and in an underwater built environment by two diving groups. Thus, the impacts of the built environment and naturally vacant environment could be compared.

The author conducted experiments to investigate the built underwater environment's impact on divers as an immersive experience. The author explores the effect on the users' Psychological Restorativeness (PR) of experiencing a built dive site in the form of an archeological scene. Depending on the participants' attitude to the effects of diving experience in the built environment, the survey explores three main data. First, it investigates the changes in pre-dive and post-dive cognitive abilities. The cognitive abilities are evaluated through the Stroop Effect Test (SET) (Appendix D1-D2). This test was applied before and after the dive. The participants who took this test also completed SRPRT after the dive. Second, it evaluates the physical reactions of the subjects towards the diving experience by self-rating the experience based on the physical changes. Third, it explores the emotional reactions of the subjects about the diving experience by self-rating tests questioning the emotions. Thus, all aspects of PR such as physical and psychological responses were taken into account since how one reacts to a certain situation and environment physically and psychologically affects one's PR (Chowdhury, 2019).

3.1. Psychological Experiments

The psychological experiments use scales from lower scores to higher scores and show one's psychological restoration. The measurement evaluates the four dimensions of the ART. These four dimensions are a sense of presence, being away, extent, and fascination. This section aims to explain how restoration scales are adopted for measuring the quality of the immersive diving experience based on these four dimensions. The measurements of the tests address health issues by their function, the purpose or application of the method. For instance, descriptive classifications focus on the function within their scope, whereas methodological classifications consider technical aspects such as the techniques used for recording information. The measurements of the PRT which this thesis uses to evaluate the function of the underwater ambiance as an immersive experience. The questions are adopted from the PRTs that evaluate the impacts of the natural environment on one's PR (Han, 2003; Hartig et al., 1997).

A simple approach to quantify estimates of psychological healthiness is to ask directly for a numerical evaluation such as "On a scale of 0 to 100, how severe is your pain?" This magnitude estimation approach is illustrated by the visual analog scales; however, this may be a difficult task; many people agree that adjectives such as mild, moderate, or severe are more natural (McDowell, 2006).

The measurement process of a PRT includes the assignment of numerical scores to health issue descriptions. These numerical scores answer for each topic the PRT covers. For instance, this thesis asks "Imagine yourself in the scene. How do you describe your physical reaction?" is a question that evaluates the extent dimension of ART in terms of physical reactions such as breathing and hands getting sweaty. Combining the scores for a given pattern of responses provides a numerical indicator of the degree of mental fatigue psychological and physical condition. Furthermore, these scaling methods also are used in rating composite descriptions of a person's overall health status when they have been rated on several dimensions such as being in the SRPRT based on Han's study (Appendix-C). This implies weighing both the magnitude of the individual elements and the relative importance of each in the overall score, and the result produces a psychological health index.

The scaling procedures are mentioned as one of the several types that fall into the broad categories of psychometric methods. This method includes the groups of people who make judgments in a given scaling task about a specific health topic. The scaling procedures were initially developed to rate feelings, opinions, or attitudes. Thus, they record values and they concern the present. The values in the scale refer to preferences presented under conditions of certainty. These are elemental perceptions. Additionally, there are no probabilities or choices in the situation to which the weights are applied. When applied to health measures, PRS methods which are used here mainly provide scores for questions that refer to current mental health status whether the reaction of the diver is physiological or psychological.

Three different PRTs were generated to measure outcomes of the diving as an immersive and restorative experience. The aim of these tests was to study how psychological restorativeness (PR) is affected by a physically immersive underwater ambiance design.

To measure the mentioned learning ability, the thesis used Stroop Effect Tests (SET). It aims to evaluate the cognitive abilities of a subject before and after a certain task is given. It is the only test that was conducted both pre and post-dive. In this context, the test aims to show how diving affects the cognitive abilities of divers to read, to indicate certain colors and the name of the colors that are written in different colors. For both the pre and post-dive, participants indicated the colors of the rectangles, to ensure that they could clearly see the colors. Second, they were asked to read aloud the words that were written various colors from the word they signified, e.g. the word “red” written in blue. Finally, they were asked to identify the color each word was written in, ignoring the word itself, for instance, the word red written in blue, should be read as blue. Their reading time and the number of errors was recorded for each phase and compared after the dive.

The PR measurement scale that divers use a scale to rate the experience is called SRPRT. ART suggests an SRPRT that evaluates the four dimensions of the theory. To choose a test that is in accordance to the immersiveness and its effects, the literature search showed that compared to the most common restoration scales of Kaplan and Kaplans 1989, Han’s scale is a revised version with 16 items investigating the same four dimensions (Appendix B). According to Han (2006), a restoration scale should be simple and straightforward in order to be used interdisciplinary. The mentioned interdisciplinary work is revolved around parties who provide a restorative experience to the users whether to reduce stress or to improve cognitive abilities (Kaplan and Kaplan, 1990). The parties of the work are researchers, designers, clients, and users. They are also advised to discuss and imply the role of design in environmental planning, and make sure that restorative environments are created and protected (Han, 2001).

Using an SRPRT raises questions on how valid their answers are since it refers to measuring the quality of a specific experience. The focus idea invalidity concerns the meaning, and interpretation of scores on a measurement. It is about turning the quality of experience in quantitative data using scientific methods. According to McDowell (2006), validity is defined as the extent to which a test measures what it is intended to measure. This conception of validity reflects the idea of an agreement with the criteria. Additionally, it is significant to emphasize, for variables such as quality of life, or happiness where a quantitative criterion, do not exist. For that reason, validity testing is challenging because the variables are abstract constructs. In order to confirm them, the measurement involves a series of steps known as construct validation. The validation process begins with a definition of the topic to be measured within a concept, indicating the internal structure of its components and the way it relates to other constructs.

While "can a self-report of anxiety replicate what a psychiatrist would have diagnosed?" remains an important question, the new and the established approaches are applied to a suitable sample of people and the results are compared using an appropriate indicator of agreement. The comparison may be used in a summative manner to indicate the validity of the measure as a whole, or it may be used in a formative manner during the development of the new measure to guide the selection of items by identifying those that correlate best with the criterion. The latter forms are part of item analysis and involve cumulative evidence on the performance of each item from a range of validity analyses outlined subsequently (McDowell, 2006).

3.2. Experiment Set-up

The artifacts that are used for the experiment will be placed onto the seabed should attract people's interests. Considering the shipwrecks, train wrecks and similar artificial reefs are already familiar to even non-divers for underwater recreational activities, (Şensurat et al., 2016), the test required a slightly unique approach for attraction. Through the literature review, it is seen that underwater cultural heritage, underwater ancient relics have been proven to attract attention for both recreational and cultural activities (Raban, 1992; Davidde, 2002; Blake, 2017). The ancient ambiance underwater attracts both divers and non-divers. Therefore, the test objects shown to the divers were chosen from ancient-looking artifacts. Inspired by the history of Izmir that goes back to 5000 years (Akurgal, 2012), the artifacts for the underwater test area were chosen from amphoras and temple columns that represent the Ancient Greek era of Izmir. The artifacts shaped the diving as an immersive experience into a museum-like experience. Furthermore, the effect of such experience measured also the learning factor for the novice divers, since museums are effective in the learning process (Ruso et al., 2014).

The set-up process for the test area has begun with the decision about what type of artifacts to be placed underwater. The user study was designed to last around 20 min (+/-3 min.) underwater. However, to prevent the anxiety for the novice divers, 10 minutes were saved for getting used to breathing underwater and being underwater. The SRPRT was for post-dive yet SET was conducted both pre and post-dive. Overall, the study consisted of six phases: pre-dive SET, on-land dive brief, trial dive, diving into test or control area, post-dive SET, and SRPRS.

Figure 13-Phases of the experiment.

Subjects of the experiment are novice divers who have never tried diving before. For that reason, a dive brief is given. Dive brief is a standard explanation of what to do underwater for novice divers by dive instructors. The brief explains that divers are not supposed to do any adjustments related to equipment or underwater navigation. They are taught to use basic diving signs that are used underwater i.e. “OK,” “Problem,” “I want to go up," “I want to go down” in addition to how to equalize their ears for the increasing pressure. The trial is done so the diver gets used to breathing underwater without anxiety. After the brief, the instructors held the diver either from the air tank or BCD and gave them the underwater tour.

The experiment consists of 6 steps (Figure 14). It started with pre-dive SET. Afterward, the divers are given dive brief about what is going to be diving like with their instructors. The third step is for divers to get used to breathing underwater. Their instructors hold novice divers and encourage them to breathe. After the novice divers get used to breathing underwater, the tour begins at the fourth step. The fifth step is conducted after the dive as a post-dive SET. As soon as the divers finished SET, they take PRT's.

3.2.1. Experiment Site

In Turkey, İzmir, Karaburun, Mimoza Bay August 2018 (Figure 15), the dive site was built by deploying clay-made archaeological replicas at shallow water levels between 5-7 m depth. Mimoza bay is located in Karaburun, Izmir city in Turkey. Its economy is mainly based on fishing and diving tourism. For that reason, the site is in accordance with the aim of the experiments.

Figure 14-Location of the experiment area in Izmir, Karaburun, Mimoza Bay

The seafloor of the bay is composed of sand, seagrass, and rocks. The environmental conditions where the tests conducted were fixed. Each trial dive lasted for 20 minutes (-/+3 min), and the average water temperature was 21°C. The ambiance design was planned according to the try dive route underwater (Figure 15). The artifacts were carefully placed in three groups; the first group consists of a small group of amphoras as a starting attraction point; a second part is a group of amphoras on a deeper level, and the third group involves columns, amphoras, and other clay artifacts as the final stop for the try divers. The features of the dive site resemble in terms of underwater visibility, and depth. The time spent underwater is 20 minutes for both groups. The only difference is the built environment. The control area is naturally vacant whereas the test area has clay amphoras and columns (Figure 16).

Test Area	Control Area
5-8 m depth	5-8 m depth
10 m visibility	10 m visibility
20 min.	20 min.
Clay amphoras and columns	Sea grass and sand

Figure 15-Features of the test and control areas of the experiment.

The try dive for novice and uncertified divers cannot exceed 5-meter depth according to diving regulations. Through the try dive, novice divers also followed the rules; however, the artifacts were placed in depths of 5-8 meters. Thus, these divers have seen the artifacts from various distances as if they were having a real museum or an exhibition experience. The seabed that was empty. It was chosen specifically in order not to interfere with any living species underwater. The test area was without seagrass and not an attractive site for divers. The objective of the tests is to prove the physical differences that affect the underwater habitat and the experience.

Figure 16-First image after the deployment of the artifacts.

3.2.2. Divers background

The participants of the research consisted of 30 people. They who were novice divers with no previous knowledge of diving were separated into two groups: Group A for the control group, Group B for the test group. Group A experienced the naturally vacant area whereas Group B dove into the test area. Among 30 participants, 8 divers of the respondents are within the age range of 19-25, 8 of them between the ages of 26-30, and the remaining 14 of the divers are from 31-41 years old. The 16 novice divers are female and the remaining 14 are male divers.

Since all of the participants were novice divers, each of them dove with an instructor who took care of their buoyancy and equipment arrangements underwater. After the dive brief which was given before the dive, all of the participants were able to dive with ease. They did not have any anxiety related to diving. The post-dive responses of these divers for the experiment were collected through SRPRT. The impact of diving on the cognitive abilities of the users was recorded using SET. The SET was conducted both pre and post diving experience. SRPRTs were conducted only post-dive.

3.2.3. Tests

When developing the PRT, two components of a restorative experience were consistently identified as present in each analysis: being away and fascination which are the core features of the ART (Kaplan, 1995). In relation to these two components of ART, diving is defined as a recreational activity, where ART applies, provides a sense of being away and fascination in terms of both mental and physical domains. For that reason, the questions in two SRPRTs seek the answers about how the participants feel and react to the underwater experience in the scope of the physical reactions that affect psychological restoration. As mentioned at the beginning of the chapter, three different tests were prepared. Two of them were based on Han’s perceived PRS and Hartig’s PRS (Han, 2003; Hartig, et al., 1997). Hence the questions are modified to measure the effects of having an immersive underwater experience.

The first test, which is based on Han’s study, is about defining the feelings of the divers’ post-dive. There are four questions and they start suggesting the divers visualize the underwater scene and asking how the divers feel physically and psychologically based on the experience. This type of test is called a self-rate test and it purely depends on the objectiveness of the divers. For that reason, it is important for the divers to answer the test in a friendly or at least familiar environment.

The tests were conducted in the dive center where they are surrounded by a certain ambiance. They were also asked to sit in the office room where they can be alone. Each question has two scales for divers to rate. The first question asks how divers define their emotional reaction on a scale from 1 to 9, from not-content to content and from anxious to relax. The second question asks how they would define their physical reaction when underwater, how fast their breath speeds up on a scale from 1, slowest to 9, fastest, and whether their hands get sweaty or not. The third question is about rating their cognitive responses as in how much underwater ambiance interests them from 1, least to 9, most. The fourth and the last question is about divers' behavioral reactions. It asks how much they would like to revisit the scene from 1, least, to 9, most, and how long they would like to stay to explore the area from 1, least, to 9, most (Appendix D).

The second PRT is based on Hartig's PPRS (Hartig et. al., 1997). There were twelve questions and each question is a self-rate test from 1, strongly disagree, to 9; completely agree (Appendix C). The questions investigate how divers describe their underwater experience within the light of the four components of ART (Kaplan, 1995). The questions ask how much the experience is an escape, provides a sense of belonging, and the scene they observed is interesting. For each question, an average of both groups has been calculated. By this means, readers can see the experience quality difference between the designed and natural underwater ambiance experience.

The third test was SET. It is the only test that was conducted both pre and post-dive. This test aims to evaluate the cognitive abilities of a subject before and after a certain task is given. In this context, the test aims how diving affects the cognitive abilities of divers to read, to indicate certain colors and their names written in different colors (Appendix E1). For the pre and post-dive, participants indicated the colors of the rectangles, to ensure that they could clearly see the colors. Second, they were asked to read aloud the words that were written in a different color from the word they signified, e.g. the word "red" written in blue. Finally, they were asked to identify the color each word was written in, ignoring the word itself, for instance, the word "red" written in blue, should be identified as blue. Their reading time and the number of errors were recorded for each phase.

In order to promote and integrate psychological restorativeness (PR) as one of the criteria in the design of underwater ambiance, the PR and Stroop Effect tests were conducted with 50 divers in shallow waters. However, 30 divers' responses were valid at the end of the testing phase since 20 divers used their right to withdrawal from the experiment (Appendix A). The control group and experimental group consisted of 15 people for each. PRTs were designed according to Han and Hartig studies. The cognitive response durations were measured by the SET. The results are analyzed for each individual. For the reliability of the results, each participant took the tests in the same environment.

For acquisition and dissemination of knowledge, AR is often used for making physical content digitally accessible, especially when the actual content is rather inaccessible (Steyn et al., 2015). However, in this thesis, for the concern of physical impacts rather than inaccessibility, the users' psychological responses are studied to gain an insight into the outcomes of an immersive underwater experience.

3.2.4. Questions of the Tests

The divers rated themselves both before and after the tests from 1 to 9 described in two SRPRTs. They are SRPRT-1 and SRPRT-2.

SRPRT-1 is based on Han's Scale and it investigates the participants' emotional, physical, cognitive, and behavioral reactions. Each question has two aspects; one relies on the user's emotional status and solid reaction caused by that emotional status. For example, the first question asks: "Imagine yourself in the scene that you have been in. How do you describe your emotional reaction?" The answers are rated by the user from 1 to 9. The first aspect expects the user to rate the emotional status, as in whether the user enjoys the experience or not. The second aspect evaluates the physical response of enjoyment based on the experience. The answer is again based on a scale from 1 to 9.

The second question evaluates the physical reaction of the user in the scene. It asks "Imagine yourself in the scene. How do you describe your physical reaction?" The question investigates the anxiety and fascination level of the user. The answers include how their breathing changes and whether their hands get sweaty or not. The users rated their status from 1 to 9.

The third question asks “Imagine yourself in the scene. How do you describe your cognitive reaction?” The answers, in two aspects, focus on the user’s interest in the scene and self-evaluation by the user about paying attention to the scene.

The last question this test investigates is the behavioral reaction of the user. The answers evaluate how frequent the user is willing to visit the scene, and how much longer they would like to stay in the shown scene

SRPRT-2 is based on Hartig’s Scale consists of 12 questions. They are also based on a self-rating scale from 1 to 9 similar to the first test. This test questions the four components of ART: the sense of presence, being-away, fascination, and extent. The questions are not direct, however, they relate the experience with the users’ emotional, and physical reactions. As opposed to the first test, this test has only one aspect for each answer. The questions ask users to rate their opinions about the place. The rating is about how relevant they feel about the statement of the questions. The first question says “Being here resembles an escape experience” The statement is related to the sense of presence from ART. The second question asks how much the diver agrees on “Spending time in the scene helps me to get away from the daily routine and get a break”. It is relevant to the sense of the presence of ART.

The third question is “This place has impressive features” reveals whether the scene stimulates fascination on the diver. The fourth question says “There are lots of things that interest me in this scene”. These two statements measure the fascination component of ART.

The questions from 5 to 8 measure the compatibility factor of ART by investigating the quality of the environment and whether divers feel like they are in a familiar environment. The questions are; “I would like to get to know this place better”, “There are lots of things to be discovered and investigated”, “I would like to take my time to look around more”, “I can do what I like here”.

The questions from the 9 to 12 rate compatibility component. The compatibility measures how much a diver is immersed in their surroundings by asking whether the divers can see themselves engaging in an activity underwater. The questions are “I feel like I belong here”, “I feel as if I'm the one with this space”, “Being here suits my character”, “I can find various ways to entertain myself here”.

The quality of experience is not a solid construction which can be measured by numeric. Thus, the evaluation process of these SRPRTs should create a framework that can cross-check the results. The results are checked based on the four dimensions of ART. This means the experience quality should be put into a framework that is based on the ART components. In order to provide the validity of SRPRTs, the new and the established approaches are applied to a suitable sample of people and the results are compared using an appropriate indicator of agreement. The comparison indicates the validity of the measure as a whole. The item analysis also involves cumulative evidence on the performance of each item from a range of validity analyses outlined subsequently.

3.3. Results

The initial results have shown that users who dove for the first time in an artificially built environment showed a greater amount of psychological restorativeness than those who dove in a naturally vacant area. Moreover, through The Stroop Effect tests, an increase in participants' cognitive abilities was recorded. According to the pre and post-dive Stroop Effect test results, Group A, the experiment group, shows greater progress than Group B as the control group in all three phases: indicating colors, reading word itself, and indicating the colors the words are written in. In indicating the colors of rectangles, the average response time fell by 14% for Group A and 8.50% for Group B after the try dive. The improvement in recorded time average for reading words is 11.70% for Group A, and 6% for Group B. The improvement for indicating the colors of words for Group A is 13.32% and 10.22% for Group B. The number of errors slightly decreased after the dive for both groups, but Group A was more successful post-dive. Figure 16 shows the average error hits for pre and post-dive for each group in indicating the colors of rectangles (Appendix E1). The blue bar is for the error hits before the dive and orange bar show post-dive results. It can be seen that the number of errors has decreased post-dive for both groups, yet Group A has fewer mistakes before and after the dive. This signifies that diving into a designed ambiance increases the cognitive abilities.

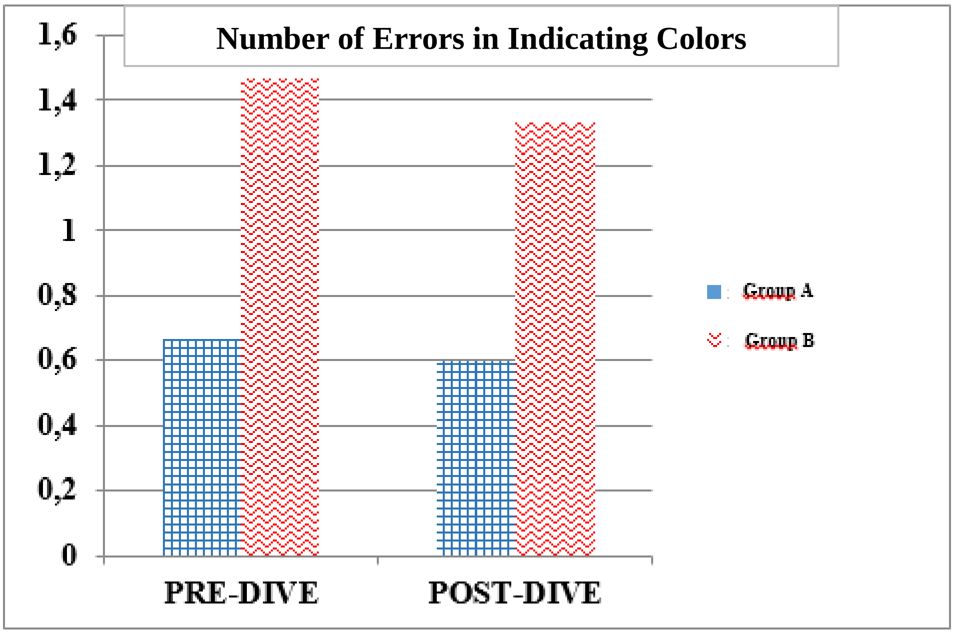


Figure 17-Graphics showing the errors in indicating the colors from SET pre and post-dive.

Reading the words was relatively an easier task, thus the comparison did not give meaningful results. For this reason, it is not shown in graphics. However, the task indicating the color of the word written in has decreased for both groups (Figure 18). The number of errors for Group B was higher than Group A.

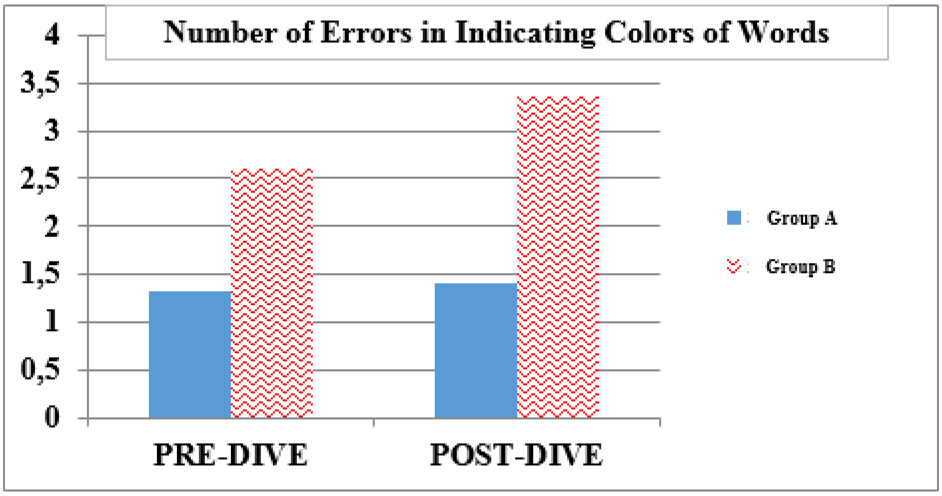


Figure 18-Graphics showing the errors in indicating the colors of the words from SET pre and post-dive.

The differences between the pre and post-dive results indicate when divers are surrounded with relatively familiar objects such as amphoras and columns; they pay more attention to comprehending the ambiance. It can be explained through Kaplan's ART theory (1989). The theory explains cases even in extreme environments when test subjects have a view of objects they know of, they are more likely to pay attention to digest the new state of the known object. Thus, their cognitive skills are forced to work more than the previous state, adjusting into the new environment with a known object.

The SRPRTs were conducted only post-dive (Figure 19). They aim to obtain an insight into the divers' psychological and physical reactions to the underwater. The results of the post-dive SRPRTs state that the divers are more likely to be curious for further exploration underwater especially when they noticed that the ambiance is specifically designed. The control group was more conscious of the environment surrounding them. This fact caused them to feel more nervous. On the other hand, the test group indicated that they would spend more time underwater to explore the area when they noticed that they are familiar with their surroundings. This proven point can be also interpreted as the human's desire to be around artifacts they know of (Kaplan, 1989). These results can provide the basis for how an immersive ambiance is designed for PR.

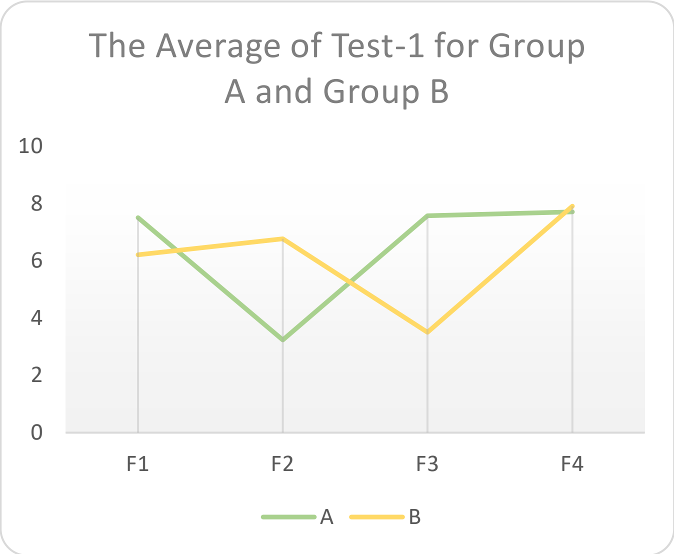


Figure 19-Average of SRPRT-1 for Group A and Group B.

The questions are shown as F1, F2, F3, and F4 (Figure 20). They draw a vertical line to show their average for each group. The vertical line with numbers from

0-9 on shows the rankings from each group. Group A's average first question is 7.5 whereas Group B's average is 6.2.

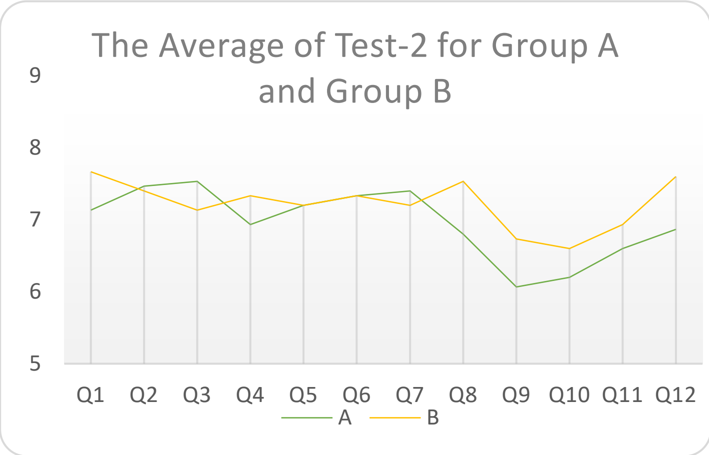


Figure 20-Average of SRPRT-2 for Group A and Group B.

The questions in Figure 19 show the average for participants from each group. For example, the green line on Q1 signifies the average response rate for Group A whereas the yellow line on Q1 is the average for Group B. This graph shows the differences between the two groups' average response ranking for each question. The test is based on PRS, so that the participants rank the questions from 1, the least, to 9, the most (Han, 2003).

According to the test based on Han scale, the divers had a higher physical reaction. The first question is to learn the divers' emotional reactions towards the underwater ambiance. The average of both groups represents that Group A is more relaxed and content with their surroundings. The second question asked how they would describe their physical reaction in terms of breathing speed and their hands getting sweaty. Group A felt more relaxed than Group B (Figure 21). The responses are evident that the divers feel comfortable around familiar and designed objects. The third question is about cognitive responses as mentioned in the previous section; Group A shows more interest in exploring the site more and staying underwater longer than Group B. It can, therefore, be inferred that a designed area in extreme conditions stimulates more attention than naturally vacant area. The fourth question is based on the behavioral reaction of the divers; the result shows that both groups have a similar level of curiosity to explore underwater whether it is designed or naturally vacant. This can be interpreted as an immersive environment that stimulates human senses intensively, arouses the tendency to stay underwater longer and visit the scene repeatedly.

These findings are complementary to the hypothesis that the design has a critical role in the level of psychological restorativeness in terms of underwater ambiance experience. Diving as a physical activity has an effect on the users by itself; however, ambiance design has a greater impact on the user’s psychological restorativeness in terms of providing a challenging immersive experience.

These experimental results show whether physical attraction points are inevitably necessary. Acknowledging that artificial environments and structures are highly attractive for many divers (Fabi et al., 2013); an integration of AR technologies can further facilitate this experience, along with a virtual ambiance design (Bellarbi et al., 2019). In order to question the necessity and potential ability of AR for enhancing PR within an underwater ambiance design, an AR-embedded mask design is proposed.

Since it was seen that designed ambiance experience improved PR more compared to the naturally vacant space, and it is known that immersive media improves underwater user experience (Jain et al., 2016), the results led us to elaborate on suggesting an alternative of digital applications, that is AR to experience underwater ambiance, while reducing the need for physical and artificial attraction points. In order to achieve that an AR embedded diving mask design is envisioned.

3.4. Discussion

At the beginning of the experiments, the implementation is divided into two phases. The first phase includes only SET that measures the cognitive abilities before the dive. The second phase includes both SET, SRPRTs. These tests were conducted on the surface right after the dive, and the results were recorded immediately.

According to the results of the experiment, when the design has a role in creating recreational dive sites, divers are more attracted to it. Furthermore, diving also has its own impact on the divers apart from the built environment itself as well. Regarding the research questions of this thesis, the concerns are first, integrating technology into diving as a recreational and immersive activity, and secondly, protecting nature by reducing the stress over natural reefs by designing alternative dive sites. Although there are physical solutions for both these concerns, the inclusion of technology underwater for an immersive experience paves the way for an AR-based underwater experience design as an alternative way of diving.

Within the scope of the thesis, the psychological and cognitive impacts of diving into the built environment and diving naturally vacant area have been compared. The results show two different approaches. First, the results present the positive effects of diving on one's psychological restoration and cognitive abilities. In other words, built environment or vacant, recreational diving has impacts and the data can be used for potential future designs. Secondly, the results showing the impacts of diving in the built environment over the naturally vacant area also indicate that divers enjoy experiencing built environment underwater. It can also be defined as immersion within the immersion. They are in an immersive environment, and they are immersed yet they see objects they know of on land. At this point, the integration of immersive digital media to designed underwater ambiance can potentially enhance the user experience while decreasing the environmental concerns. The underwater experiments were chosen because it provides a type of immersion similar to virtual experiences offer. The test duration for virtual experiments and diving experiments resembles each other. Each takes 10-20 minutes to complete. The thesis proposes to design an AR embedded diving mask that helps divers to psychologically restore while showing information through the glass underwater. To measure how effective the design can be existed psychological tests measure the impacts of virtually immersive experiences. The thesis proposes to use both physical and virtual immersion for the diving experience. Thus the impact of both virtual and physical immersion is required. The virtual experience can be exemplified through literature however; to measure the impacts of a physically immersive experience was within our limitation and possibilities. Tests worked for two goals. For the first goal, the artifacts are made of ancient-looking amphoras and columns to raise curiosity. The tests proved that it worked. The second goal was to measure the impact of an ambiance experience that is immersive. The tests proved that physically immersive experiences improves attention and accordingly provide psychological restoration.

4. AR-based Underwater Experience Design Proposal

For underwater ambiance, having physical contact with the water element is inevitable. Thus, the immersion into the water helps us to dissolve emotionally. Diving, as very basic forms of immersion, allows the body to interact with the environment. This interaction stimulates the human senses. Without trying to duplicate the underwater environment to awaken these senses, as the immersion is not easily copied and transformed into the virtual world (Varinlioğlu, 2003), augmenting the real environment is considered rather than recreating a virtual one. In this way, the touch with the environment is preserved and enhanced with the addition of digital technologies. The design proposal for this thesis is evolved from more basic versions of designed underwater experience such as museums and archeoparks.

As indicated before, diving uses all senses and provides psychological restorativeness, but the focus of this thesis has been only on the visual stimulations. Thus, an AR embedded diving mask for an enhanced view underwater is designed. The mask enables divers to experience the ambiance through AR. The divers see both the real environment and the embedded 3D artifacts during their dive. Considering the technical aspects as well as ergonomic requirements and scale-related issues, hand-held and head-mounted devices are reviewed for a virtual immersive underwater experience. Prior to the AR-based design, virtual underwater experiences have been reviewed.

4.1. Literature Review on Virtual based Underwater Designs

The literature reveals that the approaches for VE design might vary from head-mounted displays (Davies, 1998) to mobile apps (Hanson, 2019). The level of reality and virtuality depends on how much the environment is transferred from RE to VE as reality-virtuality continuum shows (Milgram et al, 1996). The equipment affects the user's perception of their surroundings in terms of embodiment, interactivity, and sense of presence (Flavian et al., 2018; Dix,2016). The interaction of the user with the virtual environment copies the movements of the real environment. The user's bodily movement in VE allows the user to navigate along with the interface of the system. The same can be applied to the ambiance and movements of the underwater environments are recreated as seen in literature from RE and VE applications. According to the Embodiment-Presence-Interaction Cube (EPI Cube) criteria, the related examples are placed onto the cube for a broad-view.

In this part, there are four examples from VR and AR. They are chosen based on their relation to experiencing underwater ambiance because the design proposal concerns augmenting the underwater experience by designing an AR embedded diving mask (Figure22).

Virtual Reality	Augmented Reality
Osmose	Sentry
Amphibians	Dolphyn

Figure 21-Examples from VR and AR for the review.

The examples are classified based on technology, mobility, indoor and outdoor use, physical immersion, embodiment, presence, and interaction (Figure 23).

POSITIONING	HEADWORN	HAND-HELD	SPATIAL	
TECHNOLOGY	SENTRY	DOLPHYN	AMPHIBIAN	OSMOSE
Mobility	available	available	restricted	restricted
Outdoor use	confined water	confined water	not applicable	not applicable
Indoor use	not applicable	not applicable	predestinated area	predestinated area
Physical Immersiveness	fully immersed	fully immersed	not applicable	not applicable
Embodiment				
Sense of presence				
Interaction				

Figure 22-Classification for the examples.

After classifying examples based on these their embodiment, sense of presence interaction features have been compared based on EPICube According to their relation with an embodiment, sense of presence, and interactivity, chosen samples are placed onto the EPI Cube (Figure 24). The first set of examples are VR experiences. The second set is the AR experiences. Their placement on the EPI cube will also show their relation to the AR embedded diving mask proposed in this thesis.

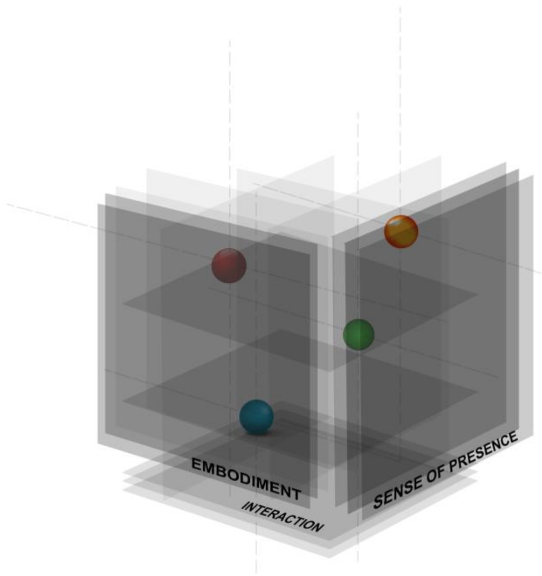


Figure 23-EPICube diagram of the for virtual underwater experience systems: Osmose (blue), Amphibian(green), Sentry(orange), Dolpyhn (red)

The first example of the first set is called Amphibian (Jain et al., 2016), a water-free VR set-up in where users lay on their torso and use their breath and body movements to navigate. The Amphibian VR uses visual graphics and navigation in order to provide the underwater experience. The system works through kinesthetic sensors that enable divers to interact with the underwater space through their own motions. Their aim is to recreate the sensations and physical requirements of scuba, without interfering with space through design. The interface composes scenes from VE and it shows underwater.

The second VR example is an installation called Osmose (Davies, 1998). It is a VR experience where the system detects users' breath and bodily movements to navigate through the interface. It is an interactive VR installation that offers a fully immersive experience. The tools used in this installation are interactive 3D sound devices, a head-mounted display and real-time motion tracking based on breathing and self-balance.

The common ground of the two VR experiences is that they provide a zero-gravity experience with visuals. They both use a harness to capture the user in the VR system and give 360-degree full-body immersion. Additionally, users' sense of presence for both is highly modified. They differentiate in terms of their interface. Amphibian displays also underwater scene whereas Osmose has a fully virtually created environment inspired by underwater.

The second set of examples are AR experiences. Instead of replacing the RE, they augment RE by adding virtual elements. The first one is called Dolphyn AR where users hold a hand-held device while they are navigating underwater in a confined area as they dive. The module has consisted of a tablet that is connected to user interface devices, GPS, thermometer, flow-meter sensors, and a WI-FI device. Dolphyn presents a quest-game for divers to complete certain quests. The main goal of the game is to destroy the moving submarines. The joystick on the hand-held objects is for pulling missiles to shoot. The users detect markers placed underwater from the lenses on the Dolphyn to view virtual submarines, fish, and plants.

The second AR example is called Sentry. It is used for commercial divers to prepare for the dive and underwater operation psychologically. Unlike novice and recreational divers, commercial divers work for long hours in the depths beyond recreational diving limits. For that reason, their dive has higher risks than recreational dives. To prevent commercial divers from dive illnesses, accidents and hazardous risks, Sentry helps these divers to rehearse in a confined area before their actual dive. One of the risks is divers get anxious while completing their tasks. The main concern of Sentry is to prepare divers to be mentally enduring for long hours under pressure both physically and psychologically. The system has consisted of a video see-through head-mounted display with a web-cam of it, protected by a custom waterproof housing placed over the mask. Optical square-markers are used for positioning and orientation tracking purposes. The tracking is implemented with ubiquitous-tracking software (Ubitrack). Even though Sentry has a commercial use for underwater construction works different than the first three designs, the psychological aims of the product as well as being related to underwater bring it into the comparison.

The optical markers are the common features of Dolphyn and Sentry. Other than the similarities in the working system, they use different types of devices. They both aim to increase the psychological well-being of the users Dolphyn uses a hand-held gear to navigate where Sentry has a head-mounted gear. The striking difference between the two is their aim of use. Dolphyn is an entertaining game tool for recreational diving. Sentry is for reducing anxiety levels for commercial divers for their risk-bearing operations. For both AR experiences the concerning part of the design is that it gives an extension to the diver that affects their buoyancy ability underwater. The movement of the diver underwater is limited, and the control of the device always adds one more task during dive.

4.2. Design Proposal

The design proposes that the underwater environment and movements in the virtual are not recreated, but instead, the ambiance is augmented by means of a look-through transparent AR glass while keeping the whole diving experience as it is. The proposed experience in this chapter is an AR museum for the novice divers. Since it is observed that diving improves cognitive abilities as well as PR, the experience, in the thesis's context, helps to improve cultural memory with the design of an artificial museum underwater, besides users' personal diving experience.

Without losing the impacts of physical immersion while digital immersion takes over with the inclusion of AR, a half physical and a half virtual museum is designed. For this, there will be artifacts underwater as a part of an ancient scene inside of a museum. These objects are also used as markers for AR readers on the diving mask. They look as if they are part of the whole shape. For instance, a column standing up underwater is a marker that completes the view into a temple when the AR diving mask is used. Thus, there will be two scenes for users: the first scene is the area that artifacts are placed. The second scene is the AR view of the museum with info-graphics on the screen of the mask.

The target group of the AR diving mask is novice divers who will use the AR embedded diving mask while being guided by dive instructors. As soon as novice divers put on AR embedded diving mask until they are used to navigate underwater. When they start ascending into the water, the mask reads square markers that are embedded into the artifacts placed underwater. The 3D objects appear on the glass of the diving mask. As diver navigates through the artifacts, objects appear closer and bigger. The diving mask, as a piece of mandatory equipment for the divers, will also have additional information about the objects displayed on the screen while the diver/user can still experience the real underwater environment.

An AR embedded diving mask that will allow divers to see the objects through markers is envisioned. Therefore, the product will improve the underwater space experience and psychological restorativeness.

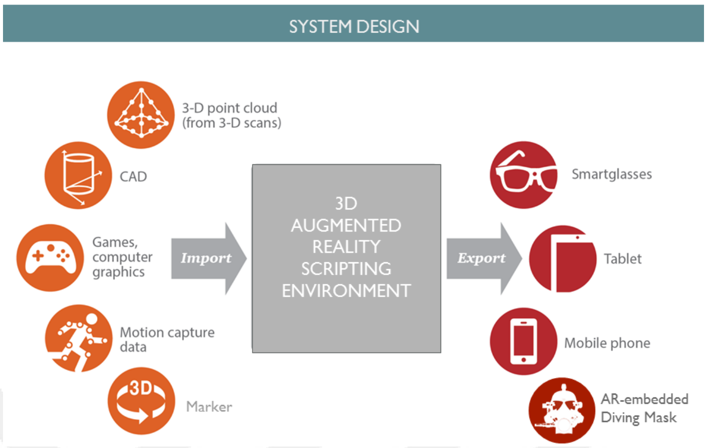


Figure 24-System Design for 3D AR Scripting Environment

There are certain system requirements such as gathering the data from the environment and processing the data with authoring tools and applications to convert the processed data through an interface implemented on a product. The system will work as the markers are scanned, processed within game engines such as Unity, Vuforia, and Unreal Game engines (G2, 2019) together with 3D models and infographics about artifacts, and this overall information will be monitored through an interface, that is, through an AR-embedded diving mask (Figure 25).

The visuals displayed on the glass complete an AR museum, thus, divers see a museum that is virtual simultaneously they see also the underwater (Figure 26). Their spatial experience is enhanced with the use of an AR diving mask. The scale is adjustable as the divers swim closer to the objects they get bigger. When they arrived at the markers they also read the information. The written information is not visible from distance. This way diver’s curiosity is awakened and their desire to explore more about the environment is encouraged.

Figure 25- AR embedded diving mask system.

Figure 26 explains what divers see with and without the mask. First, they see only the artifacts and underwater ambiance. After putting on the mask, they start seeing also the digital environment that is created through 3D objects.

4.2.1. Discussion

This study brings subjects from design, psychology, and technology subjects together to propose an AR embedded diving system. The proposal aims to merge these subjects to present an interdisciplinary approach in users' favor. The mentioned favor here is providing an augmented experience for psychological well-being and restored attention for learning. Other than the user itself, the environment also benefits from the design within its scope. The AR diving system offers nature protection and reduces the stress on the fragile aquatic habitat. The thesis shows the positive correlation between diving as a recreational activity, PR, and learning abilities. Furthermore, it proposes a diving system that can improve the whole experience with the help of AR without creating more stress on natural habitats.

Considering AR systems create an alternative, enhanced environment experience, it is understood that it is not to replace the real environment. An AR experience protects nature without having to interfere with it. Furthermore, it can be modified in terms of visuals and context. Thus, the experience can have "the immersion within immersion". Nowadays, immersive and extreme environments such as space and underwater are studied for simulations. Sometimes it is to prepare the user for a specific task; sometimes it is to augment the experience for more attraction.

Regardless of the context, virtuality is in our daily lives more than ever. Thus, designing an augmented diving system will become a common tool for those would desire to explore beyond the horizon within the accessible services. Divers will dive into the depths of other worlds without having to travel there.

5. Conclusion

The relationship between psychology, immersive experience, and design is studied in this thesis. Once the relationship is established between the ambiance as an experience and psychology according to the experiment results, the inclusion of the digital technologies of AR will potentially improve the way the role of design in one's psychological restorativeness.

The experiment was to observe the impacts of the physically immersed environment. The impacts of digital immersion on the user are reviewed through the literature. The design proposal uses these two meanings of immersion. Thus, immersion as a keyword is studied in two aspects of this thesis. One is physical immersion as diving, second is the digital immersion as AR experiences. The SRPRTs are to measure the improvement caused by the immersive ambiance experience if there are any. The Stroop effects test showed the role of immersive experience for awakening attention. They are the first step to build the relation between three keywords: Immersive experience, underwater ambiance design, and psychological restorativeness. Each has a role during the design of the context for the AR embedded diving mask. Hence, technology is an important part of the equation in that sense.

During the test phase, the goal was to measure the psychological restorativeness through immersive underwater experience design. Taking into account the influence of underwater ambiances on the user, psychological restorativeness was measured. Regarding underwater experience design, the findings showed a direct correlation between the built environment and psychological restorativeness and cognitive abilities. However, considering scientific research needs more validation than only opinions of users, more research is needed to validate the changes in restorativeness, and to create a greater level of interaction between the user and objects within a designed underwater ambiance. The future studies should involve more measurement tools of psychological experiments as well as a more confined test area. Because for a study that can compare the impacts of digital and the physical immersion, there should be a more reclusive place so that users' opinion is not affected by their surroundings. The users took the tests near the sea where they can still improve their PR. Despite these factors, the experiment results in this thesis are also valid because the users took the test by themselves.

The literature review has shown that the immersive characteristics of virtuality tools such as AR provide attention restoration through its four components; the sense of being away, extent, fascination, and compatibility. Thus, digital technology can be integrated as a tool to meet the challenge of providing an immersive underwater experience. The psychological restorativeness and Stroop Effect tests proved that the immersive design has a positive impact on user's psychological restorativeness. Both the experiment and the test group showed an improvement in terms of cognitive abilities and PR. However, the test group who experienced the built area showed greater improvement compared to the control group. Additionally, even though the structure of immersive design has the power to affect the outcomes, the input of the virtual elements such as AR, should be studied in further studies.

Future studies have the potential to cover and enhance the immersive experience design and psychological restorativeness. The results of the experiment shape the virtual immersive experience design and help eliminate exaggerated physical interference to the underwater environments. It is beneficial for both the development of diving as a recreational experience and for nature. In terms of technology, although AR can be integrated or overlapped into the real-world experience through design, they are not to replace reality. Hence, they can be used to augment the existed environment. In order to enhance the link between reality and virtuality, the design should include product design, ambiance design, and software development. Thus, it should be a design of a diving system not only the diving mask.

This thesis is an interdisciplinary study with a combination of design, technology, and psychology. The psychological test results showed the impact of designed ambiance on the user, in this case, the diver. Taking a step further, the results collected from this study will be used as a foundation for further studies. It is desired to grow a strong bond between humans and nature through design starting from this proposal.

The AR diving mask design proposal is based on three disciplines. The design aims to improve the divers' psychological gains. Thus, psychology and technology are involved in the design. The impacts of diving based on psychological restoration are observed through the specific tests in the experiment. The physical and virtual underwater experiences can be considered similar in terms of immersion. Moving from this point, underwater tests also enlighten the impacts of a digitally enhanced diving experience. Divers shall be visually stimulated by the artificial museum with the AR diving mask as well as visual stimulation of the artifacts without the diving mask. The aim of the study is to improve divers' state of mind with the design that creates an immersive museum project that builds a more solid cultural memory besides a personal diving experience.

REFERENCES

Ackerman, C. 2018. What is Kaplan's Attention Restoration Theory (ART)?. Available at: <https://positivepsychology.com/attention-restoration-theory/>. [Accessed 15.08.2019]

Akurgal, M. 2012. İzmir Müzesi. İzmir Arkeoloji Müzesi. Etnografya Müzesi. Available at:< http://www.izmirmuzesi.gov.tr/antik-yerlesim-alanlari-smyrna.aspx> [10.05.2019]

Ange, R. M. 2006. Diver Down Real-World Scuba Accidents and How to Avoid Them. New York, International Marine and McGraw-Hill: 123-148.

Art of Corner. 2017. Immersion and Digital Technologies. Available at: <https://www.artofcorner.fr/en/2017/11/27/immersion-digital-technologies-2/.> [Accessed 03.09.2019]

Atlas Scuba. 2019. Assets.Atlasobscura.Com. Available at: <https://bit.ly/2mvidun>

Azuma, R., Lee, J.W., Jiang, B., Park, J., You, S., Neumann, U. 1999.Augmented Reality Tracking in unprepared environments for augmented reality systems. Computer and Graphics. Vol. 23. 787-793

Bailenson, N. J., Yee, N., Patel, K., Beal, C.A. 2007. Detecting Digital Chameleons. Computers in Human Behavior. Vol. 24:66-87

Baños, J.H., Franklin, L.M. 2002. Factor structure of the Mini-Mental State Examination in Adult Psychiatric Inpatients. Psychological Assessment; 14:397–400

Bellarbi, A., Domingues, C., Otmane, S., Benbelkacem, S., & Dinis, A.2013. Augmented Reality For Underwater Activities With The Use Of The DOLPHYN. 10th IEEE International Conference on Networking, Sensing and Control, ICNSC 2013:409–412.

Berto, R. 2005. Exposure to restorative environments helps restore attentional capacity. Journal of environmental psychology, 25(3):249-259.

Bevan, J.1996. Infernal Diver: The Lives of John and Charles Deane Their Invention of the Diving Helmet, and Its First Application to Salvage, Treasure Hunting, Civil Engineering and Military Uses, Hampshire, Submex.

Biocca, F. 1996. Intelligence Augmentation: The Vision inside Virtual Reality. Cognitive Technology in Search of a Humane Interface. North Caroline: Elsevier Science:59-75

Blake, J. 2017. The protection of the Underwater Cultural Heritage, The International and Comparative Law Quarterly, Vol. 45, No. 4:819-843

Blueocean.com.au. 2019. 50 Virtual Reality Tools. Available at: <http://www.blueocean.com.au/news/50-virtual-reality-tools> [Accessed 09.09.2019]

Bockholt, N. 2017. VR,AR,MR and What Does Immersion Actually Mean?. Available at: <https://www.thinkwithgoogle.com/intl/en-154/insights-inspritation/industry-perspectives/vr-ar-mr-and-what-does-immersion-actually-mean/> .[01.09.2019]

Bowman, A.D., Hodges, F. L.1999. Formalizing the Design, Evaluation, and Application of Interaction Techniques for Immersive Virtual Environments. The Journal of Visual Languages and Computing:37-53

Boyd, L. 2016. Scuba Diving Equipment 8 Pieces Of Equipment You Need To Scuba Dive. Available at: <https://mpora.com/diving/scuba-diving-equipment-8-pieces-scuba-diving-gear#tKrokeC78y3WTGAy.97>

Bratman, G.N., Daily, G.C., Levy, B.J., Gross, J.J. 2015. The Benefits Of Nature Experience: Improved Affect And Cognition. Landscape and Urban Planning 138:41–50

Bruno, F., Barbieri, L., Muzzupappa M., Tusa, S., Fresina, A., Oliveri, F., Lagudi, A., Cozza, A., Peluso, R. 2019. Underwater Cultural Heritage through Digital Technologies: The Case Study of The “Cala Minnola” Shipwreck Site. Digital Applications in Archeology and Cultural Heritage. Vol.13

Čejka, J., Bruno, F., Skarlatos, D., & Liarokapis, F. 2019. Detecting Square Markers in Underwater Environments. Remote Sensing, 11(4):459.

Chen, A. H., O’Leary, D.J., Howell, E. R. 2000. "Near visual function in young children". Ophthalmic and Physiological Optics. 20 (3):185–198.

Chowdhury, Madhuleena Ray. 2019. The Positive Effects of Nature On Your Mental Well-Being. Available at: <https://positivepsychology.com/positive-effects-of-nature/>

Claman, F.L. 2015. The Impact of Multi-user Virtual Environments on Student Engagement. Nurse Education in Practice. Vol. 15:13-16

Coelho, M.C., Waters, M.A., Hine, T.J., Wallis, G. 2009. The Use of Virtual Reality in Acrophobia Research and Treatment. Journal of Anxiety Disorders:563-574

Collins, J., Regenbrecht, H., Langlotz T. 2017. Visual Coherence in Mixed Reality: A systematic Enquiry. Presence. Vol.26/1:16-41

Cross, N. 2001. Designerly Way of Knowing: Design Discipline versus Design Science: Proceedings of Design+Research Symposium, Politecnico di Milano, Italy:49-55.

Daniel, R.M. 2014. The Effects of the Naturel Environment on Attention Restoration. Unpublished Master's Thesis. Appalachain University. Boone. NC.

Davidde, B. 2002. Underwater archeological parks: a new perspective and a challenge for conservation- the Italian panorama. The International Journal of Nautical Archeology, vol:311:83-88

Davies, C. 1998. OSMOSE: Notes on being in Immersive virtual space. Digital Creativity. Available at: <https://www.tandfonline.com/doi/abs/10.1080/14626269808567111>. [Accessed 11.08.2019]

Dimmock, K. 2008. Finding comfort in adventure: experiences of recreational SCUBA divers. Leisure Studies. Vol.28/3:279-295.

Dix, A. 2016. Human-computer interaction, foundations, and new paradigms. Journal of Visual Languages and Computing. Vol. 42:122-134

Durlach, N., Slater, M. 2000. Presence in Shared Virtual Environments and Virtual Togetherness. Presence: Teleoperators and Virtual Environments.Vol. 9(2)

Edney, J.; Spennemann, D.H.R. 2015. Can Artificial Reef Wrecks Reduce Diver Impacts on Shipwrecks? The Management Dimension. Journal of Maritime Archaeology. Vol. 10:141–157.

Erdeniz, B.,Serin, E., Aslı, M., Şenol, D., Alankuş, G. 2016. Virtual Reality - The Effects of Simulated Virtual Reality Environments on Psychological Restoration. TÜBİTAK. Project No: 114K213

Fabi, G., Scarcella, G., Spagnolo, A. 2013. Practical Guidelines for Artificial Reefs in the Mediterranean and Black Sea. Rome: Food and Agriculture Organization of The United Nations

Flavián, C., Ibanez-Sanchez, S., Orus, C. 2018. The impact of Virtual, Augmented and Mixed Reality Technologies on The Customer Experience. Journal of Business Research. Vol. 100:547-560

Food and Agriculture Organization of the United Nations. 2015. Practical Guidelines for the Use of Artificial Reefs in the Mediterranean and the Black Sea. Rome: General Fisheries Commission for the Mediterranean.

G2.com. 2019. Best AR Game Engine Software. Available at: <https://www.g2.com/categories/ar-game-engine>. [Accessed 01.10.2019]

Han, K.T. 2001. Traditional Chinese Site Selection- Feng Shui: An evolutionary/ Ecological Perspective. Journal of Cultural Geography. Vol. 19/1

Han, K.T., 2003. A reliable and valid self-rating measure of the restorative quality of natural environments. Landscape and Urban Planning. Vol. 64:209-232

Hanson, N. 2019. Civilisations AR. Available at <https://www.bbc.co.uk/taster/pilots/civilisations-ar>

Hartig, T. 2004. Restorative Environments. Encyclopedia of Applied Psychology.

Hartig, T. 2011. Restorative Environment In Title of Psicologia Ambiental Entre los estudios urbanos y el analisis de la sastenibilidad. Artes Gráficas Gutenberg Almería C/. Victoria Kent, 10. Polígono San Rafael: 41-66

Hartig, T., Korpela, K. G., Evans W., Gärling T. 1997. A measure of restorative quality in environments, Scandinavian Housing and Planning Research, Vol.14:4

Hawkins, J. P., Roberts, C. M., & Adamson, T. 1991. Effects of a phosphate ship grounding on a Red Sea coral reef. Marine Pollution Bulletin, 22(11):538–542.

Ihde, D. 2011. Stretching In-Between: Embodiment and Beyond. Foundations of Science. Vol.16 (2-3):109-118.

ISO. 2014. Recreational Diving Services ISO24801-2. Available at : <https://www.iso.org/obp/ui/#iso:std:iso:24801:-2:ed-2:v1:en> [Accessed 12.08.2019]

Jain, D., Sra, M., Guo, J., Chiu, R. and Schmadt, C. 2016. Immersive Terrestrial Scuba Diving Using Virtual Reality. San Jose, CA, USA:1563-1569.

Jung, T., Chung, N., Leue, M.C. 2015. The determination of the recommendations to use augmented reality technologies: The case of a Korean theme park. Tourism Management. Vol.49:75-86

Kaplan, R. and Kaplan S. 1989. The Experience of Nature A Psychological Perspective. Cambridge: Cambridge University Press

Kaplan, R., Kaplan, S., 1990. Restorative experience: the healing power of nearby nature. In: Francis, M., Hester, R.T. (Eds.), The Meaning of Gardens. MIT Press, Cambridge:238–243

Kaplan, R.; Kaplan, S. 1989. The experience of nature: A psychological perspective. New York: Cambridge University Press.

Kaplan, S. 1995. The restorative benefits of nature: toward an integrative framework. Journal of Environmental Psychology. Vol.15:169–182

Lucrezi, S., Saayman, M. 2017. Sustainable scuba diving tourism and resource use: Perspectives and experiences of operators in Mozambique and Italy. Journal of cleaner Production. Vol 168:632-644

Lukka, L. 2014. The psychology of immersion. The Cutting Edge of Nordic Lap. Grafisk: Knutpunkt:81-91

Magson, K. 2016. "Artificial Reefs: What Works And What Doesn’T". Newhaven Reef Conservation.Org. Available at: <https://newheavenreefconservation.org/marine-blog/147-artificial-reefs-what-works-and-what-doesn-t.>[15.09.2019]

Marcello Carrozzino and Massimo Bergamasco. 2010. Beyond virtual museums: Experiencing immersive virtual reality in real museums. Journal of Cultural Heritage. Vol.11:452–458.

McDowell, I. 2006. Measuring Health a Guide to Rating Scales and Questionnaires. New York: Oxford University Press:302-313;520-523; 705-710

Mexico Underwater Museum of Art (MUSA). 2019. Available at: <https://musamexico.org/>

Milgram, P. and F. Kishino. 1994. A Taxonomy of Mixed Reality Visual Displays. IEICE Transactions on Information and Systems, Vol.77(12):1321

Milgram, P., Kishino F. 1994. A Taxonomy of Mixed Reality Visual Displays. IEICE Transactions on Information Systems, Vol E77:1-15

Morales, R., Klinker, G., Keitler, P., Maier, P. 2009. An Augmented Reality Diving System for Commercial Diving Operations. Proceedings of OCEAN 2009. Biloxi, MS, USA

Muhanna, M. A. 2015. Virtual Reality and the Cave: Taxonomy, Interaction Challenges and Research Directions. Journal of King Saud University. 2015. Vol.27:344-361

Osci, D. 2007. Underwater Archeological Park Of Baiae. Available at: < http://www.parcoarcheologicosommersodibaia.it/parco.php?id_lingua=en.> [Accessed 15.09.2019]

PADI, Reports, 2013. Worldwide Corporate Statistics Data for 2007-2012. Available at: <https://bit.ly/2kq0TGi>

PADI. 2019. Education-PADI. Available at: <https://www.padi.com/education>. [Accessed 10.09.2019]

PADI. 2019. Scuba Gear-PADI. Available at: <https://www.padi.com/gear> [Accessed 13.09.2019]

Panou, C., Ragia, L., Dimelli, D., Mania, K. 2018. An Architecture for Mobile Outdoors Augmented Reality for Cultural Heritage. ISPRS International Journal of Geo-Information. Vol.7

Pokemon Go! Team. 2018. Announcing The Winners of the First Pokémon GO AR Photo Contest!. Available at: <https://pokemongolive.com/en/post/arphotocontestnovwinners/>

Raban, A. 1997. Archeological park for divers at Sebastos and other submerged remnants in Caesarea Maritima, Israel, The International Journal of Nautical Archeology. Vol:211:21-35

Ross, F. X. 1970. Undersea Vehicles and Habitats: The Peaceful Uses of the Ocean. New York: Thomas Y. Crowell

Ruso, L., Topdal, E. B. 2014. The Use of Museums for Educational Purposes Using Drama. Procedia- Social and Behavioral Sciences. Vol.141:628-632

Sanchez-Vives, M. V.,Slater, M. 2005. From presence to consciousness through virtual reality. Nature Reviews Neuroscience, 6(4):332–339.

Scopelliti M, Carrus G., Bonaiuto M. 2019. Is it Really Nature That Restores People? A Comparison with Historical Sites with High Restorative Potential. Frontiers in Psychology. Vol.9:2742.

Şensurat, T., Özgül, A., Lök, A. 2016. Artificial Reef Applied for Diving Tourism: Proceedings of the Second International Congress on Applied Ichthyology and Aquatic Environment. Messolonghi.

Shute, T. 2009. Is it OMG finally for augmented reality? Interview with Robert Rice. Ugo trade: Virtual Realities in world 2.0.

Smith, M. 2019. Scuba Diving vs Commercial Diving | Divers Institute of Technology. Divers Institute of Technology. Available at: <https://www.diversinstitute.edu/commercial-versus-scuba-diving-essentials/> [Accessed 01.08.2019].

Steyn, N. Hamam, Y., Monacelli, E., Djounai, K. 2015. Modelling and Design of an Augmented Reality Differential Drive Mobility Aid in an Enabled Environment. Simulation Modelling Practice and Theory. Vol.51:115-134

Takatalo, J., Nyman, G., Laaksonen, L. 2008. Components of Human Experience in Virtual Environments. Computers in Human Behavior. Vol.24:1-15

Than, K. 2010. "Jacques Cousteau Centennial: What He Did, Why He Matters". Nationalgeographic Online magazine. Available at: <https://www.nationalgeographic.com/news/2010/6/100611-jacques-cousteau-100th-anniversary-birthday-legacy-google/> [Accessed 15.09.2019]

Time Magazine, “Sport: Poet of the Depths”, 28 March 1960

U.S. Navy. 2008. U.S. Navy Diving Manual. Washington DC: Direction of Commander, Naval Systems Command:1.8-1.15.

UNESCO. 2001. Convention on The Production of The Cultural Heritage: UNESCO

Valtchanov, D., Ellard, C. 2010. Physiological and affective responses to immersion in virtual reality: Effects of nature and urban settings. Journal of CyberTherapy and Rehabilitation. Vol.3/4:359-373

Valtchanov, D., KR, B., Ellard, C. 2010. Restorative effects of virtual nature settings. Journal of CyberTherapy and Rehabilitation. Vol.13/5

Varinlioğlu, G. (In Press). Assessing a Decade of Kaş Underwater Archeopark, Inetrnational Journal of Nautical Archeology.

Varinlioglu, G. 2011. Data Collection for a Virtual Museum on the Underwater Survey at Kaş, Turkey. International Journal of Nautical Archeology. Vol.40(1):182-188

Varinlioglu, G. 2013. The Fluid Experience of Space: Physical Body in Virtual Spaces Over an Analysis of Osmose. Master Thesis. Bilkent University

Villani D, Riva, G. 2008. Presence and relaxation: A preliminary controlled study. PsychNology Journal. Vol.6:7–26

Vlahakis, V., Karigiannis, J., Tsotros, M., Gounaris, M., Almeida, L., Stricker, S., Gleue, T., Christou, I. T., Carlucci, R., Ioannidis, N. 2001. Archeoguide: First results of an augmented reality, mobile computing system in cultural heritage sites. In Virtual Reality, Archeology, and Cultural Heritage:131–140.

Wilson, E.O. 1984. Biophilia. Cambridge, MA: Harvard University Press.

Zuckerman, M., Gerbasi, K.C. 1977. Belief in infernal control or belief in a just world: The use and misuse of the I-E scale in prediction of attitudes and behavior.

References of Figures

Figure 1- Diver vector: https://bit.ly/2kjYzR8

Figure 1- Free diver vector: https://bit.ly/2m2kMDH

Figure 1- Submarine vector: https://bit.ly/2korF1P

Figure 4- Great Alexander Diving Bell: https://bit.ly/2krnOBh

Figure 4- Diving Dress (1828): https://bit.ly/2lWqc3e

Figure 4- Helmet (1839): https://bit.ly/2kQxwNF

Figure 4- Helmet (1966): https://bit.ly/2m2nqcB

Figure 4- Helmet (1975): https://bit.ly/2m2nqcB

Figure 4- Full-Face (2018): https://bit.ly/2m2nqcB

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Figure 6- SCUBA equipment:

Figure 7- Full-face mask: https://bit.ly/2krrkeX

Figure 7- Double-glass mask: https://bit.ly/2lXHAoe

Figure 7- Single-glass mask: https://amzn.to/2mnvncL

Figure 7- AR embedded mask: https://bit.ly/2OdXXW2

Figure 8- Reality-Virtuality Continuum: Milgram, P. and F. Kishino. 1994. A Taxonomy of Mixed Reality Visual Displays. IEICE Transactions on Information and Systems, Vol. 77 (12): 1321.

Figure 9- Embodiment: Flavián, C., Ibanez-Sanchez, S., Orus, C. 2018. The impact of Virtual, Augmented and Mixed Reality Technologies on The Customer Experience. Journal of Business Research. Vol. 100. pp. 547-560

Figure 10- Presence: Flavián, C., Ibanez-Sanchez, S., Orus, C. 2018. The impact of Virtual, Augmented and Mixed Reality Technologies on The Customer Experience. Journal of Business Research. Vol. 100. pp. 547-560

Figure 11- Interaction: Flavián, C., Ibanez-Sanchez, S., Orus, C. 2018. The impact of Virtual, Augmented and Mixed Reality Technologies on The Customer Experience. Journal of Business Research. Vol. 100. pp. 547-560

Figure 12- EPICube: Flavián, C., Ibanez-Sanchez, S., Orus, C. 2018. The impact of Virtual, Augmented and Mixed Reality Technologies on The Customer Experience. Journal of Business Research. Vol. 100. pp. 547-560

Figure 17- Location of the site inside the Mimoza Bay: google.com.tr/maps/place/Mimoza+Koyu+Plajı

Figure 18- First Image of the test area: Author’s picture taken by Ali Ege Çelebi

APPENDICES

Appendix A: Informed Consent Form

Bilgilendirilmiş Onam Formu

Bu çalışma İzmir Ekonomi Üniversitesi, Güzel Sanatlar Fakültesi, Öğretim Üyesi, Öğretim üyesi Dr. Güzden Varinlioğlu ve Psikoloji Bölümü, Öğretim Üyesi, Dr. Burak Erdeniz tarafından yürütülmektedir.

Bu çalışma su altı ortamlarının dikkat üzerine etkisini ölçmek amacıyla geliştirilmiştir. Bu çalışmada isminiz herhangi bir şekilde istenmeyecektir. Çalışmada katılımcılardan toplanan veriler bilgisayar tarafından atanan katılımcı numarası ile eşleştirilecektir.

Çalışmaya katılmanız tamamen kendi isteğinize bağlıdır. Katılımı reddetmekte ya da herhangi bir neden belirtmeksizin çalışmayı yarıda bırakıp çıkmakta özgürsünüz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman bırakıp çıkabileceğimi biliyorum. Benden alınan verilerin ismim kullanılmaksızın bilimsel amaçlı yayınlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra araştırmacıya geri veriniz).

Katılımcı no: Tarih

İmza

----/----/-----

Appendix B: Information Form

BİLGİ FORMU

Cinsiyetiniz : Kadın Erkek

Yaşınız : …………………..

Her hangi bir sağlık probleminiz var mı ? Evet Hayır

Tanısı konulmuş herhangi bir psikiyatri probleminiz var mı ?

Evet (Tanının adı: ....) Hayır

Her hangi bir psikiyatrik kullanıyor musunuz?

Evet (İlacın adı: ....) Hayır

Herhangi bir görme probleminiz var mı ?

Evet (Problemin adı ve derecesi : ....) Hayır

En son ne zaman yemek yediniz ? : ....

En son ne zaman çay veya kahve içtiniz ? : ....

En son ne zaman alkol kullandınız ? : ....

Lütfen şu anki uyku seviyenizi 1'den 5'e kadar değerlendiriniz.

1 2 3 4 5

(1:hiç uykulu değilim; 5: çok uykum var)

Lütfen şu anki yorgunluk seviyenizi 1'den 5'e kadar değerlendiriniz.

1 2 3 4 5

(1:hiç yorgun değilim; 5: çok yorgunum)

Appendix C: Perceived Restorativeness Scale (PRS)

Algılanan Yenilenme Ölçeği (AYÖ)

Görmüş olduğunuz ortamda olduğunuzu hayal edin. Aşağıda verilen ifadelere ne kadar katılırsınız ?

1. Burada bulunmak bir kaçış deneyimi gibi.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

2. Burada zaman geçirmek günlük iş rutinlerimden uzaklaşıp, mola vermemi sağlıyor.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

3. Bu yer etkileyici özelliklere sahip.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

4. Sahnede dikkatimi çeken bir çok ilginç şey var.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

5. Bu yeri daha iyi tanımak istiyorum.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

6. Burada incelenecek ve keşfedilecek çok fazla şey var.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

7. Çevreye bakmak için daha fazla zaman ayırmak istiyorum.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

8. Burada sevdiğim şeyleri yapabilirim.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

9. Buraya aitmişim gibi hissediyorum.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

10. Bu ortamla kendimi bir bütün olarak hissediyorum.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

11. Burada olmak benim karakterime uyuyor.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

12. Böyle bir yerde kendimi eğlendirmenin yollarını bulabilirim.

(tamamıyla katılmıyorum) 1___2___3___4___5___6___7___8___9 (tamamıyla katılıyorum)

Appendix D: Perceived Restorativeness Form (Han Scale)

Algıda Yenilenme Ölçeği (HAN Ölçeği)

(F1) Görmüş olduğunuz sahnede olduğunuzu hayal edin. Duygusal tepkinizi nasıl tanımlarsınız?

Memnuniyetsiz Memnun

(çok) 1____2____3____4____5____6____7____8____9 (çok)

Endişeli Rahatlamış

(çok) 1____2____3____4____5____6____7____8____9 (çok)

(F2) Görmüş olduğunuz sahnede olduğunuzu hayal edin. Fiziksel tepkinizi nasıl tanımlarsınız?

Nefes alışım/ nefesim gittikçe hızlanıyor.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

Ellerim terliyor.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

(F3) Görmüş olduğunuz sahnede olduğunuzu hayal edin. Bilişsel tepkinizi nasıl tanımlarsınız?

Gösterilen sahne ilgimi çekiyor.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

Gösterilen sahneye dikkatimi verdiğimi hissediyorum.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

(F4) Görmüş olduğunuz sahnede olduğunuzu hayal edin. Davranışsal tepkinizi nasıl tanımlarsınız?

Burayı daha sık ziyaret etmek isterim.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

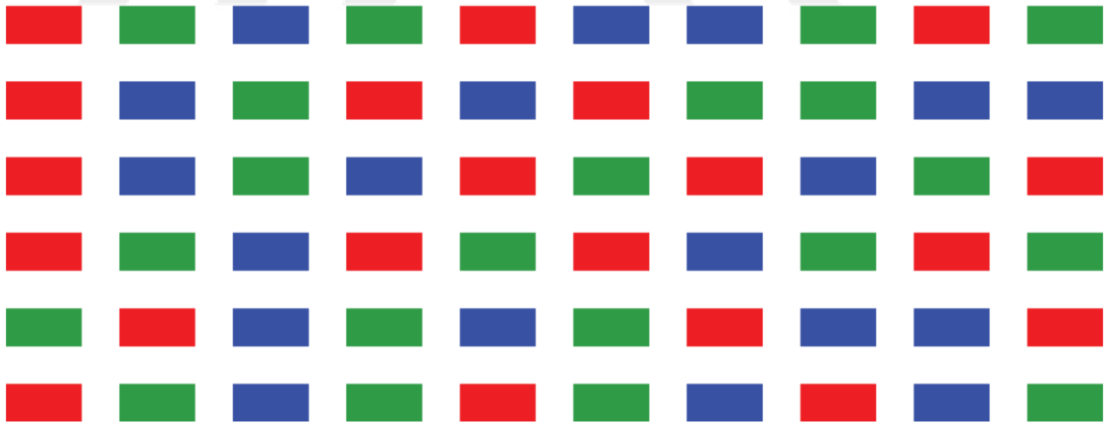
Burada daha uzun kalmak isterim.

(hiç) 1____2____3____4____5____6____7____8____9 (çok fazla)

Appendix E1: Stroop Effect Test (SET)

Stroop Efekt Testi (SET)

KIRMIZI	YEŞİL	MAVİ	YEŞİL	KIRMIZI	MAVİ	MAVİ	YEŞİL	KIRMIZI	YEŞİL
KIRMIZI	MAVİ	YEŞİL	KIRMIZI	MAVİ	KIRMIZI	YEŞİL	YEŞİL	MAVİ	MAVİ
KIRMIZI	MAVİ	YEŞİL	MAVİ	KIRMIZI	YEŞİL	KIRMIZI	MAVİ	YEŞİL	KIRMIZI
KIRMIZI	YEŞİL	MAVİ	KIRMIZI	YEŞİL	KIRMIZI	MAVİ	YEŞİL	KIRMIZI	YEŞİL
YEŞİL	KIRMIZI	MAVİ	YEŞİL	MAVİ	YEŞİL	KIRMIZI	MAVİ	MAVİ	KIRMIZI
KIRMIZI	YEŞİL	MAVİ	YEŞİL	KIRMIZI	YEŞİL	MAVİ	KIRMIZI	MAVİ	YEŞİL



Appendix E2: SET Instructions

SET Uygulaması:

Teste başlamadan önce, katılımcının renkleri ayırt edebildiğinden ve yazıları okuyabildiğinden emin olmak için aşağıdaki sorular sorulur. Buradaki renkli yazıları okuyabiliyor musunuz?

Burada gördüğünüz renkleri bana söyleyebilir misiniz? Buradaki renkli kelimelerin renklerini bana söyleyebilir misiniz? Eğer katılımcı bunları söyleyebiliyorsa teste başlanır.

Kare Rengi Söyleme

Burada renkli kutucuklar görüyorsunuz. Bu kutucukların renklerini olabildiğince hızlı ve doğru bir biçimde söylemenizi isteyeceğim. Kalemle veya elinizle takip edin ki nerede olduğunuzu bileyim.

Renkli Kelimeleri Okuma

Şimdi burada gördüğünüz renkli kelimeleri yine olabildiğince hızlı ve doğru bir biçimde okumanızı isteyeceğim.

Renkli Kelimelerin Rengini Söyleme

Şimdi bu renkli kelimelerin yazıldığı mürekkebin rengini yine olabildiğince hızlı ve doğru bir biçimde söylemenizi isteyeceğim. Eğer hata yaptığınızı fark ederseniz, hızlıca düzeltin ve devam edin.

Test boyunca katılımcının yaptığı hatalar ve anlık düzeltmeler kaydedilir.