Virtual Reality Escape Room

Raising Awareness for the United Nations Global Sustainable Development Goals by means of a Virtual Reality Escape Room

Graduation Thesis

Student name: Jelmer Weken
Student administration number: 153583
Study programme: Kunst & Techniek
Client: United Nations
Graduation Tutor: Mark Melenhorst
Project Tutor: Matthijs van Veen

Submission date: 18 June 2019
Abstract

This graduation thesis details an attempt at raising awareness, among a defined target audience, for the United Nations Sustainable Development Goal 14: Life under water, by means of a virtual reality escape room (VRER).

In order to reach the goal of raising awareness a concept was developed revolving around splitting up the complex information of the subject matter into ‘fragments’. These fragments, objects that exist in virtual space, are then placed at strategic locations inside a VRER.

A prototype of this VRER was developed and tested with people from the target audience. The target audience was interviewed before and after their experience inside virtual reality and they also filled out a short questionnaire.

The results of testing sessions show that the individual fragments of information are capable of conveying messages to a diligent observer. When the players are given the objective to ‘solve puzzles’ in order to complete the VRER within a given time limit, they no longer pay as much attention to the details of their surroundings that don’t seem immediately relevant to the completion of their goals.

In order to successfully reach the goal of ‘raising awareness by means of a VRER’ more research is required. To this end, a number of practical recommendations are made for improvements to the latest prototype.
Preface

From January to June I have worked, together with a project group, on designing, developing and testing a virtual reality escape room concept aimed at raising awareness for the United Nations Sustainable Development Goals.

This graduation report is the result of that work. It describes the processes that led to the design and development of a prototype and how this prototype performed during testing.

Contact with the client, the UN, ultimately proved to be not possible. However, I’d like to thank Matthijs van Veen, the project tutor, for stepping up when he did and assuming this role of ‘client’.

I’d like to thank Mark Melenhorst, my graduation tutor, for his guidance, feedback and quick responses to my queries, throughout the entire project.

I would especially like to express my gratitude towards the project group I worked together with over these past few months; Ivan Aščić, Kirara Chalfant, Hannah Keulen, Rodrigo Sanchez and Slavi Stoev. Without their skills, expertise, hard work and creative input I could not have developed the prototype featured in this report. You guys really came through!

I would like to thank all the participants who tested the prototype and let me interview them.

Finally I would like to thank my dad for his support and feedback, particularly during the last stages of this project.

Jelmer Weken

Enschede, June 17, 2019
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>1</td>
</tr>
<tr>
<td>Preface</td>
<td>2</td>
</tr>
<tr>
<td><strong>Chapter 1: Practical Analysis</strong></td>
<td>4</td>
</tr>
<tr>
<td>1.1 Reason for the assignment</td>
<td>4</td>
</tr>
<tr>
<td>1.2 Stakeholders</td>
<td>4</td>
</tr>
<tr>
<td>1.3 Objectives of the client</td>
<td>5</td>
</tr>
<tr>
<td>1.4 Scope</td>
<td>6</td>
</tr>
<tr>
<td>1.5 Literature research questions</td>
<td>9</td>
</tr>
<tr>
<td><strong>Chapter 2: Theoretical framework</strong></td>
<td>10</td>
</tr>
<tr>
<td>2.1 Sustainable Development Goals</td>
<td>10</td>
</tr>
<tr>
<td>2.2 Defining ‘raising awareness’</td>
<td>12</td>
</tr>
<tr>
<td>2.3 How to raise awareness</td>
<td>12</td>
</tr>
<tr>
<td>2.4 Virtual reality</td>
<td>15</td>
</tr>
<tr>
<td>2.5 Escape rooms</td>
<td>16</td>
</tr>
<tr>
<td>2.6 Raising awareness using virtual reality escape rooms</td>
<td>17</td>
</tr>
<tr>
<td>2.7 Analysis of the theory</td>
<td>19</td>
</tr>
<tr>
<td><strong>Chapter 3: Concepting</strong></td>
<td>20</td>
</tr>
<tr>
<td>3.1 Concepts</td>
<td>20</td>
</tr>
<tr>
<td><strong>Chapter 4: Designing the Solution</strong></td>
<td>21</td>
</tr>
<tr>
<td>4.1 Choosing a topic</td>
<td>21</td>
</tr>
<tr>
<td>4.2 Splitting up the information</td>
<td>21</td>
</tr>
<tr>
<td>4.3 Designing and building</td>
<td>21</td>
</tr>
<tr>
<td><strong>Chapter 5: Testing the Solution</strong></td>
<td>23</td>
</tr>
<tr>
<td>5.1 Research method</td>
<td>23</td>
</tr>
<tr>
<td>5.2 Testing prototype V0</td>
<td>25</td>
</tr>
<tr>
<td>5.3 Testing prototype V1</td>
<td>27</td>
</tr>
<tr>
<td><strong>Chapter 6: Conclusions and discussion</strong></td>
<td>31</td>
</tr>
<tr>
<td><strong>Bibliography</strong></td>
<td>33</td>
</tr>
<tr>
<td><strong>APPENDIX A: Prototypes</strong></td>
<td>35</td>
</tr>
<tr>
<td><strong>APPENDIX B: List of Information fragments</strong></td>
<td>39</td>
</tr>
<tr>
<td><strong>APPENDIX C: Interviews</strong></td>
<td>43</td>
</tr>
<tr>
<td><strong>APPENDIX D: UTAUT Questionnaire</strong></td>
<td>46</td>
</tr>
<tr>
<td><strong>APPENDIX E: Script</strong></td>
<td>47</td>
</tr>
<tr>
<td><strong>APPENDIX F: Concepts</strong></td>
<td>48</td>
</tr>
<tr>
<td><strong>APPENDIX G: Assessment form</strong></td>
<td>54</td>
</tr>
</tbody>
</table>
Chapter 1: Practical Analysis

1.1 Reason for the assignment

From 2000 till 2015 the United Nations worked towards the so called Millenium Development Goals, or MDGs. These goals were made to globally reduce extreme poverty.

The main goal of the MDGs was to half the amount of people living on less than $1.25 a day. This goal was reached well before the 2015 deadline (United Nations, 2015). Although some people say that due to the rapid economic growth in countries such as China this goal would have been reached regardless, the MDGs are still considered a success (Gaffney, 2014).

Therefore, in 2015, the UN created a new set of goals for the next 15 years; the sustainable development goals, or SDGs. The SDGs are split up in 17 different categories dealing with issues related to poverty, hunger, quality education and global environment.

A previous 3S project group took on the assignment of ‘raising awareness for the SDGs’ and they decided to develop an escape room. The UN expressed interest in this escape room and would like to see it developed further into a virtual reality experience.

Thus, a new 3S project has been created with the goal of creating a prototype of this VR escape room.

I will partake in this project with the following graduation assignment: Raise awareness for the United Nations’ Sustainable Development Goals using a virtual reality escape room.

1.2 Stakeholders

This graduation assignment deviates from the norm in some ways. Due to the complex composition of stakeholders and objectives I will try to clearly explain who is involved in this project and how.

The United Nations

The United Nations is an international organization founded in 1945. It is currently made up of 193 Member States. The mission and work of the United Nations are guided by the purposes and principles contained in its founding Charter. - (from the UN website)

The United Nations are the client for this project, it is their objective to raise awareness for the SDGs. In order to meet the expectations of this client we would normally keep them informed about our progress so they can provide us with feedback. Unfortunately we are not able to communicate with the contact person at the UN directly, this will be done through the projects supervising teacher; Matthijs van Veen.
The UN expressed interest in the assignment but didn’t actually come up with it. The assignment was actually formulated by Saxion, based on the results of a previous 3S project.

As mentioned, the United Nations is also unable to actively be involved in the project. Therefore a lot of responsibilities from the client will be handled by Matthijs, the teacher in charge of the 3S project.

The project team

I will be working closely together with a 3S project team. They are my most important partner during this assignment because my solution will be implemented into their prototype. Their assignment is essentially the same as mine, to raise awareness for the SDGs through a virtual reality escape room.

While the team works hard on building a visually stunning, functioning and fun prototype of the escape room. I have some freedom to go more in-depth into how to best achieve the underlying objective of raising awareness within this medium.

1.3 Objectives of the client

The UN has commissioned a virtual reality escape room. The intended use of this application is to raise awareness for the SDGs, but here are multiple ways one could explain that objective.

The contents of the individual goals

One way to explain the objective of ‘raising awareness for the SDGs’ is to focus on the contents of the goals and to make the player aware of the issues and goals described within.

For example: Players would be told about climate change, its effects on the environment and the causes of it. The players would be informed about the targets defined within the SDGs that should be reached in order to affect improvement. The players would be informed about the indicators the SDGs define in order to measure the severity of the issue. The players could be informed about the role of the UN in making progress towards this goal.

The ‘concept’ of SDGs

A different interpretation of the assignment is raising awareness is for the SDGs themselves, the ‘list’ of 17 goals the UN wants to achieve by 2030. This would be about the overarching ‘idea’ behind the SDGs.

For example: Players would be informed about what the SDGs are, why they exist and how the SDGs are constructed. Players would be informed about how and why the SDGs set targets and define indicators. Players would be informed about the involvement of the UN in working towards their completion.
This approach is more abstract and it is likely a bigger challenge to raise awareness for.

The objective behind the objective
In turn, the SDGs themselves could also be considered objectives, and the ‘awareness raised’ would ultimately have to contribute to achieving them.

1.4 Scope
As mentioned, this graduation assignment deviates from the norm in some ways. In order to properly execute it, we need to properly define the scope and limitations of this project.

As mentioned above, there are multiple ways to interpret the assignment and the objectives of the client and therefore multiple ways to approach the assignment. Normally, one would consult with the client in order to figure out in detail what their goals are, why they issued this assignment and what their preferences and priorities are regarding the multiple directions and approaches possible. During the first stages of the project several ways were explored by developing multiple concepts that were to be presented to the client. Due to the unavailability of said client the scope of the project has largely been defined based on consultations with the project group and Matthijs van Veen. Additionally some assumptions have been made about what the client would want most out of this project.

Direction
The 3s project group has decided to focus on a single SDG, namely number 14: Life under water. The concept they will develop will aim to address as many threats to ocean life as possible such as; acidification, ocean temperature and plastic waste. The objective will be to inform the player about these threats and cause them to think about their own personal impact on the environment and the impact of humanity in general.

Increasing the knowledge of our players will be the primary goal of of our product.

Some would criticize the pursuit of raising awareness without knowing how to translate that awareness into action. (Christiano & Neimand, 2017).
However, these same critics do acknowledge that public awareness can have its merits:

“Making the public more aware of an issue can, of course, be a critical step in creating an environment where change is possible. [...] Raising awareness about something that wasn’t known before can be a useful tactic when it’s part of a larger effort to drive social change.” (Christiano & Neimand ,2017)

Considering that our product is connected to the UN’s SDGs I would argue that it is in fact part of a larger effort to drive social change (Gaffney, 2014; Bierman et al, 2017).
The concept

During the first stages of the project we had multiple brainstorm sessions, worked out multiple concepts that approached the assignment from different angles and presented these concept to the project manager, Matthijs van Veen. Although the eventual escape room concept will be developed further throughout the project, for now the core structure has been decided on by the project group. This concept was favored over our other options because we believed the narrative structure was uniquely suited for an escape room while at the same time providing numerous opportunities for raising SDG awareness.

The narrative will take the player on a trip in a submarine to the Great Barrier Reef to do scientific research. After a short tutorial scene plastic waste will get caught in the submarine and it will crash-land on the ocean floor. The player has to fix the submarine, from both the inside and outside in order to escape to the surface before their oxygen supply runs out.

![Figure 1](image1.png) ![Figure 2](image2.png)

During their adventure the player is confronted with human impact on the environment in various ways, such as the dying coral around them. During the tutorial the player will also conduct some scientific tests. There is also the plastic waste that is a hazard to marine life and the reason the player is in their current predicament.

Target audience

The audience has been defined as both men and women within the age range 14 to 30. The goal is to reach a broad as possible audience so we will try not to focus on any particular level of education or political preference. In light of the SDGs overarching idea regarding global consensus we will not target any specific nationality or ethnic/religious group. Users might or might not have pre-existing experience with either virtual reality, escape rooms or video games. We will develop our game in English, so the ability to speak and read English is a requirement.
Having defined our audience as broad as we have does not mean we don’t have to justify choices based on our users’ preferences. Due to the inclusive and politically neutral nature of the United Nations themselves it is important that we actively avoid designs that might exclude people based on any of the above mentioned parameters.

**Additional limiting conditions and project boundaries**

When the underlying objective of the client is defined as ‘raising awareness’ then the requested method of ‘a virtual reality escape room’ could very well be considered a limiting condition. Although one could question whether this method is the best way to reach the objective substantiating this choice is also outside the scope of this project. I refer to the research report by the previous 3s project for the reasoning behind this decision.

Considering the time frame of a single semester, it is not possible to research every single facet of this assignment in equal detail. Therefore I will focus my efforts into the following question: ‘how to use the medium to achieve the goal?’ Where the medium is defined as a ‘virtual reality escape room’ and the goal ‘to raise awareness for the UN’s SDGs.’

On a more practical note there are some project requirements related to technology and facilities. The final product has to be developed using the software development tool Unreal Engine. Hardware and working space has been provided by Saxion.

**Scope summary**

- The virtual reality escape room that will be used for the goal of raising awareness will focus on a single SDG, number 14: Life under Water.
- The narrative and locations have been decided on.
- The target audience has been defined; 14-30 years of age, inclusive as possible towards all genders, ethnicities, nationalities, levels of education, political preferences and religious beliefs. However, we will presume the ability to speak and read English.
- The usage of a ‘virtual reality escape room’ could be considered a limiting condition as well.
- The question of whether or not a ‘virtual reality escape room’ is the most suitable solution for ‘raising awareness for the SDGs’ lies outside the scope of this paper.
- The focus of these paper will be directed towards: ‘how to use the medium to achieve the goal?’
1.5 Literature research questions

Main question
The scope of this project is limited to researching objective the ‘how’ part of the assignment. Following up on that I will define the main research question as:

- How can we raise awareness for Sustainable Development Goal #14: Life under Water using an escape room that is experienced in virtual reality?

Sustainable Development Goals
In order to understand the subject matter of this graduation assignment it is important to take a good look at what we are supposed to ‘raise awareness’ for.

- What are the Sustainable Development Goals?
- How are SDGs constructed?
- How are the SDGs supposed to work?

Raising awareness
The purpose of the final product is to raise awareness. But how do we define awareness? And how do we ‘raise’ awareness? We will need an answer to the following questions before we continue:

- How do we define awareness?
- How do we define raising awareness?
- What does raising awareness normally look like?
- Can we isolate a clear set of guidelines for raising awareness that we can use for this project?

Virtual Reality Escape room
The chosen medium for this project is a virtual reality escape room. Technically, virtual reality is the medium and the escape room is the genre. Regardless we should properly define both these principles. We must also investigate any relation they might already have to ‘raising awareness’ in literature.

- How do we define virtual reality within this project?
- What is an escape room?
- Have virtual reality applications been used to ‘raise awareness’, ‘generate attention’ or ‘provide knowledge’ before? And, if yes, how?
- Have escape rooms ever been used to ‘raise awareness’, ‘generate attention’ or ‘provide knowledge’ before? And, if yes, how?
Chapter 2: Theoretical framework

2.1 Sustainable Development Goals

The Sustainable Development Goals (SDG) are a rather abstract construct, but since they form such an integral part of this paper's subject matter I believe it is important that we take some time to explain what they are, how they are set up and how they are supposed to work.

Sustainable development

“meeting the needs of the present without compromising the ability of future generations to meet their own needs” - World Commission on Environment and Development, 1987

Targets & Indicators

The SDGs are goals, they are split up into 17 categories, each category has a goal. Within these categories there are targets and indicators. Targets are concrete objectives that should be achieved. Targets have corresponding indicators, those are ways to measure to what extent the objectives are being accomplished.

Some examples (un.org):

<table>
<thead>
<tr>
<th>Category</th>
<th>Goal</th>
<th>Example of target</th>
<th>corresponding indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 No poverty</td>
<td>End poverty in all its forms everywhere</td>
<td>By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day</td>
<td>Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)</td>
</tr>
<tr>
<td>#5 Gender equality</td>
<td>Achieve gender equality and empower all women and girls</td>
<td>End all forms of discrimination against all women and girls everywhere</td>
<td>Whether or not legal frameworks are in place to promote, enforce and monitor equality and non-discrimination on the basis of sex</td>
</tr>
<tr>
<td>#14 Life under water</td>
<td>Conserve and sustainably use the oceans, seas and marine resources for sustainable development</td>
<td>By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution</td>
<td>Index of coastal eutrophication and floating plastic debris density</td>
</tr>
</tbody>
</table>
Rationale behind the Sustainable Development Goals

The SDGs are the heart of the 2030 Agenda for Sustainable development, they have been adopted by all member states of the United Nations in 2015 and they are ‘an urgent call to action by all countries’ (UN Website, z.d.).

The SDGs are an acknowledgement of global issues and concerns, a statement, a pledge, a promise. They are about forming partnerships to work together towards a better future.

The SDGs are not a contract. There isn’t any governing body equipped with the authority to enforce countries to make decisions that further the SDG agenda or to forbid countries to take courses of action that jeopardize the SDG objectives.

Instead, the success of the SDGs depends on countries and organizations to take initiative and work towards achieving them on their own accord.

“In order to make the 2030 Agenda a reality, broad ownership of the SDGs must translate into a strong commitment by all stakeholders to implement the global goals.” - (UN Website, z.d.)

What makes them work

“The 17 Sustainable Development Goals (SDGs) of the United Nations present a novel approach to global governance where goal-setting features as a key strategy.” - Biermann et al, 2017

Even though the SDGs are seemingly without any real obligation, they are related to concerns shared by all participating partners. The SDGs basically assume that people, organizations and governments care about working towards a sustainable future.

By providing goals, the SDGs aim to structure and prioritize the effort that goes towards achieving the objectives. While at the same time they aim to underline and promote the perceived relevance of the global issues they are about.

“In short, the ultimate goal of the SDGs is to promote a new worldview and provide the beginnings of a plan to end poverty without imposing significant costs on Earth’s lifesupport systems.” - Gaffney, 2014

Does that work?

Bill Gates, an outspoken advocate of the MDGs and SDGs argues that setting clear goals with measurable targets were of great importance to getting people to work together towards achieving the Millennium Development Goals.

Mister Gates has described the MDGs as a global report card that rates our performance, and like how report cards motivate students, the MDGs motivated nations (Bill Gates, 2008).
2.2 Defining ‘raising awareness’

Although there are plenty of articles about raising awareness for publicly relevant topics none of them seem to take the trouble of carefully defining the term ‘awareness’.

In the dictionary, awareness is defined as “the quality or state of being aware : knowledge and understanding that something is happening or exists” (Merriam-Webster, z.d.). Raising awareness would be to raise the state or heighten the quality of being ‘aware’. To increase the knowledge and understanding of a subject.

In commercial marketing however, there exists the concept of ‘brand awareness’, which is defined as ‘the customers ability to recognize and recall the brand when provide a cue’ (Berry, 2000, Bilgihan et al. 2014, Bareda et al. 2015).

In our particular context, we want to raise the knowledge of the target audience about human impact on marine ecosystems. When asked about this topic, we want them to be able to recall that knowledge and be able to reproduce it.

2.3 How to raise awareness

There are many examples of public information campaigns with the objective to increase the awareness of publicly relevant issues, normally with the intent to affect behavioral change. Although our product won’t exactly be a ‘campaign’, the similarities in purpose and setup make it relevant comparison.

Weiss & Tschirhart (1994) have evaluated a 100 public information campaigns. Their evaluation demonstrates that an effective campaign successfully navigates the demands of 4 tasks:

1. To capture the attention of the right audience
2. To deliver an understandable and credible message
3. To deliver a message that influences the beliefs or understanding of the audience
4. To create social contexts that lead toward desired outcomes
(Weiss & Tschirhart, 1994)

#1 Capturing the attention of the right audience

The first task, is split up in three challenges; (1) defining the audience, (2) selecting the right channel and (3) generating attention (Weiss & Tschirhart, 1994). Defining the right audience is about knowing who you want to reach with your campaign. When you have clearly defined a specific audience, you can pick the right channel to reach this audience (Weiss & Tschirhart, 1994).

For this assignment, the channel has been decided for us; a virtual reality escape room. This is not the order advocated by Weis & Tschirhart, but the 3S project group has defined the target
audience with this medium in mind. Therefore we may assume an appropriate fit between channel and audience.

Challenge number 3, generating attention, is to make your audience take notice of your message. Simply putting your message in front of them is not enough. On most media you have to compete with entertainment, news, commercial advertising and other forms of information vying for the attention of your audience (Weiss & Tschirhart, 1994). For example; to generate attention for their message a campaign could use a ‘catchy slogan’ or star a celebrity that is loved by the target audience.

For this project the relative novelty of virtual reality and the rising popularity of the ‘escape room concept’ will be the key generators of attention.

#2 Delivering an understandable message

“Campaigns should deliver messages that are clear, credible, and easy to understand.” (Weis & Tschirhart, 1994)

Source credibility
The message should come from a source that members of the target audience find credible. Whether our target audience perceives the UN as a credible source on global issues or not, we do not know, but, since this is not something we have any control over whatsoever, we will assume that they do.

Message clarity
Delivering an understandable and clear message can become a complex challenge given the prerequisite of using a virtual reality escape room as the channel. Clarity is related to the channel and for example print can deliver more complex messages than broadcast media (Weis & Tschirhart, 1994). Further on in this theoretical framework I do research into the virtual reality medium, where I shall take specific care investigating its capacity for conveying complex messages.

Fit with prior knowledge
A campaign tends to be more successful when it delivers a message that fits with prior knowledge the target audience might already have about the subject. The message shouldn’t contradict established beliefs or introduce brand new language or material (Weis & Tschirhart, 1994). We do not believe our subject matter contradicts established beliefs, but we should take note that when composing the dialogue for narrative we are careful with our choice of words.

Exposure duration
Finally, for a successful campaign it must be known how long the campaign must run and how many exposures are required for the audience to understand its message (Weis & Tschirhart, 1994).
Our product consists of a single experience that will last around 20 minutes. During our concepting stage, we did take scalability of our product into account and theorized the possibility of turning our product into a ‘series’ where each episode could be an escape room related to a different SDG. This falls outside the scope of our current project but it is something we should recommend to our client to look into when the current project has been concluded.

#3 Influencing the beliefs or understanding of the audience

Even if the right message has reached and been understood by the target audience, they might still not be persuaded or convinced (Weis & Tschirhart, 1994). Weis & Tschirhart discuss four models that can be used to effectively influence the target audience, each with different objectives.

Provide information

This model comes down to educating the target audience about the consequences of their decisions and/or providing alternatives. The drawback of simply providing new information is that it is hard to control or predict the way individuals process and interpret this information. For example; anti-drug campaigns sometimes inspire members of the target audience with a desire for experimentation with drugs (Weis & Tschirhart, 1994). Regardless, many campaigns succeed in informing people about the consequences of their actions by providing new information (Weis & Tschirhart, 1994).

Direct Attention

Media campaigns have the effect of influencing what people think about. Exposure to certain topics cause people to judge those topics as more important or relevant (Weis & Tschirhart, 1994).

Trigger norms

“By reminding the audience of the social acceptability or the ethical implications of their behavior, the campaign seeks to shift the relative influence of various considerations in the individual’s reasoning.” - (Weis & Tschirhart, 1994)

In order for this approach to be successful it is important that the norms triggered are powerful and connected to the behaviour you want to influence.

A paper on the psycho-social determinants of pro-environmental behaviour supports this: “Problem awareness is an important but indirect determinant of pro-environmental intention. Its impact seems to be mediated by moral and social norms, guilt and attribution processes.” - (Bamber & Möser, 2007)

Change underlying values and preferences

According to Weis & Tschirhart this is the most ambitious and difficult to achieve as it tries to convince people to change the way they think about a certain topic.
#4 Creating Social Contexts that Lead Toward Desired Outcomes

Successful campaigns acknowledge the importance of social context and aim to influence not just the target audience, but also significant social groups that in turn influence the behaviour of the audience as well.

In our project we do not focus on our target audiences social context, but they can be considered a social context themselves.

2.4 Virtual reality

Defining Virtual Reality (VR)

In a paper dedicated to specifically to finding a definition for virtual reality (VR) Jonathan Steuer proposes the following definition:

“A “virtual reality” is defined as a real or simulated environment in which a perceiver experiences telepresence” - Steuer, 1993

This definition requires us to define ‘telepresence’ as well:

“Telepresence is defined as the experience of presence in an environment by means of a communication medium.” - Steuer, 1993

In his paper, Steuer also defines ‘presence’ as “the sense of being in an environment”. Attempts at finding a more recent definition for the term VR have proved very challenging. The most recent paper I found that provided a clear definition of the term VR was from 2015:

“use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear and feel similar to real world objects and events” - Laver et. al, 2015

However, this text sources another paper from 2006 (Weiss et. al, 2006), that in turn sources two other papers from 1992 and 1998 (Sheridan 1992, Weiss and Jessel 1998).

For this project, Steuers definition seems quite impractical. Steuer claims that VR is typically portrayed as a medium, that is usually defined in terms of hardware. Steuers issue with a technology-based definition for VR is that it is not suitable for academic purposes.

Lavers definition seems much more suited for our particular use case, but it remains rather unspecific.

In our case, I believe a technology-based definition, derived from the requirements of this project is in fact what we really need. Therefore I define ‘virtual reality’ within the scope of the project as follows:
Virtual reality is a digitally rendered environment that is perceived by the user by means of a head mounted device.

A head mounted device (HMD) is a device that uses stereoscopic imaging and tracking hardware to show the user a view of the digital environment that is perfectly aligned with the real world position and orientation of their head.

It is assumed that the user experiences a sense of ‘being present in the digital environment’.

The user can interact with the virtual environment using two hand-held controllers that are also being tracked and are therefore ‘present’ in the environment.

2.5 Escape rooms

“An escape room is a game played by a team of people where they have to ‘escape’ from a room filled with challenges within a given time limit. In order to win (‘escape’), the players must solve the challenges contained within the room. At the outset of the game, the challenges may be made inaccessible and must be found by completing puzzles” - (Wiemker et al, 2015)

For our project we shall adopt this definition of an escape room. However, due to technical restrictions we cannot allow our product to be experienced by more than one person at once. Therefore our game will not be played by a team of people but by a single player.

Challenges and puzzles

At the core of every escape rooms lie challenges and puzzles. Without further clarification, the terms ‘challenge’ and ‘puzzle’ as used in our definition, could be used interchangeably. Since solving the puzzles are challenges and the challenge of escaping the room lies in having to solve puzzles. To avoid these terms to get confusing I will define them individually.

Challenges

The challenges are the ‘goals’ the game presents to the player. The main challenge is to ‘escape’, but in order to escape you need the key for the door, which in turn is hidden somewhere in the room. This way the main challenge gets divided into sub-objectives. Some sub-objectives might not reveal themselves until certain progress has been made in the game.

Puzzles

Puzzles are the ‘hurdles’ the player has to overcome in order to achieve the goals, or, in other words, complete the challenges.
2.6 Raising awareness using virtual reality escape rooms

Now that we have defined the individual aspects of our assignments we will take a look at what can be found in literature regarding the combination of one or more parts.

Raising awareness using virtual reality

Numerous examples can be found of virtual reality being used to ‘raise’ awareness.
- Zeiss science vision lab, by NMY. Raising awareness about eye disease.
- The Environmental Defense Fund’s virtual Methane CH4llenge. Raising awareness about the global oil industry.
- TRAPPED: A VR Detective Story, by REEF. Raising awareness about human trafficking.
- Compliment, by Lucy Bonner, raising awareness about harassment.
- Three short films, shown at the Tribeca Film Festival, commissioned by our own client the United Nations. Raising awareness about three different global issues.

By analyzing these examples and looking for similarities between them there are a few things we can learn.

Empathy
VR can make a lot of impact, and it is regularly used for quite ‘heavy’ topics. For example, by putting people in the same room as a mother who lost two sons during the Israel-Gaza conflict in 2014, or a girl living under the overwhelming conditions of the crisis in Syria. A lot of these issues can feel very remote to people under normal circumstances. By placing people ‘in’ these situations they are forced to empathize.

Perspective
VR has the ability to put you in a different environment, but it also has the ability to put you in someone else’s shoes. The Zeiss science vision lab, Trapped, and Compliment applications all make use of this by making you experience what it is like to, respectively; have an eye disease, become a victim of human trafficking or be a woman being sexually harasseed in the streets.

Applied escape rooms

Education
Quite a few examples can be found of escape rooms being used for educational purposes. Due to the classical definition of escape room pertaining to a ‘group of people’ however, many of these examples are directed at topics such as; team-building, cooperation and communication (Clarke et. al, 2017; Eukel et. al, n.d.; Paradise & Suchard, 2018; Kinio et. al, 2019).
Some examples can be found where escape rooms have been used as a tool in a marketing campaign.

From 16 November 2017 until 20 December of the same year, the Ministry of Defense in the Netherlands opened a pop-up store featuring an escape room as part of a recruitment campaign (Ministerie van Defensie, 2016).

From 15 November 2017 until 6 February 2018, Google executed a similar pop-up concept called the Google Backstage Tour. They built an escape room in Amsterdam where people could take a look ‘behind the scenes’ at Google (Google, 2017).

This last example is especially interesting to us as it is similar to our project in the way that it ‘raises awareness about a complex topic’. I couldn’t find any additional data about results it might have generated so I have to rely on my own analysis based on a press release (Google, 2017) and a video of people playing the escape room (van der Ven, 2018).

The goal of this project was to raise attention about privacy and Google’s privacy policies in particular. This was done by informing people about how Google collects and uses the personal data of their users.

The escape room was split up into 6 areas, each one had their own purpose. The first one was about security, in order to enter the escape room you had to log in to Google with Google’s two-step verification using your phone.

The second area introduced 4 different people each with their own privacy settings, these 4 people would be the protagonists of the narrative. The story of the escape room was that the players had to take on the role of ‘Google’ itself and help these 4 people with different services.

The third area was a game where the protagonists of the story where watching videos on YouTube. The players had to make appropriate suggestions on ‘what video to watch next’ based on the personal information they had received in the previous area.

The fourth and fifth areas were similar setups, but these covered the services ‘Google maps’ and ‘search’ respectively.

The final area was dedicated to privacy, it told the players that privacy was very important to Google, they could grab a leaflet to take home and they could perform a ‘privacy check’.
2.7 Analysis of the theory

Now that we have a good understanding of the theory surrounding our assignment we can start answering our main research question: “How can we raise awareness for Sustainable Development Goal 14: Life under water, using an escape room that is experienced in virtual reality?”

In order to come up with fitting concepts that answer this question we should take a step back and analyze what important pieces of information we can take away from our theoretical framework.

Based on my findings I believe there are two main challenges to overcome if we want to turn the virtual reality escape room into an experience that can achieve the underlying objective of ‘raising awareness’ for the SDGs.

**Scalability**

A single escape room has the ability to generate attention to the SDGs. But in order to really raise awareness people need to be repeatedly exposed to the message. Campaigns with several novel spots perform better than those with just one or two shown repeatedly (Weis & Tschirhart, 1994).

This leads me to conclude that a scalable solution to raise awareness for the SDGs would be of extra value to the client.

**Communication**

It is important that we convey a clear and understandable message (Weis & Tschirhart, 1994).

Given the requirement that awareness has to be raised through a virtual reality escape room this becomes a complex challenge. Besides formulating and deciding on a concise and comprehensive message relevant to the objectives of any given SDG, it is a challenge to formulate this message due to the nature of the medium.

In order to minimise the chances of failing at this task it is important to research to what extent the target audience understands the message.
Chapter 3: Concepting

3.1 Concepts

Using the challenges regarding scalability and communication as a starting point I did an individual brainstorm session to come up ideas. This led to the creation of some concepts that focus on different aspects of the assignment but all try to solve challenges related to one or both; scalability and communication. I have worked out these concepts in some detail but I will not describe them that thoroughly here. I will include the relevant files as appendices.

In short I developed 4 ideas to pursue:

1. Focussing completely on making the escape room concept as scalable as possible. I would propose to develop a toolkit to develop a series of rooms that would be part of larger campaign.
2. Focussing on both scalability and communication I propose to develop a virtual agent that can serve as a guide to assist players during the VR experience.
3. A solution focused on communication that places traditional media inside a virtual world.
4. A solution utilising the natural incentive to ‘explore’ that is triggered by the escape room concept. Letting players ‘discover’ the story and message by having them encounter ‘snippets’ of information throughout the environment.

Final concept

After discussing the concepts I decided to continue with concept 4. Both concepts 1&2 aren’t feasible to design, develop, implement and test within the time limits of this project. Concept 3 might be possible but I am afraid relying on traditional media to relay the message would undermine the advantages presented by the use of virtual reality.

Concept 4 is the solution that I believe makes the most appropriate use of the benefits provided by the the scope of the project: the natural form of gameplay found in escape rooms.
Chapter 4: Designing the Solution

4.1 Choosing a topic

The first order of business for designing my first prototype is to decide on a topic to share information about. I have decided to choose ‘Coral Bleaching’ as this topic.

Coral bleaching is a problem that is connected to most other problems we want to address with our game. Coral reefs are complex, vast but unfortunately also quite fragile ecosystems. Even small changes in water temperature, acid levels or a slight increase in presence of chemicals can cause corals to bleach and subsequently die (Rafferty, 2012). Industrial pollution, global warming, overfishing and commercial waste are therefore all directly or indirectly causes of coral bleaching (Rafferty, 2012).

Since coral bleaching is such a multi-faceted issue it seems particularly suited for this project.

4.2 Splitting up the information

In order to inform the audience about our chosen topic we must make inventory about the available information and divide them into fragments we can turn into informative objects we can place in our environment.

I have decided to split up the information into 4 parts that I formulated as questions.

- What does healthy coral/bleached coral/dead coral look like?
- What causes coral to bleach and then die?
- What are the consequences of coral bleaching on a global scale?
- What can the player as an individual do to help stop coral bleaching?

This way I can test the solution later by letting the target audience play the game and interview them afterwards using these questions as guidelines.

4.3 Designing and building

Designing & building fragments of information

The next step is to take each of these 4 questions and come up with objects that can be used to teach the player their answers. For a full list of all objects I designed and built I refer to appendix .. but I will provide a few examples here as well.

In order to teach the players what, for example, healthy/bleached/dead coral looks like I made three ‘jars’ containing ‘coral specimen’, one for each of the aforementioned stages.
The corals inside these jars are designed to look either healthy, bleached or dead and they have labels on them indicating what they contain. Observing and studying these objects should teach the player the answer to the first question I formulated.

In order to teach the players about the causes of coral bleaching I created an interactive ‘aquarium’ and placed it inside the submarine. The player can play around with this aquarium by pressing the buttons located on the front. When the player presses a button the corals inside will be subjected to a bleaching event caused by either an increase in temperature or acidity.

Apart from the jars and the aquarium I made various other objects ranging from newspapers to posters. Again for a full list of objects I used I refer to appendix..

**Designing & building a playable level**

Simply having fragments of information is not enough. We, of course, need an environment players can move around in to hide these fragments of information in.

Luckily I do not have to do this part entirely by myself. I have worked together with the 3S project group on creating an underwater environment and a submarine.

In order to create a realistic scenario for testing purposes the level needs to be playable. That means the player must be able to interact with the environment and have an objective.

Therefore I have implemented 3 puzzles inside the level that players can actually try to solve.

The environment contains an array of orbs as well, which, at the start of the game are all colored red. Every time a player solves a puzzle an orb is turned green, indicating that the puzzle is solved. This allows players to monitor their own progress.
Chapter 5: Testing the Solution

5.1 Research method

I want to test my solution on its ability to transfer information about the chosen subject. In order to do this I will let people from the target audience play the game and then interview them about their experience.

Interview

In order to review how much the target audience learned about the chosen subject after experiencing the game interview questions were prepared.

These questions are divided into four parts with different purposes:

1. Information about the interviewee, so we can verify that participants belong to the intended target audience and to provide a frame of reference when analyzing the gathered data.
2. Assessing existing knowledge the target audience already has about the chosen subject in order to establish a basis for comparison.
3. Assessing how much the target audience learned about chosen subject during their playthrough of the escape room. In order to analyse the difference in knowledge gained and what they already knew we will compare this to the knowledge they displayed in the previous set of questions.
4. Investigating how the user went through the experience using UTAUT questions to identify external factors that might have had significant impact on the learning process.

Qualitative & Quantitative

In order to test to what extent the target audience has learned about the chosen subject, quantitative data would be ideal. Quantitative data would allow for comparing how much the audience knew about the subject before the experience and how much they knew afterwards.

Unfortunately, acquiring such data is made difficult by various factors. With quizzing participants extensively and in-depth on the subject matter beforehand, comes the risk of informing them about the subject through the questions asked. This would then influence their experience and their learning process.

Another factor is that thoroughly quizzing the audience on the subject would require a lot of time and commitment from the participants. Since this project relies on volunteers there is a limit to what can be expected of them.

In order to get as valuable data as possible a middle ground has been chosen between quantitative and qualitative data.

Open ended questions are used to assess the participants knowledge on the subject both before and after the experience.
Before the experience the participants are asked what they know about, for example, ‘UN’s SDGs’ and if they can list goals and relevant topics. This way we can ask an open ended question but we can still look at the amount of answers to gain some measurable degree of insight into the level of knowledge a participant has on the subject.

**Oral interview**

The interviews are conducted face to face, by the author of this report, rather than letting the participants fill out forms by themselves. I will keep notes, and I will make audio recordings of the interview for later analysis.

**UTAUT Questionnaire**

On top of the interviews I ask participants to fill out a short questionnaire (appendix ...). This questionnaire was made using the UTAUT model (Venkatesh et. al, 2003). UTAUT stands for Unified Theory of Acceptance and Use of Technology. It is a standard model that can be used to research the attitude users have towards your application. I didn’t design my questions from scratch, I found another thesis (Brünink, 2016) that made extensive use of this model and formulated questions using their form as an example.

I have adapted their way of formulating statements that participants can respond to by filling out on a Likert-scale how much they either disagree or agree with that statement.

The UTAUT model identifies quite a few factors influencing the attitude towards technology. I have chosen the ones I believe can generate the most valuable feedback.

**Ease of Use**

Ease of use is a topic that queries the participants about how easy they find it to use the application. I formulated statements regarding some of the core game mechanics such as movement and interaction with physical objects.

**Attitude towards the technology**

This topic asks the participants about how they feel about using virtual reality technology.

**Attitude towards the application**

This covers the participants opinions about the application. I focussed on statements about the visuals of the game and also included statements regarding the extent to which they had fun using the application.
5.2 Testing prototype V0

Before I really started playtesting I tested the first finished fragments with the members of the project group. I wanted to know if the individual fragments were clear and able to teach the players something about the subject. Secondly, I wanted to test my research setup and the interview questions themselves. I wanted to make sure they were formulated clearly enough for everybody to understand, and interpret them the same way.
I did use the data I received from prototype v0.0 to improve v1.0 but this first series of tests do not provide an answer to the research questions proposed by this thesis for several reasons, the most important reason being that this prototype wasn’t a game.

The prototype did not have a goal for the players to strive for. Participants were simply put in the environments and encouraged to ‘explore’.
Combined with the fact that this prototype did not have much else to discover it was no surprise that they all were, without fail, found by all participants.

V0 results

This series of testing might not directly provide answers to the overarching research questions that are asked in this thesis, they did however provide some insights into the extent by which participants learned about the subject through the fragments of information.

Coral safe sunscreen

Studies indicate that the chemicals used in most sunscreens are a particular hazard to corals (Donovaro, et. al.). There are however alternatives available.
The poster I designed to inform about, and encourage the use of, mineral based sunscreen was noticed by all.
On top of that, when asked question #5 of the interview about how the participants thought they as individuals could contribute to the prevention of coral bleaching, they were all able to reproduce the fact about mineral-based sunscreen.

Economics flyer

Although everyone encountered the flyer that contained information about the values of the Great Barrier Reef to humanity in general, and the economy of Australia in particular. Only one participant could reproduce this information during the final interview.
Most people didn’t seem to understand the flyer itself, nor did they pick up the general notion that coral reefs have values beyond being wonders of nature.
Straightforward

The difference between the sunscreen poster and the values flyer is that the poster is very straightforward and concrete whereas the flyer is quite abstract. The poster has a very specific message to the player: ‘use mineral-based sunscreens’. The flyer has a very abstract message: ‘coral reefs are important to multiple very different fields’. When it comes to ‘straightforwardness’, the newspapers[appendix ] are probably on a middle ground between the poster and the flyer. The results from the interviews seem to support this, people were able to reproduce parts of information from the newspapers, but not everyone seemed to understand the whole message.

Practical results from UTAUT questionnaire

The UTAUT questionnaire provided some general insights as well. The attitude towards the technology among participants was generally neutral to positive. The attitude towards the application was generally positive. Participants were somewhat divided however regarding the ‘ease-of-use’ of the application. Although on some aspects, such as ease of movement they did agree that it wasn’t user friendly, the participants had very different opinions on how easy it was to interact with objects in the environment.
5.3 Testing prototype V1

5.3.1 Testing prototype V1.0

The V1 prototype was a great step forward from V0, many more assets were finalized and it had been turned into a real game with puzzles. This however led to the decision to do a preliminary round of testing, with people from the project group, to make sure people understood the game, it’s puzzles and what was expected of them. I was also interested in finding out whether or not there were any game-breaking bugs that could severely interfere with my testing.

Alterations

Although the tests went surprisingly well, some alterations were made to the prototype:

- Some additional textures that had been finished were applied to make the level look better.
- I changed the material on the circuitry blocks to a ‘glossier’ one. This made the markings on the tops and bottoms more distinct and easier to see.
- We modified the so-called ‘nav-mesh’ to prevent players from teleporting to areas of the level they were not supposed to go.
- I changed the location of some of the gears.
- I changed the win-condition of the gearbox puzzle to be a bit more lenient in case some puzzle-pieces were to disappear due to bugs.

Script

For the sake of the research it is important that all participants have the same experience. Therefore I used the results of these tests to write a short script\[appendix \]to guide future participants when playing the game. This script consist of a short introduction of what they will encounter once they put on the headset. They will be told what their objective is (find and solve three puzzles) and how they can monitor their own progress (orbs turning from red to green).

I timed everyone who played prototype V1.0 and found that they completed the game in between 12 and 17 minutes. I decided on a time limit of 15 minutes and included this in the script.

At last the script contains a number of hints that may be shared with the player once certain conditions are met. These conditions can be a time restraint, or they might encounter a specific issue with the prototype that I will then elucidate immediately.
5.3.2 Testing prototype V1.1

After having thoroughly prepared and refined the prototype and research method I tested the application with people from the target audience. I managed to interview 8 people, before, and after the experience. I had everyone fill out the questionnaire as well.

Amongst the group of participants were 3 different nationalities. They all fit in the 14-30 age range. All of them had pre-existing experience with games, 6 of them with virtual reality and half of them with escape rooms.

5.3.3 Results

Overall perception of the subject before the experience

Most people had some pre-existing knowledge of the subject matter, although the degree in which they could explain what they knew differed.

When queried about what they knew about the world’s oceans and its well-being 8 out of 8 participants said that it is going ‘bad’. The extent to which they could elaborate however, differed as shown in figure 3.

![Figure 3](image)

When the subject was narrowed down from ‘the world’s oceans’ to ‘the Great Barrier Reef’ people were less knowledgeable about its status and well-being.

![Figure 4](image)
Fragments of information encountered during the experience

After the experience participants were asked which objects they encountered that they remembered held information about the subject.

![Figure 5](image)

Identifying coral status

Participants were asked what coral looked like in the three different stages of being healthy, bleached or dead.
Not everyone was able to answer this question, but save 2 everyone knew that healthy coral looked colorful, and bleached coral was grey.
Only 3 people were able to tell what dead coral looked like. The notion that there are 3 stages relevant to the concept of coral bleaching did not seem to sufficiently get across.

Knowledge about causes of coral bleaching

When asked what caused coral bleaching, the participants responded with a large number of answers.

![Figure 6](image)

These answers are very diverse and although most of them make sense considering the question, they don’t really make sense in the context of the experience they just had.
Consequences of coral bleaching

The answers of 6 out of 8 participants indicated that they realised coral bleaching caused damage to the local ecosystems and that in particular ‘fish’ would suffer, die and perhaps go extinct. At least 3 participants mentioned the possibility of a chain reaction were more and more species would be exposed to harm due to the collapse of the ecosystem.

Ability to be a positive influence

When asked what the participants could do by themselves to contribute to the prevention of coral bleaching 7 out of 8 answered that they didn’t think they could do much as individuals. 5 out of 8 did mention things like ‘throw your waste in the bin, not in the water’ and ‘try to recycle’. 3 out of 8 mentioned they could contribute by choosing the appropriate sunscreen.

UTAUT

The statements participants responded to in the questionnaire can all be interpreted as either a positive or a negative expression of attitude.

Therefor the answers from these questionnaires has been translated from a strongly disagree/disagree/neutral/agree/strongly agree Likert scale to a very negative/negative/neutral/positive/very positive interpretation based on the positive or negative nature of the statement it corresponds to.

The results of this are visualized in figure 7.

![Figure 7](image-url)
Chapter 6: Conclusions and discussion

Fragments of information
Testing showed that when people found and observed the individual objects they did learn something from them. Admittedly, this varied per fragment. Some fragments of information worked better than others. The level of abstraction seemed to be an important determinant towards the extent by which participants were able to reproduce the information during the interviews.

A fragment of information that has a clear message such as: ‘choose the right sunscreen’, is easily understood and can be reproduced by those who encountered the fragment during their session in virtual reality.

A fragment of information that does not have a clear message, or tries to mix too many messages at once, such as: ‘The economy of Australia benefits from the presence and well-being of the coral reef because of these reasons…’, is often discarded and ignored.

Impact of a game
The results from prototype V0 were very promising, but the extent to which participants explored and took their time carefully observing individual objects was much lower in prototype V1. The main difference between V0 and V1 being, of course, the fact that V1 was an actual game that gave the participants objectives to pursue. These objectives could in theory, distract the participants from learning about coral bleaching and the testing proved they, in fact, did. Players seemed to no longer pay quite as much attention to those details of their surroundings, that didn’t seem immediately relevant to the completion of their goals.

Raising awareness
The main research question of this thesis was “How can we raise awareness for Sustainable Development Goal 14: Life under water, using an escape room that is experienced in virtual reality?”. A concept was designed, built and tested, to see if that concept was a valid answer to that question.

I noticed that participants gave considerably more answers to the control question: “can you explain in your own words what causes coral bleaching” during the interview after the experience. The odd thing however, is that a lot of the answers they reproduced, did not seem to stem from new information they had encountered while playing the game. On top of that, a few answers were incorrect. The answers differed quite a bit as well although some of the answers as shown in figure 4 could be pooled together into overarching categories if desired.
The participants who had given correct answers to this question before the experience were the ones who gave the most correct answers after the experience as well. I suspect, based on my observations of the participants while I interviewed them and while I watched them play the game, that participants simply 'tried harder' to give good answers. Another possibility is that the first interview and/or the experience 'jugged their memory'. More than a few participants concluded their answers with a 'maybe?' at the end of their sentence implying that they were guessing or at least not entirely sure about their answer.

Again, in the case of the fragment about 'use coral-safe sunscreen', the participants who noticed this were able to reproduce this after the interview and I believe it is safe to conclude that this information is something the experience has made them aware of.

Prototype V2

I don't believe the prototype we used for testing raised enough awareness about coral bleaching among the participants for our client to be satisfied.

However, we learned a lot and I do think that if we can successfully implement our new knowledge into a next prototype we would be able to make this concept work.

We need to alter/redo some of the individual fragments. Some fragments simply do not convey their message well. We have learned that fragments containing concise and specific information work best.

Another way to make better use of the fragments could be to move them to more strategic locations around the level. In the current prototype the puzzles and fragments are both in different areas of the submarine meaning you don’t really have to interact with the fragments to complete the game.

We need to incorporate the fragments more tightly into the game. The fact that players have objectives has great impact on their behaviour. Moving the fragments around is one way to do that, integrating the fragments into the puzzle itself is another.

This was already attempted with the ‘sequence’ puzzle which used the images printed on the newspapers as a code. Unfortunately the way the puzzle was set up made players simply ‘guess’ the answers rather that figuring it out. The feedback system for this puzzle would have to be fixed.

Finally, I believe the implementation of our narrative will greatly impact the effectiveness of the product. We unfortunately hadn’t managed to finish that part yet, but I believe the story we wrote would really help to connect everything and also make the fragments work better because they would have a clear context.
Bibliography


APPENDIX A: Prototypes

Prototype V0.0

This prototype consisted of a greyed out version of the submarine. Partially decorated interior. The submarine was placed in the center of an 'ocean floor' environment that consisted of textured rocks and textured sand.

The player was able to move freely around the environment using a standard 'teleport' control scheme. The player can project an arc by pointing his hand and teleport to the other end of it by pressing a button.

Prototype V1.0

This prototype consisted of a much more visually advanced version of the submarine. Both the interior and exterior were at advanced stages of completion. The exterior contained textured models of rocks and various types of corals, there was also a textured sand floor.

The interior was at an advanced stage of visual completion. Most objects we intended the final prototype to have were present and a lot of them were textured.

1. Newspaper 1 & 2
2. Newspaper 3 & Economics Flyers
3. Coral-safe sunscreen poster
Layout

1. Puzzle #1: Sequence puzzle
2. Interactive aquarium
3. Living area starboard side
4. Puzzle #2: Circuitry puzzle
5. Puzzle #3: Engine gearbox puzzle
6. Living area portside
7. Laboratory area
8. Progress indicator
Puzzles

The level had 3 functioning puzzles for the player to solve. Two of those were puzzles we designed and intended from the start, the final one was a makeshift sequence puzzle we made to bring the prototype up to a standard where it could be used for playtesting.

**Puzzle #1** is a sequence puzzle. The player sees 5 blue buttons with icons floating above them. 3 of these buttons have to be pressed in the right order. The icons on the buttons match the figures on the newspapers.

**Puzzle #2** is a puzzle where players have to stack blocks on top of eachother in the right order. The order is determined by markings on the tops and bottoms of the blocks.

**Puzzle #3**, the final puzzle is a gearbox puzzle. The players have to find ‘gears’ that are distributed around the submarine. The gears have different sizes and only by fitting them in the correct order onto an ‘engine block’ can the players get the engine to work again.

The player can monitor his own feedback by looking at the 3 red orbs in the cockpit of the submarine.
Prototype V1.1

After prototype V1.0 was subjected to some practical testing with members of the project group the following improvements and alterations were made.

Graphical
- Textures were applied to the engine.
- Textures were applied to the gear puzzle gears.
- Textures were applied to the scuba-diving gear.
- The material on the circuitry puzzle was made green and more reflective.

Gameplay
- The engine puzzles win condition was modified making it possible to complete even if the player does not find all 8 gears, or loses one of the gears due to glitching colliders.

Technical
- The navmesh was modified to prevent the player from teleporting outside the intended play area.
- The player's own collider was scaled down to prevent glitches when picking up stuff off the ground that are located directly below the player.
APPENDIX B: List of Information fragments

Below is a full list of the information fragments that are featured in the prototypes used for the graduation research.

Newspapers

There are 3 newspapers featuring news related to coral bleaching. All news-articles are from news.un.org.

The aim of the newspapers is primarily to inform the player about the consequences of coral bleaching, but also the severity of the issue and causes of the problem.

<table>
<thead>
<tr>
<th>Newspaper #1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Headline</td>
<td>Annual global bleaching</td>
</tr>
<tr>
<td>Tagline</td>
<td>Climate change will lead to annual global bleaching</td>
</tr>
<tr>
<td>Date</td>
<td>January 2017</td>
</tr>
<tr>
<td>Average global temperature</td>
<td>12.88 °C</td>
</tr>
<tr>
<td>Image</td>
<td>[broken coral with skull]</td>
</tr>
<tr>
<td>Text below image</td>
<td>Climate change will lead to annual global bleaching, UN-supported study predicts</td>
</tr>
<tr>
<td>Text on the back</td>
<td>If current trends continue, severe bleaching will occur every year on 99 per cent of the world’s coral reefs within this century.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Created assets</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Newspaper #2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Headline</td>
<td>We face a global emergency</td>
</tr>
<tr>
<td>Tagline</td>
<td>UN Chief sounds the alarm at G7 Summit event</td>
</tr>
<tr>
<td>Date</td>
<td>June 2018</td>
</tr>
<tr>
<td>Average global temperature</td>
<td>16.25 °C</td>
</tr>
<tr>
<td>Image</td>
<td>[world with warning signs]</td>
</tr>
<tr>
<td>Text below image</td>
<td>We face a global emergency UN Chief sounds the alarm at G7</td>
</tr>
<tr>
<td>Text on the back</td>
<td>The facts are clear. Our oceans are a mess, plastic</td>
</tr>
</tbody>
</table>
waste is now found in the most remote areas of the planet.

Created assets

Newspaper #3

Headline
“onslaught of threats”

Tagline
underwater life is severely impacted

Date
March 2019

Average global temperature
13.76°C

Image
[dead fish]

Text below image
How we can continue to save marine biodiversity for future generations?

Text on the back
Underwater life is severely impacted by an “onslaught of threats” but we already have the tools to positively influence ocean conservation.

Created assets

Coral safe sunscreen

Studies link chemicals commonly present in sunscreens to coral bleaching in areas with a lot of recreational activity. Mineral based sunscreens however do not threaten the corals in the same way.

I made a poster and a bottle of sunscreen with information about this topic.
The poster contains 3 statements:

1. **CHOOSE PHYSICAL SUNSCREENS -** Titanium dioxide & zinc oxide based sunscreens physically block the sun’s rays and don’t contain harsh chemicals that harm the coral reefs.
2. **READ THE LABEL -** Read the ingredients to make sure your sunscreen only contains the active ingredients titanium dioxide and/or zinc oxide, is biodegradable and all natural and is mineral based.
3. **AVOID OXYBENZONE -** Oxybenzone is a known endocrine disruptor and one of the most toxic chemicals to coral reefs.

There is also a sunscreen bottle. This bottle does not contain additional data but serves to draw attention to the poster.

**Jars of coral**

There are 3 stages relevant to the process of coral bleaching: healthy, bleached and dead. Bleached coral can restore itself, provided environmental parameters such as temperature and acidity return to acceptable levels.

I made 3 ‘Jars’ filled with coral samples, one for each stage, so players can see what this coral looks like.
Interactive aquarium

Coral bleaching events can be triggered by a number of causes. Two of those are rising ocean temperature and ocean acidification.

The interactive aquarium is a tank filled with coral that has buttons on the front that players can press to simulate a bleaching event.

The simulation shows coral transitioning from healthy and colorful, to white grey bleached, to dark green dead.

There is a UI that provides additional information on what is happening. There are indicators for the ph levels and for the temperature.

The first button from the left is a reset button, this button reverts the aquarium to its starting condition.

Great Barrier Reef value flyer

In order to teach the players about the importance of coral reefs I made a flyer containing data about how the Great Barrier Reef contributes to the Australian economy.

It contains figures with information on how much money is generated.

I also contains an overview of other areas in which Australia benefits from the presence of a barrier reef, such as coastal protection from erosion and the potential for scientific research.
# APPENDIX C: Interviews

## Part 1: Questions before the experience

### Personal information

<table>
<thead>
<tr>
<th>Gender</th>
<th>○ Male</th>
<th>○ Female</th>
<th>○ Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>○ under 14</td>
<td>○ 14 - 30</td>
<td>○ over 30</td>
</tr>
</tbody>
</table>

### Pre-existing experience

| ○ Escape rooms | ○ Virtual reality | ○ Games |

### Are you familiar with the United Nations’ Sustainable Development Goals, and if so can you list the goals you are familiar with?

### What do you know about the status and well-being of the world’s oceans?

### What do you know about the status and well-being of the Great Barrier Coral Reef?

### Can you explain in your own words what causes coral bleaching?
Part 2: Questions after the experience

Question 1: Inventarising what information they encountered

| Throughout the environment you could encounter information related to SDG 14: Life Under Water. |
|                                                                                                       |
| Can you list some of the ‘objects’ you found that contained information about ‘life under water’? |
|                                                                                                       |
| Newspapers with headlines |   |
| Coral friendly sunscreen poster |   |
| Coral friendly bottle of sunscreen |   |
| Interactive aquarium |   |
| Pressed button #1 |   |
| Pressed button #2 |   |
| Pressed reset button |   |
| Economics flyer |   |
| Coral Jars |   |
| Healthy |   |
| Bleached |   |
| Dead |   |
Questions #2, #3 & #4: Understanding of the problem

Throughout the environment there was information to be found about corals and coral bleaching.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can you tell me what healthy coral looks like?</td>
<td></td>
</tr>
<tr>
<td>Can you tell me what bleached coral looks like?</td>
<td></td>
</tr>
<tr>
<td>Can you tell me what dead coral looks like?</td>
<td></td>
</tr>
</tbody>
</table>

Can you explain in your own words what causes coral bleaching?

Can you explain in your own words what the consequences are of coral bleaching?

Question #5: Personal influence on global affairs

Can you explain in your own words how you as an individual can contribute to the prevention of coral bleaching?
## APPENDIX D: UTAUT Questionnaire

### Ease of use

<table>
<thead>
<tr>
<th>Ease of use</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE2.1 Moving around in the environment is easy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>EE2.2 Interacting with object in the environment is easy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>FC1.1 I have the knowledge necessary to use the virtual reality system</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>FC1.2 I have the knowledge necessary to understand the game mechanics and play the game</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>ANX1 The idea of using Virtual Reality is somewhat intimidating to me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

### Attitude towards the technology

<table>
<thead>
<tr>
<th>Attitude towards the technology</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1.1 I find the use of a Virtual Reality system enjoyable</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>ATU1 Virtual reality is unsuitable for escape rooms</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>AF1 The use of Virtual reality is frustrating for me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>AF2 Once I am in Virtual Reality I find it hard to stop</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

### Attitude towards the application

<table>
<thead>
<tr>
<th>Attitude towards the application</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1.2 I find observing my surroundings inside the submarine enjoyable</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IM1.3 I find observing my surroundings on the ocean floor exterior enjoyable</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IM1.4 I find playing the game an enjoyable experience</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IM3.1 I find the submarine interior a visually pleasing environment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IM3.2 I find the ocean floor exterior a visually pleasing environment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>IM3.3 I had fun playing the game</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
APPENDIX E: Script

Mission brief:
You are now going to put on a headset and play an escape room game.

In the game you will find yourself inside a submarine. In the cockpit of the submarine, on the portside (left) you will see three red orbs. For every orb there is a puzzle to be found inside. Solving all these puzzles and turning all the red orbs green is your objective for this game.

You have 15 minutes to explore and puzzle.

Allowed hints:
Controls:
- You can move around to an extend, to move to the far ends of the environment you can use the teleport function
- Explaining teleportation
- When buttons don’t respond I may tell them to press down more firmly

After 2 minutes:
If people are still only exploring I may tell them to look for puzzles
If people have not interacted with any object I may tell them that they can pick stuff up

After 5 minutes:
I may direct them in the direction of the button puzzle if they have not found any puzzles yet

After 10 minutes:
I may direct them to the final or second puzzle if they still need to complete a puzzle

Sequence puzzle:
I may inform them about the bug where you can only see the icons with the left eye and mention this is not intended.

Circuitry puzzle:
I may inform them about the glass door that is in front of the circuit box immediately.

Gearbox puzzle:
I may reassure them that the puzzle is solved when they find out they can’t complete it anymore due to the bug where gears disappear from falling through the floor.
APPENDIX F: Concepts

Concept 1: Focus on a lasting campaign

Points we learned from theoretical framework:

A single escape room has the ability to generate attention to the SDGs. But in order to really raise awareness people need to be repeatedly exposed to the message. Campaigns with several novel spots perform better than those with just one or two shown repeatedly (Weis & Tschirhart, 1994).

I propose to develop a toolkit, containing the design guidelines, structures and technology assets required to create a series of Escape Rooms.

A series where SDGs are divided over different escape room concepts that are released as separate episodes.

I will develop this toolkit together with the 3S project group who will focus primarily on building the escape room commissioned by the client which would be ‘episode 1’.

Through testing the prototype of the escape room with users we will analyze our setup and make improvements to both this instance of escape room as well as our template.

Concept 2: Deploying a virtual agent

Points we learned from theoretical framework:

It is important that we convey a clear and understandable message (Weis & Tschirhart, 1994).

Given the requirement that awareness has to be raised through a virtual reality escape room this becomes a complex challenge. Besides formulating and deciding on a concise and comprehensive message relevant to the objectives of any given SDG, it is a challenge to formulate this message due to the nature of the medium.

In order to minimise the chances of failing at this task we could aim to expand the existing methodology of storytelling in virtual reality. One possibility would be to implement a virtual agent into our solution. An artificially intelligent assistant that is able to engage in conversation with the player could identify gaps in the players understanding and provide additional explanation accordingly.

I would develop a prototype of this agent and test it by putting it in the solution developed by the project team.

I would also let a control group use the solution developed by the project team without the agent enabled.
I would then use a questionnaire to research the added value of this agent.

Developing a virtual agent has value to the client because it could provide a more structural solution to conveying the complex subject matter of the SDGs compared to a solution that was developed for a specific scenario. A virtual agent could be provided with different information and placed in a different situation, while retaining the conversational approach to conveying information as the core solution.

I extensively research the technical feasibility of this concept. I experimented with IBM: Watson Assistant and some of their other Machine Learning tools and I tried to build a working prototype that would work in unreal.

I worked out a plan on how I would implement the different parts of this concept but ultimately the technical challenge proved too great.

Concept 3: Using traditional media inside VR

Virtual reality deviates from traditional media such as television, radio, print or theater. It is possible to place all of these media inside virtual reality but do conventional media still work the same way inside virtual reality?

I propose to research the effectiveness of traditional marketing tools inside virtual reality in order to provide a structural solution to conveying information within the restrictions of a virtual reality escape room.

Concept 4: Utilising exploration

The amount of information we are required to convey to the audience in order to raise their awareness of the subject matter is great. It would be very challenging to clearly communicate the message by solely relying on the narrative.

However, 'escape rooms' naturally challenge the player to explore their surrounding and to pay close attention to all details.
By filling up the environment with snippets of information related to the message, players will learn about the SDGs as they play.

I will fill the environment of the prototype developed by the 3S group with such snippets and I will let a group of people playtest it.

I will use a questionnaire to research how many snippets of information they encountered and to what extent they remembered their contents. I will also research if they were able to connect these pieces of information and if they understood the complete message.

Knowing if this solution is viable would be relevant to the client because it could be easily reproduced in similar concepts.

Working out Concept 4 in detail

The topic

I will focus on informing the audience about the phenomenon called ‘coral bleaching’, because it ties together a lot of other subjects relevant to SDG14. Coral bleaching is caused by ‘stress’ which might stem from a number of different sources. These sources are often caused, either directly or indirectly by human influence.

Carbon emission > Global Warming > Rise of ocean temperature > Coral bleaching
Carbon emission > Oceans absorb carbon > Dropping pH levels > Coral bleaching
Chemical products used by humans e.g. sunscreen, pollute coastal waters > Coral bleaching
Carbon emission > Global Warming > Extreme weather > Hurricanes > Coral bleaching
Coral bleaching > Coral dying > Algae blocking sunlight > more coral bleaching

The fragments
I will hide Fragments of information throughout the environment. I will structure these fragments around the following questions:

What does healthy coral/bleached coral/dead coral look like?
- Pieces of coral in jars, 1 healthy, 1 bleached, 1 dead
- Players can pick them up, the jars have dates on on them so they can figure out the order

What causes coral to bleach and then die?
- I'd like an interactive aquarium of sorts where you can press different buttons to expose coral to different stimuli such as higher temperature, lower ph, a hurricane and watch the coral bleach and die.
  Kind of like a simulation inside the game
- If this is too much work I would make a short animation that does the same.

What are the consequences of losing the great barrier reef ecosystems?
- Consequences are chain reactions of animals dying
  - A poster that shows the hierarchy of prey and predator of life surrounding coral reefs
  - Newspapers with headlines about disease spreading faster among fish because bio-diversity gone down
- Barrier reefs are named as such because they protect the coast from big waves and storms
  - Newspapers with headlines about hurricanes causing more destruction in Australia and Florida and blaming it on the death of corals

What can we do?
- Flyers of organizations trying to fight coral bleaching
- Information about scientific research being done
- A bottle of coral friendly sunscreen

A Plan

**Question #1**

<table>
<thead>
<tr>
<th>What information do I want to convey?</th>
<th>What does coral look like when its healthy/bleached/dead?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How will I convey this information?</td>
<td>Plan A: Small models of corals in each of the three states. Placed in jars on display inside the submarine</td>
</tr>
</tbody>
</table>

51
<table>
<thead>
<tr>
<th><strong>Plan B</strong>: Not physical objects but rather a poster</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Do I need to find any additional information? If yes; what?</strong></td>
<td>I have already found all relevant information</td>
</tr>
<tr>
<td><strong>What assets do I need?</strong></td>
<td><strong>Plan A</strong>: A textured model of a coral, and a glass jar.</td>
</tr>
<tr>
<td></td>
<td><strong>Plan B</strong>: A poster</td>
</tr>
<tr>
<td><strong>What do I need to develop in Unreal?</strong></td>
<td>Nothing, apart from maybe setting up shaders</td>
</tr>
</tbody>
</table>

### Question #2

<table>
<thead>
<tr>
<th><strong>What information do I want to convey?</strong></th>
<th><strong>What causes coral to bleach and then die?</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How will I convey this information?</strong></td>
<td><strong>Plan A</strong>: An aquarium on display inside the submarine, where players can push several buttons in order to introduce different stimuli to the environment. The player can then watch the coral bleach and die.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Plan B</strong>: Instead of a 3D aquarium, video that does the same thing.</td>
<td></td>
</tr>
<tr>
<td><strong>Do I need to find any additional information? If yes; what?</strong></td>
<td>I have already found all relevant information</td>
<td></td>
</tr>
</tbody>
</table>
| **What assets do I need?** | **Plan A**:  
- A textured model of a coral  
- A glass aquarium  
- An array of buttons with clear icons indicating what they do  
- Clear sources of bleaching  
- An animation of the coral bleaching (sped up)  
Plan B:  
- An animation  
- A screen  
- Buttons to interact with |  |
| **What do I need to develop in Unreal?** | **Plan A&B**: The ability to trigger different 'animations' based on a button press. Triggering should not be too hard, animations might be a challenge. |  |
### Question #3 - Status: 3 newspapers ready

<table>
<thead>
<tr>
<th>What information do I want to convey?</th>
<th>What are the consequences of losing the great barrier reef ecosystems?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How will I convey this information?</td>
<td>Plan A: Newspapers littered about the submarine with different headlines indicating problems related to collapse of marine ecosystems</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Do I need to find any additional information? If yes; what?</td>
<td>I should come up with a list of good headlines.</td>
</tr>
<tr>
<td>What assets do I need?</td>
<td>Plan A: A model of a newspaper, several textures for different headlines</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>What do I need to develop in Unreal?</td>
<td>Nothing</td>
</tr>
</tbody>
</table>

### Question #4

<table>
<thead>
<tr>
<th>What information do I want to convey?</th>
<th>What can we do to protect our coral reefs and marine ecosystems?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How will I convey this information?</td>
<td>Plan A: Posters of organizations that do scientific research or raise funds</td>
</tr>
<tr>
<td></td>
<td>Plan B: A coral friendly bottle of sunscreen</td>
</tr>
<tr>
<td>Do I need to find any additional information? If yes; what?</td>
<td>I need to work on my message about how to do something</td>
</tr>
<tr>
<td>What assets do I need?</td>
<td>Plan A:</td>
</tr>
<tr>
<td></td>
<td>- A model of a newspaper</td>
</tr>
<tr>
<td></td>
<td>- Several textures for different headlines</td>
</tr>
<tr>
<td>What do I need to develop in Unreal?</td>
<td>Nothing</td>
</tr>
</tbody>
</table>
APPENDIX G: Assessment form

Technological | 1. Technical research and analysis

- has a thorough knowledge of the current digital technologies within the field of interactive media.
- is capable of conducting technical research and analysis.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of current digital technologies was presented to the student. The student needed a lot of support by setting up and conducting research.</td>
<td>The student adequately applied the knowledge of current digital technologies that was presented to him during his study program. The student did independently set up and conduct research.</td>
<td>Sufficient + the student gained new knowledge of current digital technologies.</td>
<td>Good + the graduation process strongly focused on the development of an innovation or an application of current digital technologies that is innovative to the client.</td>
</tr>
</tbody>
</table>

Good. I have applied technical skills to various aspects of this project and I gained new knowledge through research and practice.

Situation: My original ambition was to use IBM: Watson to develop a virtual agent
Task: I had to investigate whether this was a feasible option to pursue for this project or not.
Action: I looked into all aspects of this technology, I experimented with rudimentary prototypes.
Result: It turned out that implementing a function prototype of a virtual agent was not possible within the scope of my graduation project.
Reflection: Even though this line of inquiry didn’t lead to anything tangible I did learn a lot about a current digital innovation. I was able to make a justified decision not to pursue this solution based on this newfound technical knowledge.

Situation: Due to the project requirement of international cooperation with students from Ferris State university we were forced to develop our project in Unreal Engine, a development tool I was barely familiar with prior to this project.
Task: Learn to use Unreal.
Action: I followed tutorials and experimented with creating prototypes.
Result: I have gained a decent understanding of Unreal Engine, I can work with most of the standard tools available within this development environment and I was able to develop parts of the final prototype by myself.
Reflection: Working in Unreal was not my choice and I explicitly expressed my preference of the Unity Engine to the parties involved in making this decision. When it became clear that Unreal was going to be the final choice I committed to learning with it. I even managed to become quite comfortable working in this new environment. I realise some aspects of this game engine still elude my such as C++ coding, but having made several blueprints(Unreal visual scripts) I have developed a pretty good sense of my own ability within this environment which I think is pretty extensive.

Technological | 2. Designing and prototyping

- is capable of creating value by iteratively designing and prototyping, based on a (new) technology, creative idea or demand articulation.
- shows an innovating, creative attitude at defining, designing and elaborating a commission in the margin of what is technically and creatively feasible.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The design process was linear. The</td>
<td>The design process was iterative. The student</td>
<td>Sufficient + the problem statement focused on</td>
<td>Good + the student worked within the</td>
</tr>
</tbody>
</table>
The problem statement of the client was taken as the starting point without critical consideration.

Critically approached the problem statement of the client. The final product enables the client to create value.

The development of an innovation or application of current digital technologies that is innovative to the client.

Margin of what is technically and creatively feasible.

Sufficient to Excellent.

I found critical consideration of the client's problem statement very challenging, but I tried to analyze every aspect of it to the best of my ability and defined the scope of the project appropriately.

I iteratively designed and prototyped the concept. I focussed on developing an application using the current digital technology that is virtual reality and I investigated and then worked within the margins of what was technically and creatively feasible.

I am afraid that there is a lot of room for debate whether or not the final product enables the client to create value. My research does provide them with new insights into how they could reach their objectives but the current prototype does not yet accomplish them directly.

### Technological | 3. Testing and rolling out

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior and experience of the user were disregarded by the student.</td>
<td>During the design process the technical results are tested on their value for the behavior and experience of the user. The requirements from the user, the client and the technical context were applied to the final product. A standard prototype was developed.</td>
<td>Sufficient + the final product shows a clear connection to the design.</td>
<td>Good + various prototypes were developed based on the criteria that should be tested concerning the user, the client and the technical context.</td>
</tr>
</tbody>
</table>

Good. I tested various prototypes with users focusing on different aspects of its functioning.

**Situation:** After extensive literature research and concepting I had decided on a final concept to develop.

**Task:** Develop a prototype and test with users.

**Action:** I tested the prototype as soon as I had something to test and I documented my findings.

**Result:** The first prototype allowed me to test my core concept (fragments of information spread throughout an environment) by researching their ability to convey information inside virtual reality. This was relevant to the user as I tested whether or not the information was clear and comprehensive to them. Relevant to the technical context as I tested if the fragments worked within VR.

Consecutive prototypes included gameplay adding another dimension to the product. Which is again relevant to the user as it allowed me to refine their experience.

All tests together create value to the client as the prototype becomes more suited for the intended purpose of creating awareness with each step.

**Reflection:** It was probably the pressure of having to do research that led to conducting the first tests with prototype V0. Normally I am someone who is inclined to rely on his own reasoning and analysis rather than actually testing with people. In hindsight however, the findings from these tests were really helpful. They gave insight into which fragments worked and which didn’t.

This also helps to support my final conclusions regarding players being distracted by the game and
therefore not paying as much attention to the fragments. Without the tests with V0 I would have been more difficult to draw this conclusion, since I couldn’t have been sure the problem lied with paying attention to the fragments or with the fragments themselves.

Designing | 4. Investigating and analyzing

- is capable of substantiating a commission by means of research and analysis.
- shows to have a repertoire of relevant research skills at his disposal and is able to select from this repertoire the proper method, given the research circumstances.
- is capable of developing prototypes as a communication tool within the context of implementation.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The research method and analysis is almost entirely provided to the student.</td>
<td>The student has used knowledge of research provided by his study program. One or more prototypes were developed to conduct the selected tests.</td>
<td>Multiple research methods have been considered, and relevant methods have been selected. The student learned and used newly acquired methods. One or more prototypes were developed to conduct the selected tests.</td>
<td>Good + the test results of the prototype, the conclusions, and the recommendations are seamlessly connected.</td>
</tr>
</tbody>
</table>

Good. I carefully considered the research circumstances and then made the decision to conduct interviews and a questionnaire to gather both qualitative and quantitative data.

Situation: I wanted to test my solution on its ability to convey information about the selected subject

Task: I had to select a method to conduct this research

Action: I looked up different ways to approach this situation. I looked at methods available to me. I looked at what kind of data would be most beneficial to me. I looked at my specific situation and circumstances of the research. I consulted my graduation tutor for advice and feedback.

Result: I had a prepared interview consisting of two parts; before and after the experience. I used a telemarketing style of formulating my interview questions so I could gather at least some quantifiable data. I also applied the UTAUT model (Unified Theory of Acceptance and Use of Technology) to create a short questionnaire.

Reflection: I think my preparations of my research were quite good. I also believe that the final prototype I used for testing was very appropriate. I found it very difficult to ask people to participate in testing and I am worried if the amount of respondents is sufficient.

Designing | 5. Conceptualizing

- proves capable of being able to get to realistic (cross-sectoral) demand articulation and project definition.
- is capable of developing an innovative concept that creates value on the basis of his own idea or demand articulation.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The customers demand is literally adopted as problem statement.</td>
<td>The customers demand is translated into a proper problem statement, hatching the opportunity to creative innovate solutions.</td>
<td>The question behind the customers demand has been explored, resulting in a completely new problem statement with an open direction.</td>
<td>Good + the problem statement focused on innovation and value creation.</td>
</tr>
</tbody>
</table>

56
Sufficient.

**Situation:** The problem statement wasn’t directly formulated by the intended client, the UN. The eventually proved insurmountable challenge of communicating with said client meant I couldn’t engage in a dialogue exploring the customers demand.

**Task:** Formulate a proper problem statement.

**Action:** Despite the challenges I tried to analyze the problem as well as possible, and I tried to anticipate the different opinions and answers the client ‘might’ have to questions I would like to ask them.

**Result:** When it became clear the the client would not respond, at least not within the required timeframe, I tried to make decisions myself, conducted the project tutor, Matthijs van Veen and made decisions together with the project group.

**Reflection:** The circumstances regarding our client were very complicated but I think I did well considering. Looking at the end result I can’t help but feel insecure as to whether or not it is enough, but I have a hard time imagining what I could/should have done differently.

### Designing | 6. Designing

- is capable of shaping concepts and elaborate these in a substantive, graphic and/or aural way.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the design of the concept(s) that is (were) developed, the student exclusively applied knowledge gained during his study program.</td>
<td>For the design of the concept(s) that is (were) developed new knowledge was applied.</td>
<td>Sufficient + only small adjustments are needed to make the design of the concept(s) that is (were) developed “ready to market”.</td>
<td>Sufficient + the design of the concept(s) that is (were) developed is “Ready to market” without any adjustments.</td>
</tr>
</tbody>
</table>

Sufficient.

**Situation:** The concept required information to be split up in different fragments that were to be designed and developed.

**Task:** Design ‘fragments’ that contain information about the chosen subject

**Action:** I designed a number of fragments; a poster, a number of newspapers, a flyer, jars of coral, an interactive aquarium and a bottle of sunscreen.

**Result:** The results are good, although there is some variety in quality. The graphics of the interactive aquarium are functional but hideous. The assets for the coral jars and aquarium were produced by another member of my team based on some rough sketches I made so I can’t take credit for their appearance.

**Reflection:** I did design visual parts of the concepts and I also applied new knowledge (I learned to use substance painter, and substance designer) but I can’t say that my contributions to the design are very substantial. I also repurposed/restructured some existing content I found on the internet to use as ‘fragments’. These designs are copyrighted and therefore not ‘ready to market’.

**Situation:** Our story takes place under water, we require some graphical effects to communicate the presence of ‘water’ to the player.

**Task:** Make water caustics in Unreal

**Action:** I followed a tutorial and made a water caustics light function.

**Result:** The result is a production level water caustics effect that is ready to be used in the final product. Based on feedback from the artists I added two additional ‘caustic textures’ for them to experiment with.

**Reflection:** This is not a major contribution, but I thought it fits well into this competence category

## Organizing | 7. Enterprising attitude
- sees opportunities and possibilities and knows how to translate them from a market-oriented point of view into (new) concepts, products, services, in order to thus get to creating value and new revenue models.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the signaling of chances on the market and the opportunities to create value, the student adopted the knowledge of the client without critical consideration.</td>
<td>The student signaled chances on the market at existing target audiences of the client. Innovative applications of the final product are possible, through which value can be created by existing business models.</td>
<td>The student signaled chances on new markets and/or new target audiences of the client, through which value can be created by new business models.</td>
<td>Good + valuable recommendations for the client are given regarding value creation and new business models.</td>
</tr>
</tbody>
</table>

Sufficient. This is not really a commercial product so I find it difficult to argue my case regarding this competence.

**Situation:** The desired product is pretty much a precondition of this product.

**Task:** Raise awareness using a virtual reality escape room.

**Action:** One of the market-oriented approaches to turn this assignment into a success was by defining a clear target audience.

**Result:** Together with the group we looked into defining a target audience that would be a good fit with the product and the technology. At the same time we hypothesised what requirements an organisation such as the UN would consider important in the definition an audience. We concluded that it would probably be important to have the target audience be inclusive to people from around the world. We would establish that by safeguarding a certain neutrality towards political, religious, ideological and other such issues.

**Reflection:** In hindsight it occurs to me that there were some additional steps I could have taken to score higher on this competence. I have thought about, for example, distribution of our final product but I failed to include this in my final report.

I personally think it would be a great idea to finalise our concept to a standalone game and make it available for free on a platform such as Steam. Ours is not a triple-A game due to its modest scale but what we do have is of a very high quality. I believe a lot of people would give our game a try and it could generate a ton of attention for the UN’s SDGs.

---

**Organizing | 8. Enterprising skills**

- has enterprising skills in order to be able to function both as an employee and independently.
- is capable of converting commercial skills into innovative products, services or collections; bearing commercial feasibility in mind.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student disregarded the commercial aspects that are related to the solution of the problem statement of the client.</td>
<td>The student took into account the commercial aspects that were presented to him by the client, related to the solution of the problem statement.</td>
<td>The student signaled himself commercial aspects that are related to the solution of the problem statement.</td>
<td>Good + valuable recommendations for the client are given regarding the commercial feasibility.</td>
</tr>
</tbody>
</table>

Sufficient. Again, since this wasn’t really a commercial project I find it difficult to argue my case regarding this competence.

**Situation:** The project isn't really commercial in nature, no commercial aspects were presented to me by the client.
**Task:** Raise awareness for a publicly relevant topic using a virtual reality escape room.

**Action:** As I mentioned before we analyzed the product and tried to define a target audience that would be a good fit. I also analyzed existing commercial examples of both virtual reality and escape rooms as part of my literature research.

**Result:** We defined an appropriate target audience. I provided examples of commercial products that showed similarities to our intended product.

**Reflection:** Since the client didn’t present us with commercial aspects of the assignment I find this hard to reflect on. I suppose my ‘enterprising skill’ mainly show when I was able to utilise commercially relevant knowledge that I acquired during my studies at CMGT. I made comparisons to commercial marketing in my research into ‘raising awareness’ for publicly relevant topics.

---

**Organizing | 9. Working in a project-based way**

- shows himself capable of being able to accept, set up and carry out projects from an engagement with stakeholders, whether or not in cooperation with others as a team.
- shows that he is capable of cooperating with others in a (multidisciplinary) team in a productive way, reaching a good balance between introducing his own expertise and relying on the complementary expertise of others.
- shows himself capable of directing team members.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student disregarded the requirements from the stakeholders. The extent to which the student relies on his own expertise and that of others is out of balance.</td>
<td>The stakeholders and their requirements are pointed out by the student. The student worked in a team, keeping the contribution of his own expertise and that of others in balance.</td>
<td>Sufficient + the stakeholders were involved in various stages of the design process.</td>
<td>Good + the student managed team members.</td>
</tr>
</tbody>
</table>

**Situation:** My graduation assignment was connected to a Smart Solutions project and I worked together with a project group throughout.

**Task:** Work together on a product with a project group that has their own objectives (completing 3S) while conducting my own research.

**Action:** During the beginning of the project I worked closely together with the project group. I worked out concepts with them, prepared presentations, learned Unreal and attended the meetings with Matthijs. I have worked together with them in the same room from the Ariensplein location in Enschede.

As the project progressed my own graduation became gradually more important and towards the end of the project our objectives no longer aligned as much as they did initially. However, we still work in the same space, we discuss progress and since 3S is also focussed on research we can exchange valuable information and advice to each other.

**Result:** We have cooperated well throughout the course of the project and this has led to the creation of a high-quality prototype that looks rather professional.

**Reflection:** I believe my contribution and that of the team have been very well balanced throughout the project. I have had a lot of influence in the development of the concept, I worked a lot on the puzzle design, and some of the main puzzle concepts have been developed entirely by me. The Game Design & Game Engineering students seem to have a much more ‘skilled’ background when it comes to actually building stuff, so while I focussed on working out the concepts they concentrated on producing assets and implementing mechanics.

Big design choices, narrative and direction of the concept are of course always a group decision but I feel like I’ve had my say in most of those decisions and the group always made me feel my input and ideas were appreciated.
Towards the end of the project our objectives no longer aligned as much as they originally did. A month before the end of the project the group was offered a ‘new client’. The focus of the group shifted from building a working prototype of a game to creating a visually compelling presentation of the concept. This was not ideal for me, since I still depended on the creation of a working prototype to conduct my research.

I managed to communicate my situation to the group and they were kind enough to oblige me in getting the prototype in needed ready in time.

Organizing | 10. Communication

- shows himself capable of presenting both his person and his work professionally and well-groomed to third parties.
- shows himself capable of being able to communicate with a client about choices and progress in the design process.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The design process is difficult to follow.</td>
<td>The final product is presented adequately. The cohesion between steps in the design process is comprehensible.</td>
<td>Sufficient + the student can justify the choices he made in the design process.</td>
<td>Good + the professional product is presented as part of a portfolio suitable for a starting professional.</td>
</tr>
</tbody>
</table>

Sufficient?

I am not sure how I would grade myself. I believe I have documented my design process and prototype sufficiently in my report, however since there was no client to communicate with I have no means of verifying this belief.

Professional | 11. Learning ability and reflectivity

- shows himself to be a ‘reflective practitioner’ by constantly analyzing and adjusting his own action, fostered by feedback of others.
- shows himself permanently directed and capable of being able to keep up with relevant developments in the field of expertise.
- is able to further develop and deepen the craftsmanship, the personal substantiation of the professional situation and his creativity.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student followed a linear process, without using feedback of others.</td>
<td>The student reflects on his graduation process.</td>
<td>The student uses feedback of others in his reflection. The student pays attention to new knowledge and skills in the discipline.</td>
<td>Good + the student takes a clear position as a starting CMGT professional in the discipline.</td>
</tr>
</tbody>
</table>

Good

My iterative process includes testing with the target audience, thus generating ‘feedback of others’.

I have tried to process the feedback I received on my report to the best of my ability and where I failed to do so I believe I can defend my decisions.

I learned to use Unreal Engine, one of the biggest players in the industry when it comes to game development tools.
I expanded my knowledge of 3D asset creation by learning to use the software packages substance-painter and substance-designer.

Filling out this form means I am reflecting on my graduation process. (Although this is a single moment of reflection and is not proof of constant analysis and adjustment of own action throughout the entire process)

### Professional | 12. Responsability

- has a capacity for empathy with other sectors and shows awareness of ethical issues in his role as a designer and is able to explicitly make such considerations in accounting for choices in the design process.

<table>
<thead>
<tr>
<th>Insufficient (0)</th>
<th>Sufficient (1)</th>
<th>Good (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student only focused on the current assignment, without keeping into account relevant sectors outside his own discipline.</td>
<td>The student was provided with relevant knowledge from outside his own discipline, and used it adequately. If applicable, ethical considerations were made.</td>
<td>The student has independently acquired new knowledge outside of his own discipline. If applicable, ethical considerations were made.</td>
<td>The student has independently acquired new knowledge outside his own discipline. Student had to make ethical considerations and he clearly justified the choices he made.</td>
</tr>
</tbody>
</table>

Good.

**Situation:** The original assignment was to raise awareness for the United Nations SDGs.

**Task:** Raise awareness for publicly relevant topics.

**Action:** Together with the project group we thoroughly investigated the Sustainable Development Goals. We read articles about them summarized them ourselves, tried to categorize them for the sake of grouping them together in a way that would serve our project.

**Result:** We came up with different concepts that focussed on one or more of the individual goals.

**Reflection:** This project required us to broaden our view to a wide range of socially relevant subjects. The SDGs cover a large number of greatly varying topics that each have their own complexities and challenges when it comes to raising awareness for them.

Since the beginning of the project assignment forced us to take into account many relevant sectors outside our own disciplines. I myself, immersed myself in the subject of ‘coral bleaching’ in order to be able to translate the information into fragments for the concept.