Gaming with sustainability and the life below the waves

HOW TO STIMULATE A PEACEFUL CO-EXISTENCE WITH OUR PLANET’S WATER AND THE LIFE THERE-IN THROUGH ENGAGING EXPERIENCES

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ABSTRACT

In 2015 the UN completed a list of environmental and social goals, one of these goals is the “life in the water” goal, or goal 14. It focuses on the factors endangering the diversity and the ecological balance in the water. However, the goals are formulated with a focus on changes to be done by countries or bigger organisations, not by individuals. This project focused on creating a design for a technical solution that teaches and motivates youths how to help take care of the planet. To do this a design process consisting of a pre-study, concept phase and a workshop were done. The pre-study consisted of interviews, a questionnaire and a pre-study of similar digital games. The interviews focused on how youths and what values and knowledge youths are taught today. These interviews informed a questionnaire that focused on how and what the students were taught about taking care of the oceans. The last part of the pre-study was a review of games with focus on the environment, which was later used to inspire the design process. The concept phase consisted of three iteration phases of concepts and the last phase created the concept tested in the following workshop. Each iteration ended with a discussion of concepts were one or two concepts chosen to focus on. The final concept was a type of exhibition of two digital minigames or simulations and one physical simulation. The three prototypes were linked, in a wizard of Oz type of style, where two of the prototypes, the physical and one of the digital prototype, influenced the environment in the last digital prototype. The collective prototype seemed to inspire engagement and interest from the participants and was mainly received as a good idea. The workshop was held with youths between 12-16 years old and resulted in feedback and a proposition to a redesign.
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In 2015 the UN decided on 17 sustainable development goals (UN Sustainable Development Goals, 2015; United Nations, 2015) spanning from no poverty and sanitation for all to how to care about the planet. These goals are meant to stimulate sustainable changes between 2015 and 2030 (United Nations, 2015). One of these goals, goal 14, concerns the world’s oceans, seas, costal lines and the drinking water and goes under the name “life below the water”. Goal 14 has ten different points concerning the conservation of the life below the water spanning from reducing pollution and ocean acidification to overfishing. Many of these goals may be interpreted as directed towards big companies or countries rather that the individual people. For example, point three: “Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels” (United Nations, 2015, p23).

It may be hard for single individuals to know what he or she might do to help in achieving this goal. In Sweden, there are similar goals to the UN’s sustainable development goals. They are called “miljömålen” (the environmental goals) and there are sixteen different goals (Naturvårdsverket, 2015). The Swedish environmental goals focus on the environment and have no focus on the humanitarian side of the UN goals. The Swedish goals were constructed with the vision that Sweden must actively work to reach these goals from 2015 (United Nations, 2015) for both Sweden and the world (Naturvårdsverket, 2015). Many of the UN’s goals can be found in the Swedish goals but most of the goals are reframed, for example the third Swedish goal is “only natural acidification”, which is a sub-point under goal 14 (“life below water”) of the UN’s goals. The water on the planet, the oceans, rivers and seas are important for how humans live on this planet. Over 3 billion humans depend on the sea and coastlines for their food and income every day and marine phytoplankton produce 50% of the planets oxygen (Department of Economic and Social Affairs from now on will be called DESA, 2015). It is therefore very important to focus on sustainable development to not influence the ecosystem in ways that we are unable to repair (DESA, 2015). Some big problems in the oceans today is emissions and dumping wastes as plastics and wastes from agriculture into the sea (DESA, 2015).

Most of the plastics in the oceans are classified as micro-plastics. Micro-plastics may come from everyday product such as beauty products often used for peeling effects (Kemikalieinspektionen, 2016), but may also come from bigger collections of plastic such as car tyres (SUÖ & UMF, n.d.). The plastic from beauty products then get flushed out and some of it ends up in the seas and oceans (SUÖ & UMF, n.d.). Further there are problems concerning the pollution from the agriculture, where nitrogen and phosphors from agriculture lead to eutrophication of the seas and oceans. To prevent this, farmers often create wetlands to filter out the nitrogen and phosphor before it reaches the seas or oceans. (Land et al. 2016). Another problem is the overfishing of endangers species. The United Nations (2016) write that the level of fish stock declined from 90% in 1974 to 69% in 2013. In a project done by Naturvårdsverket (2011) it was tested to preserve the amount of different fish species in the Baltic sea. The project focus was to create bigger non-fishing areas to try out the fisheries restrictions and therefore, stabilise the fish stock in the Baltic sea. Overfishing is not just a problem in the Baltic sea but in most seas and oceans in the world and if this does not change it will influence many of our lives (DESA, 2015).

1.1 LEARNING IN SCHOOLS

Naturvårdsverket (2015), the environmental protection agency that formulated the Swedish environmental goals also states that the school system needs to be stimulated to promote a sustainable lifestyle and understanding of consumption in the students. This goes in line with the Swedish school system requirements which states that the schools must teach the students respect for all human’s equal right and respect for the environment.

They state that:

In translation, it means that the student shall take responsibility both in the nature that they may influence every day and learn a responsible way to the global environmental questions. The education must show how one can live in an environmental sustainable way. This may be done in many ways, such as educating the teachers about the environmental challenges being faced and how they may be handled. Such knowledge may later be integrated into students’ school projects which in turn can stimulate the learning and understanding of the goals.

One way to stimulate learning can be to turn a learning task into a game or a playful experience. Playing as a form of practise or experiment to learn new skills is not a new idea, humans have done that as far back as we know (Whitton, 2014). When done deliberately, this is often called “gamification” (Deterding et al. 2011), a situation where children have fun while learning. Gamification can be seen as using principles of game design, which make games fun and addictive, in other areas of non-game design (Deterding et al. 2011) such as learning (Gros, 2014). The evidence of digital game-based learning is problematic for many reasons. For example, games used in formal learning situations are often smaller games used for short times (Whitton, 2014). This often means that the effect of the games may be minimal and short-lasting on the overall learning. Also, the research on learning games is often done by teachers or researchers who have created the games and so have an interest invested in them. This may make it harder to create an objective study. Lastly, in many situations it is very hard to measure learning in a meaningful way which also takes, for example, unintentional learning into account (Whitton, 2014). Gros (2014) made a research review on the use of games in education. Games can create a rich learning environment which may make it possible to learn subjects such as maths and social complex tasks. Gros (2014) notes that games often take long time to complete, which may be a problem in a school setting as time for such games may be limited. Whitton (2014) also notes that there is research that indicates that digital games can heighten engagement and motivation in learners. Whitton (2014) also writes that learning games may be seen almost as problem based learning, as almost all games revolve around problems that the players must solve.

2 DESIGN BACKGROUND

Norman (2004) describes in his book “Emotional Design” how designs that affect our emotions can be perceived as working better or worse. He argues that designs we find attractive make us happy, this happiness in turn activates a more creative thinking process. This thinking process might make it easier to find solutions or try to want again after a failure. This might be an influencing factor to the success and failure of games. The emotions that different experiences provoke might influence the usage and learning of learning games. Korhonen, Montola and Arrasvuori (2009) created a framework for creating playful experiences, their framework looked at qualities that are found in video games. It is created to focus designs not only on a smooth interaction but a playful interaction. Korhonen et al. (2009) wrote that since the players of no-learning video games always might change to another game if a game is not fun the video game industry must have principles on how to create fun games to keep the player interested. They proposed 20 different playful experience categories. Two of them are competition and fellowship. Ke, Xie & Xie (2016) write in their article that an engagement in learning is important for learning new skills. Therefore, games are often used for this
purpose, as games may facilitate active and deeper learning when used. Haywood and Cairns (2005) did a grounded theory study of children visiting a museum. They found three key categories for engagement with the exhibits: participation, narration and co-presence of others. With participation, they mean that the children may participate in a situation or interact with the exhibit. Narration refers to that the children can create their own stories and fantasise while trying things. And with co-presence they mean that the children interact with the exhibit in front of others (Haywood and Cairns, 2005). One way to test if a concept is engaging and to improve concepts is by participatory prototyping (Brodersen, Dindler & Iversen, 2008). This is a practice where the participants through staging of a situation or by roleplay may test out a prototype in a specific situation. This may give important feedback and give an understanding on how a design may influence a situation. This goes in line with what Salen and Zimmerman (2004) wrote in their book “Rules of play - game design fundamentals” where they write about the importance of prototyping the designs early on. Another important aspect of design may be to create values for the user, Smith and Colgate (2007) created a framework of customer values. They identified four values that may be important for creating valuable designs, these values were: functional/instrumental value, Experiential/hedonic value, symbolic/expressive value and cost/sacrifice value.

- The functional/instrumental value refers to a design’s usefulness and its fulfilment of the wished-for function.
- The second category, symbolic/expressive values, are values found in designs that create the right experiences, feelings and emotions.
- The third, experimental/hedonic value refers to designs that let the users attach meaning to them, for example designs that make us feel good about ourselves.
- The last category, the cost/sacrifice values, refers to designs that may lower costs, for example economic, personal or relational costs.

A way to create a design that provokes the desired emotions is to involve the users in the design process early. Sanders & Stappers (2014) propose three approaches to easily involve the users in a so-called co-design process. They propose the use of probes: simple designs, where the user may try to figure out what it is and how to improve its use. Toolkits: which describe simple design languages which let the users express what they think and how they want to live. And Prototypes: which may be used to try out if a design is and does what the users want or need. This report will mainly use prototypes.

2.1 EXPERIENCES IN MUSEUMS

A way to get people interested may be to create tangible interactions. In an article by Hornecker and Buur (2006) they define tangible interactions as things that are realised in a range of systems and interfaces. Further Hornecker and Buur (2006, p438) identify some special characteristics that tangible interactions share: “tangibility and materiality, physical embodiment of data, embodied interaction and bodily movement as an essential part of interaction, and embeddedness in real space”. Hornecker and Buur (2006) categorised tangible interactions into: tangible manipulation, spatial interaction, embodied facilitation and expressive representation.

- The first category, tangible manipulations refers to a design were someone may touch an object, what kind of surface does it have, if it reacts.
- The second, spatial interactions, refers to how someone may interact with the body, does something react if someone moves or if objects may be moved.
• The third category, embodied facilitation, refers to objects and spaces that can change a group’s behaviours, for example that the shy get more space.
• The last category, expressive representation, focuses on if the representations have a meaningful and/or long-lasting effect, if the tangible interaction is meaningful in some way.

These ideas can be linked back to Norman (2004) in that the interactions might wake some emotions, which in turn might help with distributing information. This also goes in line with a study done by Hornecker and Stifter (2006) where they looked at a digitally augmented museum. They found that out of a lot of different displays, which required active participation or required hands on approaches, engaged the visitors more and visits more popular. Ciolfi and Bannon (2002) also found that making visitors actively participate and explore a display engages and gives important insights to the visitors. In their article Ciolfi and Bannon (2002) describe a few different displays with which the visitors can interact. For example, the so called “cabins of curiosity” which are displays where the visitors can open different cabins and look closely at the contents. This very non-classic way of interacting with the displays seems to stimulate discussions and interest in the visitors. Further Ciolfi and Bannon (2002) describes a simulated arkeological dig sight where children can learn about archology and different time periods. After learning how to dig, the children can start to find object which they then have to date. Afterwards, the children must replace the object in the earth and can so be part of the next person’s experience. Ciolfi and Bannon (2002) write that this gives the children important information and is seen as a enjoyable experience by the children. From these observations Ciolfi and Bannon (2002, p4) draws the following conclusions: “that artefacts have implications for the shaping of the emotional experience, the museum’s cultural rules and constraints play a role in terms of the range of interaction possibilities that are given to the visitor and the multiplicity of artefacts involved and their mutual relationships require a flexible method of designing interaction”.

2.2 RESEARCH QUESTIONS EXPLORED IN THIS REPORT
Studies have looked at and seem to show the importance of engagement on learning (Ke, Xie & Xie, 2016). Studies show that there are many ways to engage youths in learning, for example by using learning games (Whitton, 2014; Gros, 2014; Deterding et al. 2011) or by using exhibitions that invite visitors to interact with them and create experiences (Hornecker and Buur, 2006; Ciolfi and Bannon, 2002). These learning experiences can vary in what they teach and how they teach, but the common denominator is that they all try to create engagement.

This lead to the research questions:

1) How can one make a “taking care of the oceans” themed design that engages youths and 2) what qualities in the design can influence the engagement?

2.3 SPECIFICATION OF THE RESEARCH QUESTIONS
The research questions 1 and 2 were answered by a concept generating process with three iterations, followed by a prototyping workshop where one of the concepts got tested. The qualities of engagement were taken from Haywood and Cairns’ (2005) study: participation, narration and co-presence of others. This was discussed in the discussion. Thereafter, the prototyping workshop was compared with values and qualities found previous in a pre-study.
2.4 LIMITATIONS

Due to the timeframe and geographical focus of this project the questions were primarily focused on how and what the school system and scouting organisations teach, in relation to taking care of the oceans, and what restraints for that there were present in Sweden. The project also focused on the collaboration with Naturum, a chain of museums that operate under the Swedish department of nature (Naturvårdsverket), therefore, the focus was on creating a learning environment in collaboration with the already existing learning opportunities in the field. Because of the time restraints on the project it was chosen to focus this project on youths between 10 and 16 years old. Engagement was in this report interpreted as Haywood’s and Cairns’ (2005) framework with participation, narration and co-presence of others as main signs of engagement.

3 DATA COLLECTING METHODS

When creating designs, questionnaires may be used to get background data in the subject area and to get many opinions on the area early on. The cost of making and distributing such a questionnaire may be low and it is an effective way of getting many answers (Tourangeau, Conrad and Couper, 2013). It may lead to some biases as there is no way of guaranteeing that it reaches all of the population of interest, as some may not have internet. It also cannot guarantee that all of the people of interest answer the questionnaire (Tourangeau, Conrad and Couper, 2013). Another way to collect data may be through interviewing (Howitt.a, 2010). Howitt (a, 2010) writes that it is important that the interview is recorded as they are crucial for quality transcriptions. The interviews in this report were semi-structured which are supposed to encourage interviewees to freely recall their experiences (Howitt.b, 2010).
4 Method

The project consisted of a pre-study part with a focus on collecting data and a design process with three iterations. The pre-study part consisted of interviews, a questionnaire, a study of environmental digital games and a visit to a museum with interactive displays. The method will go through this by first describing the participants, then the materials used, then more in depth the steps in the process followed by the ethics section.

4.1 Participants

This section will first look at the participants from the questionnaire and then the participants from the workshop.

4.1.1 Questionnaires

The questionnaire was answered by 59 people, aged between 17-58 years (M=37.88, SD=11.72) from which 10 were man, between 18-53 years old (M=37.70, SD=11.72) and 48 women, between 18-58 years old (M=37.88, SD=11.53) and one gender neutral (for whom the age will not be mentioned for sake of privacy). 11 of the answers were from scouting leaders (3 for all ages, 4 for the ages 10-12 and 4 for the ages 12-15), 47 of the answers were from teacher (7 for teachers from age 6-9, 9 for the age 10-12, 16 for the age 13-15, 7 for the age 16-18 and 2 for all years) and 6 participants were other of professions. The participants were not given anything for their participation. When asked how long they had been working with children (given the answers: 1-10, 10-20, 20-, still studying) 3(5%) of the participant’s answers that they were still studying, 25(43%) answered that they had worked for 1-10 years, 19(33%) had worked 10 to 20 years and 11(19%) answered that they had worked for more than 20 years (see figure 1).

![How long have you been teaching?](image)

Figure 1: How long have you been teaching?

4.1.2 Workshop

There were 8 participants for the workshop, between 12-16 years old (M=13.25, SD=1.39), 6 boys, between 12-16 years old (M=13.17, SD=1.60) and 2 girls, between 13-14 years old (M=13.5, SD=0.71). These participants were split into two groups so the first group consisted of 4 boys between 12-13 years old and the second group consisted of two boys, between 14-16 years old and two girls, between 13-14 years old. 5 of the participants were children of employees of the firm were
the project was conducted. 6 out of 8 of the participants said that they had an interest in games (four in the first group and two in the second), and 6 out of 8 (three in each group) answered that they had an interest in nature. They all had permission from their parents to participate in the workshop. The workshop participants received food, snacks, and a certificate that they had participated in a test as compensation.

4.2 MATERIAL /INSTRUMENTS

The questionnaire was a Google online form (Google, 2012), with 15 questions (See Appendix 10.1). It was distributed mainly via social media (Facebook, n.d.) via both general Facebook flow and in groups for teachers and scouts. The questionnaire was also sent directly to some schools, museums and scout organisations. There were three prototypes made, one in paper and two in the game engine Unity. The two digital prototypes used some open material from the Unity Asset Store (Game Developer Studio, copyright 2017 and Freesounds, n.d.). The modelling program Blender (Blender Foundation, 1995) was used to create 3D models for the digital prototypes. The digital prototypes were shown on two computer screens. One of them was a laptop computer and one was a stationary computer. The simulations were played using the up and down keys or the computer mouse. The paper prototype was made up by pictures that were printed out and then cut out.

4.3 THE DIFFERENT STEPS IN THE PROCESS

The process consisted of a pre-study phase consisting of interviews, a questionnaire and a smaller study of digital environmental games. There were two interviews, one was loosely transcribed and coded into values and the other was used as a background for the questionnaire. The questionnaire was sent out to educators and teachers and was analysed partly by using descriptive statistics and partly by using a qualitative coding approach. The games were analysed by their length or type of game and what they were perceived to teach. It was found that a type of game was less usual and this was later used in part as inspiration for the final concept. The game study was followed by a concept phase that had three iterations and led to a workshop to test one of the concepts. There were two workshops held with the same prototype, the workshop was evaluated and the input from the workshop led to propositions for a re-design, but no re-design was made. To illustrate the process, look at figure 1 below.
4.3.1 Interviews
The project started with a pre-study of interviews with teachers, educators and students studying to become teachers. The interviews were semi-structured interviews (Howitt, 2010). This was done to get a better understanding of the subject area and how the information was taught today. The main interview was done with an educator and guide for one of the Swedish Naturums, which are a form of nature centres. This was mainly done to generate values (see section 5.1) which were later used in the design process. The values were ordered using a framework created by Smith and Colgate (2007).

4.3.2 Questionnaire
The questionnaire was a 15 question Google form, sent out via social media to teachers, educators and students who teach or will teach youths the importance of taking care of the oceans (see Appendix 10.1). The goal of the questionnaire was to explore how and what teachers and educators teach youths about taking care of the oceans. The questionnaire focused on how the teachers taught the subject, what they considered as important. It also looked at if they focused on micro-plastics, the effects of agriculture and eutrophication or overfishing. The question 1—5 from the questionnaire was used to analyse the demographic information about the participants. The answers to questions 6, 9 – 13 were analysed with descriptive statistics, question 7, 8 and 14 were analysed using a qualitative coding approach. Question 15 was a feedback question asking for things the participants thought was missed in the other questions (see section 5.3).

4.3.3 Pre-study Inspiration
A pre-study was done testing 30 different digital environmental games. The focus was on digital games as they were easier to access, and care was taken to try games from different organisations. In total, games from 11 different organisations were tested, every game taking between 2 minutes to about an hour. The games tested were both online games and mobile applications. One game was a multiplayer game, constructed to be played by two players. The games were categorised after what
type and what the game was perceived to teach. This resulted in a matrix which showed a few different types of games and revealed “blind-spots”, types of games which were not found. It showed that there was a blind-spot in the combination of “shorter tic-tac-toe games” and “focus on teaching context”. The matrix was not analysed further but continuously used as inspiration for the design process. The reasoning behind this was that the pre-study of games should be limited in amount of games and analysis. This was done due to the time constraints, the analysis of games could have included very many games, both digital and non, and both very small and normal commercial bigger once. Also as the games were more thought to be an inspiration it was chosen not to analyse them further as it was not considered to be the main objective of the study.

Another part of the pre-study was focused on interactive displays and similar museums. For this the “Visualiseringscenter” (Kungsgatan 54, 602 33 Norrköping), was visited for inspiration and to inform the project on how interactive displays may be utilised. The visit focused primarily on how they had decided to use their technology and how the transaction between different screens and different pieces in the exhibition was done.

4.3.4 Concepts
The pre-study led to a concept phase where concepts were iteratively created based on inspiration from the pre-study of games, the visit to “Visualiseringscenter” and the interview. To broaden the possibilities a sketch session was held where many ideas were created within a limited amount of time to create a wide array of concepts. Every concept was evaluated by looking into the positive and negative attributes the concept had (see section 5.3). An example of a positive attribute may be “Easy to see and understand consequences and real-world problems” or “using empathy” an example of a negative attribute may be “to abstract”. Thereafter, the concepts were then evaluated in a discussion with two other members of the development team. After this a list of the good and bad attributes was created and further used to broaden the new concepts. Thereafter, one new idea was chosen to continue to focus on.

After this, a second iteration of the concept creation phase started. This iteration resulted in more new sketches, from which two were chosen to be evaluated with a group of project members. From this evaluation, a synthesis of the concepts was created in the third concept generation phase. This combined concept led to a workshop with a prototype (Sanders & Stappers, 2014). The workshop was in-part inspired by Brodersen’s, Dindler’s and Iversen’s, (2008) article where they describe a participatory prototyping approach for testing and developing prototypes. Brodersen, Dindler & Iversen (2008) also described staging an environment to test a prototype in, to test the impact of the design and the environment. Therefore, the concept tested was a type of simulation or game consisting of many smaller parts that together influence one bigger simulation or game. This was based on the thought that the design may be useful for a museum environment. This idea was loosely based on previous sketches and on the results from the pre-study with games, where shorter games that teach context were rare. In the first sketches of the idea there was a planet that one could create on their phone and which could be influenced by interactions with an exhibition with connected games. This idea was then scaled down to be tested which lead to an idea about a pond instead of an entire planet. Since there was a small focus on playful experiences (Korhonen, Montola and Arrasuori, 2009) it was discussed if the concept was supposed to be used in competition between people or in a teamwork (fellowship) setting. It was chosen to focus the concept on teamwork in smaller groups. While designing the prototype all the previous concepts were categorised to look at what types of ideas had been produced before and what types had been missed. This lead to the revelation that very few physical or tactile design ideas were created. Therefore, and based on the article by Hornecker and Buur (2006) the prototype was split in three
parts using a few connected devices instead of just one. All these parts of the prototype were presented in one space as it gave a possibility for the youths to interact with the different simulations and with each other at the same time, making it a tangible interaction and a physical interaction. Similarly, the one prototype was in paper and could be seen as an early stage spatial interaction (Hornecker and Buur, 2006). The concept lead to a prototype of a simulation of an invasive seagrass species on one computer and a simulation of fishing on another computer. In between them there was the paper prototype of a farm with three different fields. The main simulation was a simulation of an invasive species of seagrass and a group of fishes that could eat the seagrass (see figure 2). The player steers the fishes to eat the seagrass.

If a strand of seagrass is not eaten by the fish it will turn brown and die, using up a bit of the oxygen in the water. To simulate this there is an oxygen measuring bar in the top left corner. In the easiest setting, the oxygen regenerates fast enough so that it does not matter in the long run. There are two ways to make the game more challenging. One is to limit the amount of fishes in the pond and the other is to heighten the eutrophication in the pond. The background colour of the pond got more brown the more the eutrophication in the pond got higher (see figure 3). Figure 3, shows a simulation with only one fish, high eutrophication and low oxygen levels.

When the oxygen level reaches the end the game is over (see figure 4) and all the fishes die.
The simulation that focuses on overfishing has the goal to catch 20 green fishes. The participant could choose to either fish with a hook or a net. The player could change between the net and the hook and could then steer the net or hook up and down to catch fish (see Figure 5).

The simulations were constructed to make it almost impossible to win with the hook, but the net lead to a lot of bi-catch. The amount of caught fishes was presented in the winning or losing screen (see figure 6). The amount of seagrass eating fishes in the first seagrass simulation was changed depending on how many extra fishes were caught in this second simulation.
Figure 6, The catch

The last part on the prototype was a paper prototype that showed a farm with three fields in front of it and a river along the bottom of the picture (see figure 7). The participants then had the choice of what to use the fields for. They could either plant corn, have pigs, cows or a water cleaning pool. They had three of each except for the water cleaning pool, of which they had only one. The choice made by the participants influenced in turn the seagrass simulation by changing the eutrophication if they choose to have more animals and no water cleaning places as compared to corn and a water cleaning pool. This prototype was a more “hands on” prototype as it allowed participants to move physical objects around.

Figure 7, Paper prototype for eutrophication

4.3.5 Workshop

There were two workshops held, each took about 20 minutes plus around 10 minutes in the beginning and end for a briefing on what was going to happen and general questions from the participants. Making it in total around half an hour for the testing of the prototype and the discussion. The aim of the workshops was to test a prototype of the three simulations concept idea. The set-up was in an office and used two computers and one paper prototype. The concept was to
have different stations which were interconnected. To simulate this a wizard of Oz approach was used, where one person from the team manually changed values for one of the computer simulations. The participants were given the topic of the simulations or games, thereafter they were asked what they knew about eutrophication, overfishing and invasive species. Thereafter, the participants could test the simulations, the first group without being instructed on what the simulation represented and that they were linked together. The second group were instructed on how the simulations worked together. They were given ten minutes to try out the prototypes and then the prototypes were discussed, the set-up explained and checked if they had understood the set-up, all of this was done together as a group. Thereafter the participants could try the prototype again and were asked to give feedback.

4.4 Ethic

All Participants, in the interviews, questionnaire and the workshops, were told that their answers would be kept anonymous and that they may quit whenever they wanted. They were also informed that the information collected would be used in a master thesis and in a real-world project. When working with children the parents were asked to give consent. The youth were told that they may get the results of the study from the firm where the study was conducted. This was done as some of the youth were children of employees of the firm or friends of people from the firm. Also, they may be continuously asked to try out new ideas in the project in the future. It was sadly overlooked to give the participants from the questionnaire the option to leave an e-mail address in case they wanted to know what happened with the results and they did therefore not get the chance to take part in the results. The two participants in the interviews were both offered to take part in the results if they wished.
5 RESULTS

5.1 INTERVIEW VALUES

The values from the interview with an educator / guide at a Naturum showed that there was a definite interest in new ways to visualise information about taking care of our planet in a new way. The values were later in the project used as inspiration.

Table 1, Values.

<table>
<thead>
<tr>
<th>Functional / instrumental value</th>
<th>Experiential / hedonic value</th>
<th>Symbolic / expressive value</th>
<th>Cost / sacrifice value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching about taking care of oceans</td>
<td>Entertaining</td>
<td>Trying to teach the value of the oceans</td>
<td>Avoid doomsday feelings, end on a “this is what you can do” - note.</td>
</tr>
<tr>
<td>Make people think by themselves</td>
<td>Creating learning experiences such as tours and water school</td>
<td>Maybe use animals (digital or similar) that visitors can interact with to wake empathy</td>
<td></td>
</tr>
<tr>
<td>Create many different approaches to teaching such as games and text</td>
<td>Touch people emotionally</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create displays that wake their curiosity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use both sight, touch, and other ways to interact with displays</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use experiments that the users can do</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2 PRE-STUDY OF GAMES

The categories of games were: longer games / more complicated games, shorter tic-tac-toe games and recycle games (where you have to sort trash). The recycle-game category was included as this was one of the bigger categories of environmental games and the games usually had similar game functions were the participant had to put trash into the right bag. The other categories consisted of more related but not environmentally focused games. After trying the games, they were categorised after the perceived lesson. The categories were: focus on teaching context (what leads to what), functions explained (how does a solar cell work?), No perceived point (for example a picture slider of the earth), Tips for real-life games and random information (for example an endangered species quiz). This resulted in a matrix (see table 1) for the resulting matrix. Not all games are shown in the matrix, the reason behind that is that many of the games were similar, so only around 2 -3 games per
category were chosen for illustrative purposes. The games used in the pre-study were chosen because they were marked or described as an environment games in their descriptions.

Table 2 Pre-study matrix of games

<table>
<thead>
<tr>
<th></th>
<th>Focus on teaching Context</th>
<th>More simpler functions explained</th>
<th>No perceived teaching point</th>
<th>Tips for real-life games</th>
<th>Random information, not really connected</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longer Games</strong></td>
<td>BBC Climate challenge (BBC, N.D), Clim’way (Clim’way, n.d), NASAs Go Green (NASA.c, n.d)</td>
<td>Clim’way (Clim’way, n.d), NASAs Go Green (NASA.c, n.d)</td>
<td>-</td>
<td>-</td>
<td>NASAs Missions to planet earth (NASA, 2011),</td>
</tr>
<tr>
<td><strong>Shorter Tic-tac-toe</strong></td>
<td>-</td>
<td>NASAs Offset (NASA.e, n.d), NASAs Power up (NASA.f, n.d)</td>
<td>NASAs Bingo (NASA.b, n.d), NASAs Recycle this (NASA.g, n.d), WWFs Rad the Rhino (WWF.b, n.d)</td>
<td>NASAs Bingo (NASA.a, n.d)</td>
<td>WWF animal IQ (WWF.a, n.d), NASAs Climate trivia (NASA.b, n.d)</td>
</tr>
<tr>
<td><strong>Recycle games (sorting trash into cans)</strong></td>
<td>The adventures of Vermi the Worm (CalRecycle, 2000)</td>
<td>Recycle city (EPA, n.d),</td>
<td>Green Rank: Save our oceans (Gagos Green, LLC, 2016)</td>
<td>NASAs Page for nature games (NASA.d, n.d)</td>
<td>-</td>
</tr>
</tbody>
</table>

5.3 QUESTIONNAIRE RESULTS

In this part, the results from the questionnaire will be presented. The questionnaire was originally only intended to collect answers from teachers for the age-groups 10-15 but as other answers showed to be giving information relevant to the project other answers were included in the analysis. Questions 5, 6, 9 and 10-13 were analysed using descriptive statistics, and questions 7, 8 and 14 were analysed using a qualitative coding approach. The coding was done by first giving every different part of an answer a code, and then organising these codes into bigger categories or themes of answers.

Q5) What do you teach in?

As can be seen in figure 8 below one participant answered that they were still studying, 7 answered that they taught a mix or other subjects, 12 answered that they were scout leaders, 4 answered all subjects as they were teaching to younger students (usually between 7-12 years), 32 answered that they taught natural sciences and 2 that they taught social sciences.
Q6) In what part of Sweden do you teach?

As can be seen in figure 9 below the participants were teaching in different parts of Sweden, only parts of Sweden were participants were from will be mentioned in this analysis. 1 participant declined to answer, and there was one participant from Lapland, Gästrikland, Västmanland, Närke and Halland respectively. There were two participants from both Medelpad and Blekinge, there also were 3 participants from Södermanland, Östergötland and Gotland. 10 participants were from Västergötland, 14 from Skåne and 15 from Uppland (see figure 9 below).

Q7) In what way do you instruct children on how they can take care of the oceans, seas and rivers?

The answer to this question was analysed by coding and then grouping all the answers given by the participants. This led to ten themes: food chains, the circulation of water, eutrophication, plastics/micro-plastics, excursions, recycling, handling of chemicals, what can we do, mixed in with normal lectures, sustainability. Most of the groups turned out to be equally big, although the mixed
in with normal lectures group was the biggest. Also, the sustainability group was the only noticeably smaller group.

Q8) What do you see as the most important part, that you teach, of taking care of the oceans, seas and rivers?

The answers to this question were coded and then grouped, this gave eight themes: saving water, recycling/littering, how important the water is for us, the cycles of the water, sustainability and politics, how we influence, rebuilding/preventing, the effects of our consumption. The group sizes were mostly smaller and visually equally big, except for the “how we influence” group, which was about half of all the answers and so the biggest group.

Q9) Do you talk about: Littering, Micro-plastics, Effects of agriculture, eutrophication, overfishing, Environmental Protection (Conservation, protecting endangered species, National parks)?

1 participant (2%) did not answer, 3(5%) participants answered micro-plastics, 9(15%) answered taking care of nature, 13(22%) answered littering and 27(46%) answered all the above (See figure 10 below).

![Figure 10](image)

**Figure 10, Topics that they talk about**

Q10) How do you teach about this? Do you use books, games, exhibitions, walking out in the nature?

1(2%) participant reclined to answer, 2(3%) answered that they used games, 3(5%) participants wrote that they use discussions, 17(29%) participants answered all of the above and 17(29%) answered books, movies, lectures and documentaries and 19(32%) answered that they teach by going out into nature (see figure 11 below).
Q11) Do you usually visit Naturum (environmentally focused museums/exhibitions) when teaching about this theme? (yes/no)

16(27%) of the participants answered yes and 43(73%) answered no (see figure 12 below).

Q12) Do you discuss how a person’s lifestyle can affect oceans, seas and rivers, and how that can affect us? For example, strong alga blooming?

52(88%) of the participants answered that they talk about the impact that our lifestyle can have on the nature and 7(12%) answered that they did not teach about the impact of our lifestyle (see figure 13 below). Out of the once answering yes, 9(17%) were scout leaders and 43(82%) were some form of teacher. Out of the participants answering no 2(29%) were scout leaders and 5(71%) were some form of teacher or educator. There seemed to be no patterns in what kind of age-group they teach or what they teach and if they discuss the impact of our lifestyles on the oceans.
Q13) **Do you discuss what the students can do to contribute with taking care of the oceans, seas and rivers?**

When asked if they participants discussed what the students can do to contribute to change 47 (87%) out of 54 answered yes and 7 (13%) answered no (see figure 14 below).

Q14) **How do you talk about what effect climate change has on the oceans?**

The answers to this question were coded and then grouped this gave two different categories of themes: what they teach about and how the teach about it. The category about what they teach about consisted of 12 themes: the melting of the ice, algae, natural disasters, ice bears, the influence on the eco-system, how it all is connected, acidification of the oceans and seas, corals, water-levels, how we influence everything and the influence of politics. In this category, the group sizes varied a lot. The groups: ice, the influence on the eco-system, how all is connected and water levels were the
biggest groups and equally big. The remaining groups were somewhat small groups. In the category “how they teach about it” there were 4 themes: practical exercises, lectures or guiding, movies or in discussions. In this category, the groups were about equally big, the biggest groups were practical exercise and lectures or guiding.

Q15) Do you have any other thoughts?

A few people commented that they saw a need for more instructions to them as educators, better instructional movies and more short courses for educators. One comment spoke about the importance of informing but not frightening the youths. Others wrote about the importance of starting early with the information and that talking about personal responsibility is very important.

5.4 CONCEPT PHASE

The first part of the concept phase gave 11 different concept ideas (see appendix 11.1). These concept ideas were validated by noting down the perceived good and bad attributes that each concept idea might contribute. These attributes were then clustered to four categories: multimodal learning, connections, motivation and supporting learning (as shown in figure 2).

Table 3 Matrix of attributes

<table>
<thead>
<tr>
<th></th>
<th>Positive attributes</th>
<th>Negative attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multisensory learning</td>
<td>- Participate / interact physically in activities</td>
<td>- Is it necessary?</td>
</tr>
<tr>
<td></td>
<td>- To see the consequences of your actions all around you</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Not dependent on a special platform or tool</td>
<td></td>
</tr>
<tr>
<td>Connections</td>
<td>- The information is in a clear context</td>
<td>- To abstract, hard to understand</td>
</tr>
<tr>
<td></td>
<td>- Gives a deeper understanding of actions and consequences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Having to weight different alternatives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Easy to see and understand consequences and real-world problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Using empathy</td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>- Giving of a feeling that you’re a scientist</td>
<td>- Boring</td>
</tr>
<tr>
<td></td>
<td>- Fun</td>
<td>- Feeling fake</td>
</tr>
<tr>
<td></td>
<td>- Teamwork</td>
<td>- Scary</td>
</tr>
<tr>
<td></td>
<td>- Competition</td>
<td></td>
</tr>
<tr>
<td>Supporting learning</td>
<td>- Teaching to others</td>
<td>- Wrong age</td>
</tr>
<tr>
<td></td>
<td>- Searching for information by themselves</td>
<td>- Having to search for information by themselves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Everyone has to participate</td>
</tr>
</tbody>
</table>
5.5 Workshop

The questions before the workshop revealed that the participants had a good understanding of what eutrophication, overfishing and invasive species were. The reasons and mechanism behind these environmental damages were a bit more unclear for the participants. What caused eutrophication was especially unclear. The participants had also limited knowledge on how to prevent or repair these kinds of environmental damages, they did know that eutrophication may be counteracted with calcium carbonate. The participants mentioned that they thought that grown-up should take clearing for nature more seriously. The participants tested the prototype together in groups of four, this often led to a situation with one participant at each prototype and one participant watching. The group sizes were chosen by age and the participants showed great consideration and let everyone try the concepts. This also created a natural circulation where everyone got to try all the designs. The testing of the prototypes showed that the participants thought it was interesting that all the three prototypes were connected. It seemed to stimulate heighten participation and collaboration between the participants. They also thought it was interesting that one of the simulations was physical rather than digital. That one part of the design was physical also seemed to heighten collaboration, and the co-presence of other youths seemed to make even the very simple designs interesting. Haywood and Cairns (2005) described participation, co-presence and narration as three important parts of engagement. Both co-presence and participation were clearly present. The simple designs may have created a situation where the participants had to imagine how everything was linked together and so created narration for the participants. This enabled more than one person to play with it at a time. As the functions and effects of the different cards were hidden it made it into an explorative process to see what kind of effect the paper prototype had on the prototype with the seagrass. This also stimulated the participants to discuss what effects animals or plants can have on the seas to figure out the best combinations of farming to have clean water. The fishing simulation was the one game that seemed to be interesting to play on its own, and it seemed to make the participants care about not fishing up too many fishes. The group that was not told that the simulations were connected did not notice that by themselves, and had to be told that the simulations were connected. Over all the participants seemed to engage both emotionally and intellectually with the prototype. And they were able to connect the games with real life situations even without being prompted. Each of the prototypes seemed to be interesting together with the other designs. One group was not told that the designs were connected and they first thought that they should play one of the designs each. At this point the physical design was almost ignored. However, after being told that the designs were connected, the group started discussing more loudly and the physical design received a lot more attention.
6 Discussion

The discussion will discuss the pre-study, the questionnaire and interview, the concept creation and the workshop, in that order.

6.1 Pre-study

The matrix of environmentally themed games showed that there were some category combinations that were either not found and so included or did not exist. The two squares in the row of longer games (No perceived teaching point and Tips for real-life games) might have not been included as there might not be an interest in creating the games or tagging them as environmental games. Similarly, the empty square of recycle games and random information is not very surprising as they exclude each other. The square of shorter tic-tac-toe games and focusing on teaching context was interesting as it showed that one usually creates longer games to teach context, not shorter. This goes in-line with Gros (2014) writing about how learning games often are long. This might indicate that games focusing on bigger topics with a lot of context often require longer games. At the same time, this might be caused by the limited amount of games explored or that only digital games were tested. Another part of the pre-study was the visit to an interactive museum (Visualiseringscenter). There had been some discussions about visiting more similar exhibitions but because of time pressure and some geographical distances this was not done. Had this been done it would undoubtedly have influenced the concepts generating phase and maybe also the concept created.

6.2 Questionnaire and interview

Tourangeau, Conrad and Couper (2013) argue that if the questionnaire was internet based it may have excluded some teachers and educators that do not use the internet frequently or at all. They also write that some potential participants won’t answer questionnaires which may lead to a biased sample that does not reflect the world. In this questionnaire, the oldest participant was 58 in-fact there were eleven participants over 50 that answered the questionnaire. As the main retirement age in Sweden is 65 (Pensionsmyndigheten, 2017) it is not nearly the maximum age which goes in-line with Tourangeau’s, Conrad’s and Couper’s (2013) argument. Similarly, the medium age of participants was 37,88 years of age. But as there were some older participants they may have balanced the biases somewhat. Further it might be interesting to discuss the impact from the questionnaire participants working background on the answers in the questionnaire. This because more than 50% (32/59) participants answered that they were teachers in the natural science department (see Q5 in results). This of course should have had an impact on the questionnaire results. The questionnaire was also answered by 10 men and 49 women. This may have impacted the results but it is just a speculation. Also, the questionnaire may have overlooked some information that may have been interesting for the study. For example, in question 10, the participants were asked how they teach about the oceans. They were given alternatives such as movies, games, books and discussion. The question did not go deeper and ask what kind of games or books, which might have been interesting to know for the pre-study of games for example.

Also, the questionnaire had questions that may be interpreted in different ways such as question 11 where the participants were asked if they used to visit Naturum. The questionnaire was, before sending it out, read by a student studying to become a teacher. This student thought the questions were adequately formulated. In the interview with the educator it was said that many school classes visit their local Naturum to learn about the local nature. Therefore, the question was found to be adequately formulated.
The interview was conducted using guidelines from Howitt (b, 2010) and was a semi-structured interview. This gave a deep and informative interview. As the person being interviewed worked in educating youths in how to take care of the oceans the person had a lot of experience in teaching in this certain area. At the same time, this may have biased the interview. Nevertheless, this interview formed a very good and informative basis for the project.

### 6.3 Concept creation

In this study only two of the 20 categories defined by Korhonen, Montola and Arrasvuori (2009) were used (competition and fellowship). These two were chosen as the people discussing the concepts could not decide if the concepts were supposed to be used in group or alone. And they were also used mostly to categorise the designs, the framework that Korhonen, Montola and Arrasvuori (2009) created may else be used to inspire sketching to focus more on the experiences of the participants. To not use the playful experience categories more as an inspiration might have been an oversight, never the less it seems as if the last concept inspired collaboration and fellowship. There could also have been more of a focus on contacting the museum to collaborate and get more insights on what already is in place. There of course is the interview that gives an overview, but a participatory observation may have given interesting insights and inspirations.

### 6.4 Workshop

The workshop seemed to show that the youths did get engaged in the prototype and that they did care about the environment. This based on the framework by Haywood and Cairns (2005) that argues that important features of engagement are: if the youths participate, if they have to use their imagination (narrate) and if they have stimulation co-presence of others. As all the youths participated and seemed to enjoy the simulations it may be seen as participation, although arguably they all were participants in a workshop and it may so be questionable if they would do so in a museum. Nevertheless, they had to collaborate as their actions influenced the other games therefore, it can be said that there was co-presence. Similarly, as Whitton (2014) wrote, the very basic designs created a problem-based learning situation, where the participants had to use their imagination to understand the connections between the designs. This was done while discussing the design with others. It may of course be that they only reacted in a way they thought the workshop leaders wanted. But it may be argued that the youths had to reflect by themselves and create their own rules of how the simulations worked together. To control against this the youths were asked to be honest and say exactly what they thought about the designs. They were also asked to compare the different parts of the prototype (like the paper prototype and one of the digital once) against each other in the hope that this might make it feel more acceptable to take the designs apart that way. It might have been easier to discuss the designs if two of the simulations had not been almost finished digital games but paper prototypes. It might have stimulated to more discussion. At the same time, there was a paper prototype too and it was received very positively, the chance to interact directly with it giving the participants a different type of interaction. This goes in line with Ciolfi’s and Bannon’s (2009) study where exhibits with more “hands on” approaches were appreciated by the visitors. The workshop was done with two groups. One group with only boys and one group with two girls two boys. This mix was chosen as the first group consisted of youths in generally the same grade and the second group consisted of youths from some grades abode. There was a general difference noticed in the behaviour of the participants between the groups, which may be attributed to the general feeling in the group. The first group was more outwards engaged with the design, and they experimented more. The second group however, was much more subdued and took longer to try and experiment with the design. It may have been fruitful to try and get another
older group to test if the design was not as interesting for older youth or if it was the makeup in the group that made them quiet. It may also be a result from lack of interest in games in the group.

6.5 MEANING OF THE RESULTS

This section will start with a look at the results from the pre-study, followed by the workshop, first discussed via the values from the interview and then the workshop discussed via the attributes from the design-process.

6.5.1 Pre-study

As mentioned before the pre-study consisted of the games and the inspirational visit to Visualiserings Center. The results from this pre-study were used to inspire the concept process. The focus on games was also chosen as to not invent the wheel again, so to say, but to try to approach the task in an inform and inspired way. Therefore, it was chosen to look into what types of games seemed a bit more unusual, and to try to come up with concepts that may be a bit unusual. At the same time, these games might have been analysed in a totally different way if they had been analysed using a framework for analysing games. But just for inspiration it seemed enough for the project to keep them structured the way they were (see section 5.2). Also, it may be argued that there should have been a bigger focus on museums and nature centres such as Naturum and Visualiserings Center. More of these types of visits were discussed, as the inspiration and background seemed valuable but time and geographical restraints did not permit this.

Further the interviews were used to give some background information and to give an answer to one of the research questions. The interview with the educator gave background for the theme of taking care of the sea, and an understanding for the way in which they tried to teach it to the youths. The interview results were later structured into a format that looked at the values expressed during the interview (see section 5.1). This structure made it easy to go back and re-read the values for inspiration and structure in the concept creating process.

The questionnaire answers were interesting to the study as they showed how youths today get taught from other adults than just parents, how to take care of the oceans and much around this. Interesting here is for example how many of the answers showed that youths get told a lot about how our lifestyles impact the planet (see section 5.3 Q12) or what the students can do themselves to contribute to taking care of the ocean (see section 5.3 Q13). It may also be interesting to contemplate, for this project, that 88% of the participants answered that they did not take youths to the nature centers (Naturum). The questionnaire was mostly used for giving a background in themes and overall view on the theme. Over all, the responses were positive towards taking care of the oceans and made sure that the youths got to know the subject.

6.5.2 Workshop and values

The workshop was done to try out the prototype consisting of the three simple simulations. There was only one type of workshop made, on one of the concepts. The reason behind that was that there simply was no time to test another concept. At the same time, the concept tested built on the idea of one game or simulation consisting of many smaller simulations where participants can try the concept out together. This led to the simulations being simple because it let the participants experiment and try out the effects of their decisions. This could be seen as going in line with the functional values from the interview (see section 5.1, table 1) which taught them of the oceans, and made them think for them self’s, while experimenting. If used in a nature centre one might even reach the last functional value of giving information in different ways such as in text form or games. Moving on to the experiential values, the participants seemed to find the prototype entertaining, if it
created a learning experience may be debated as the participants all had a good understanding before the tests, and there was no indication that the knew more after the workshop. If or not the designs touched the participants emotionally may not be known, but the displays did wake the participants curiosity and used both sight and touch for interaction. And lastly it did let the participants experiment with the designs. The symbolic values were to try and teach of the oceans and to maybe use a type of animal to wake empathy. These were discussed and in an earlier version of the sea grass simulation there was only one fish called “Abby the Aborre”. In the end, this idea was not chosen and so the final design does not really use a character to try and evoke empathy. It does however try and teach about the oceans. The last value in the matrix is the cost value: avoid a doomsday feeling, end on a “this is what you can do” – note. This value was partly in the simulation, as it did not seem to give of a “doomsday feeling”, but all the “what you can do” things in the prototype were focused on agriculture and overfishing. It may give some sort of understanding. But if it really did give concrete advice on what in one’s lifestyle may be changed for the better of the oceans may be debatable.

6.5.3 Workshop and attributes
In the concept phase an array of positive and negative attributes were generated to inspire the concept generating phase. These concepts were categorised into four groups after what their perceived topic was; multisensory learning, connections, motivation and supporting learning. This was done entirely subjectively and only done for inspiration throughout the process.

Nevertheless, some of these values may be found in the final design. In the category “multisensory learning” there are the three positive attributes: participate / interact physically in activities, to see the consequences of your actions all around you and not dependent on a special platform or tool. The part of the prototype that was made from paper let the participants interact with it in a physical way, which may be seen as the first of the attributes. Also, the simulation with the seagrass may show the consequences of actions done in another simulation. Lastly the third attribute in multisensory learning concerned non-platform dependence, this may be interpreted as a physical prototype, or maybe a simulation they also may try on their phone. Therefore, depending on interpretation, the prototype may have been non-platform bound. Nevertheless, none of the simulations could easily be displayed on another platform, therefore making it very platform dependent. There also was a negative attribute to multisensory learning, the question “is it necessary?”. This question referred to designs which would work better as only digital or only physical. In the case of the prototype tested in this report the digital/physical nature of the prototype seemed to make it more engaging, and so in this case the mix of presenting ways seemed to be necessary.

The next category of the attributes was the connections category which refers to how they teach deeper contexts or connections between different information or things. There are five positive connections categories: the information is in a clear context, gives a deeper understanding of actions and consequences, having to weight different alternatives, easy to see and understand consequences and real-world problems and using empathy. It may be discussed if the prototype had the information in a clear context as the participants had to be told that the simulations were connected, at the same time point of each simulation seemed to be clear. The entire point of the design tested was to try and give a deeper understanding of actions and their consequences, and it seemed to have worked as it required some amount of trial and error experimenting. Similarly, the design required an amount of weighting alternatives against each other to understand the connections and so the designs seems to have incorporated these two attributes to an extent. It is hard to know how easy it is for the participants to relate the things learned or tested in the prototype to the real world. But it
was the goal to reach some level of information transfer to the real-world, for this reason all the
parts of the prototype were based on real-world problems and scenarios. It was chosen to not
explicitly try and create an empathy by for example using a character that the participants had to
save. Instead the prototype was a simulation, the reason was because of the timeframe did not allow
a creation of a real game. There was one negative connections attribute: to abstract or hard to
understand. Except for the fact that the different simulations were connected the designs seemed
not too hard to understand. So as long as there is something that tells the participants the different
simulations are connected it should not be a problem.

In the motivations category, there were four positive attributes: giving of a feeling that you are a
scientist, fun, teamwork and competition. The scientist feeling could, especially in exhibitions and
similar, be heightened by letting participants wear lab-coats and lab-goggles. Else, as the design
required the participants to experiment a little, it may already give a feeling of exploration. The
design was also somewhat limited in the amount of actions, but for a shorter period it may be
entertaining and even fun. The participants seemed most engaged when experimenting and trying to
figure out how the designs were connected together with others. So, the design promoted
teamwork, it did however have any parts focused on competition. The motivation category also
has three negative attributes: boring, feeling fake and scary. The design may very well be seen as
boring if one is trying to explore it by themselves. It also may not be fun to play for longer stretches
of time or after the connections are figured out. But for a shorter period of time with a group it may
be engaging and fun. None of the participants said anything about the design feeling fake, but that
does not mean they did not think it. At this point, there is no way to know if the design seemed fake
to the participants. However, the design really did not seem to be perceived as scary.

The last category was the “supporting learning” category with the two positive attributes: Teaching
to others and searching for information by themselves. The teaching to others - attribute may have
happened while they were trying to figure out the connections between the simulations together.
The participants knowing more about the problem in real-life may have told the others or suggested
a solution. As there was nothing to read up on, on the themes, there was no real searching of
information going on, but if this is used in a museum or nature centre there may also be situations
where people can search for information by themselves.

Supporting learning also had three negative attributes: wrong age, having to search for information
by themselves and everyone has to participate. The wrong age attribute refers to when the design is
not interesting for a participant or group as it is aimed at another age group. This design seemed to
work well for the participants although it worked better for the first group, which may be because of
the makeup of the group but also may be because they were younger. As mentioned before the
design did not include situations where the participants had to search for information, so the design
and the situations the design used were clear enough without googling the answers. The last
negative attribute “everyone has to participate” may very well be a critique to the design tested in
this report. It is probably much harder to explore the design fully if one is alone.
7 Conclusions

The research questions were “1) How can one make a “taking care of the oceans” themed design that engages youths and 2) and what qualities in the design can influence the engagement?”.

7.1 How can one make a “taking care of the oceans” themed design that engages youths and 2) what qualities in the design can influence the engagement?”

The first part-question was answered by the design process and the resulting design that was based on both literature and the pre-studies. The design seemed to be perceived as engaging by the participants (for a discussion on if the designs was engaging see section 6.4) and so the process seemed to have created an engaging design. The approach to use a design where the participants have to work together and use their understanding of how the world works to explore the situation, seemed to create an engaging experience. Whether this may be used for an entire exhibition or just a part of an exhibition has to be tested. But as the design requires more than one participant to interact with it at the same time, it may be confusing to make an entire exhibition like this as it will be much harder to discern what effect one action has. Interesting to note is that the design, as it was three on their own non-interesting simulations, was engaging. This may be because of the teamwork that was created by having the task of testing the design. It may also be because of how the simulations worked together and simulated a more complex simulation which they were able to explore. The exploration factor, may of course be an interesting and engaging element in the design.

And to answer the second part-question there seemed to be engagement from the participants with the design. This was very interesting as the different parts of the design were not very interesting games or simulations on their own. However, it seemed to be interesting for the participants to explore how these games or simulations worked together. It may be that all the parts of the prototype together with a situation that required teamwork created an interesting situation. For the qualities in the design the prototype was discussed using the positive and negative attributes from the concept generation process and the values from the interview. This was done to see if the attributes and values were in the design and to evaluate the designs via them. Many of the attributes and values seemed to exist in the design, this does not mean that these values or attributes are general for design, they are only important for this work. But as the values came from an educator on the subject they seemed a good way to evaluate the design. The attributes where chosen to be used in the evaluation as they were previously found in ideas to do with the subject and so were deemed relevant to the design. This proved to be an interesting way of evaluating a design, as it required some reflection on the design. There were some unexplored or improvable parts of the design found for the future.
8 PROPOSITIONS FOR A REDESIGN AND FUTURE STUDIES

The design let participants test things out and play side by side, together and alone. This was a somewhat interesting concept. It sprung from the idea that a class or every person could have their very own earth on their phone and then with help of the nature centres change some parameters and watch the changes. A kind of mini-earth that people could take care of and take with them back home to watch for long-time effect, a tool for schools to teach the youths how everything affected each other. This lead to the idea of a few minigames or simulations that influence one simulation or game. This end-concept will here get some propositions for change, starting with some general thoughts and then a suggestion to extensions.

8.1 GENERAL
One proposed change was to make the seagrass eating fish – simulation just a simulation where one does not have to steer the fishes. This to make it clearer that the simulation was influenced by the other simulations and so make it more intuitive that all the simulations work together. It might also be good to consider if competition (everyone has their own pond) might lead to similar enthusiasm and learning, more or if it works better with collaboration.

8.2 EXTENSIONS
It proposed by the participants that a simulation about the impact of recycling / littering might fit in well with the other simulations. The idea behind this design was to let the youths develop their own recycling system by labelling digital trash barrels and putting example trash in them. As an aid, it was planned to give them a booklet with the classical recycling groupings. Depending on if the youths recycled in a good way it would either hinder or help in the main simulation. The main thought with this idea was to let the youth experiment and in a creative way explore how recycling works and what it results in. If this idea can create a form of active experimental participation than it goes in line with the findings by Hornecker and Stifter (2006) that active participation or hands on situations are more engaging.

8.3 FUTURE STUDIES
An interesting question may be to look at how an entire exhibition may work together in such a way that a group of three to five people may explore it together. This may be a challenge as the entire exhibition somehow needs to have an impact on a simulation or game but it may be very hard to know how everything works together if all the simulations or games in an exhibition influence the same simulation or game simulations.

It may also be interesting to look at if three active games or simulations may be enough or if more or less simulations or games might work better or worse together. It might be better not to have to many active displays that influence one simulation. Nevertheless, it might be useful to explore what number of displays is enough displays. There might be theories in teamwork and group dynamic research that explore similar situations. Also, how does this get influenced by if the displays are digital or physical or mixed? This may be done by trying different combinations of designs and different number of designs, and maybe different numbers of participants.

How could groups compete against other groups? This was something that came up in the discussion of the workshop via the attributes. Is there a way to let the design allow for competition?
For example, for smaller groups to compete against each other? And will that be more or less engaging then without competition?

Could or how could an exhibition with these types of exhibits, which require teamwork, be used of an entire class instead of a smaller group. Is there some way to let them take something back? For example, a way to see how the seagrass simulation continues to live or die when left alone in the way they did the settings?
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### 10.1 References Games


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11 APPENDIX

11.1 QUESTIONNAIRE

Hej, Tack du vill svara på den här enkäten. Dina svar kommer vara anonyma, varken jag eller någon annan kommer kunna länka svara till dig, svaren kommer användas i mitt masterprojekt. Målet med denna enkät är att ta reda på hur barn och ungdomar i mellan och högstadiet undervisas i hur de kan bidra med att ta hand om miljön och specifikt haven.

Hello, thank you for answering this questionnaire. Your answers will be anonymous, neither me nor anybody else will be able to link the answers to you, the answers will be used in my masters thesis. The goal with this questionnaire is to explore how children and youths, in the ages between 10 and 16, are educated about how they can contribute in taking care of the environment and specifically the oceans.

Q1) Hur gammal är du? / How old are you?
Q2) Är du kvinna eller man? (kvinnan, man, annat) / Are you a woman or a man? (woman, man, other)
Q3) Vad arbetar du som? Med vilken åldersgrupp? / What do you work with? What age group?
Q4) Hur länge har du arbetat med barn? (1-10, 10-20, 20 – ,studerar fortfarande)/ How long have you been working with children(1-10, 10-20, 20- , still studying)?
Q5) Vad undervisar du i? / What do you teach in?
Q6) I vilken del av sverige undervisar du i? / in what part of Sweden do you teach?
Q7) På vilket sätt tar du i din undervisning upp hur man kan ta hand om vattendrag, sjöar och hav? / In what way is teaching children how they can take care of the oceans, seas and rivers part of your instruction?
Q8) Vad anser du är det viktigaste att lära ut om hur man kan ta hand om hav, sjöar och vattendrag? / What do you see as the most important part, that you teach, of taking care of the oceans, seas and rivers?
Q10) Hur lär du ut om detta? Använder ni Böcker, spel, utställningar, går ni ut i naturen? /How do you teach about this? Do you use books, games, exhibitions, walking out in the nature?
Q11) Brukar ni besöka Naturum i samband med detta tema? (ja/nej) / Do you usually visit Naturum (environmentally focused museums/exhibitions) when teaching about this theme? (yes/no)
Q12) Tar ni upp hur våran livsstil påverkar hav, sjöar och vattendrag och vad det har för effekt på oss? Till exempel kraftiga algblomningar? /Do you discuss how a person’s lifestyle can affect oceans, seas and rivers, and how that can affect us? For example: strong alga blooming?
Q13) Tar du upp vad eleverna kan bidra med för att ta hand om hav, sjöar och vattendrag? / Do you discuss what the students can do to contribute with taking care of the oceans, seas and rivers?
Q14) *Hur talar ni om vilken inverkan klimatförändringar har på haven?* / How do you talk about what effect climate change has on the oceans?

Q15) *Har du några andra tankar?* / Do you have any other thoughts?